Texas City Multi-Hazard Mitigation Plan

2019

"Under the Federal Disaster Mitigation Act of 2000 (DMA 2000 or "the Act"), Texas City (City) is required to have a Federal Emergency Management Agency ("FEMA") - approved Local Hazard Mitigation Plan ("the Plan") in order to be eligible for certain pre- and post-disaster mitigation funds. Adoption of this Plan by the City and approval by FEMA will serve the dual objectives of providing direction and guidance on implementing hazard mitigation in the City, and qualify the City to obtain federal assistance for hazard mitigation. Solely to help achieve these objectives, the Plan attempts to systematically identify and address hazards that can affect the City. Nothing in this Plan is intended to be an admission, either expressed or implied, by or on behalf of the City, of any City obligation, responsibility, duty, fault or liability for any particular hazard or hazardous condition, and no such City obligation, responsibility, duty, fault or liability should be inferred or implied from the Plan, except where expressly stated."

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1.0 Introduction and Background

1.1 Participating Jurisdictions

The City of Texas City has prepared a single-jurisdiction Multi-Hazard Mitigation Plan.

1.2 Hazard Mitigation Plan History

Texas City has not participated in previous mitigation planning efforts.

Texas City will address the following natural hazards: Hurricane / Tropical Storm, Flood, Extreme Heat, Tornado, Windstorm, Hailstorm, Lightning, Severe Winter Weather, Drought, Wildland Fire, Expansive Soils, and Dam and Levee Failure.

Omission Statement

The local planning team determined that coastal erosion, earthquake, and land subsidence have had limited, if any, previous impact in Texas City. Those hazards' likely impacts during the planning period have been determined to be negligible, and they are unlikely to need mitigation during the planning period.

Although some areas within Galveston County are vulnerable to coastal erosion, Texas City's vulnerability to that hazard is limited by the city's extensive levy system, so it won't be addressing that hazard.

Similarly, Texas City's vulnerability to land subsidence is minimal because the jurisdiction relies on surface water, rather than ground water. Ground water usage is the primary cause of land subsidence in the greater Houston-Galveston metropolitan area.

2.0 Planning Process

Texas City's Multi-Hazard Mitigation Plan is a single jurisdiction plan. Planning team members represented the following offices and departments:

Table 1: Local Planning Team Representatives

Title	Department
Emergency Management Coordinator	Emergency Management
Director	Public Works
Director	Community Development
Executive Director	Management Services
City Engineer	Engineering and Planning

Once the planning team was established, members developed a schedule with specific goals and proposed meeting dates over the planning period.

Hazard mitigation planning team (HMPT) members contributed to the following activities throughout the planning process:

1. Providing technical assistance and necessary data to the HMPT.
2. Scheduling, coordinating, and facilitating community meetings.
3. Providing necessary materials for public planning meetings.
4. Collecting and analyzing data.
5. Developing mitigation goals and implementation strategies.
6. Preparing the first draft of the plan and providing technical writing assistance for review, editing, and formatting.

Each member of the HMPT participated in the following activities associated with development of the plan:

1. Identifying, contacting, coordinating, and implementing input from stakeholders.
2. Attending, conferencing in, or providing meeting support and information for regular HMPT meetings.
3. Identifying hazards and estimating potential losses from future hazard events.
4. Developing and prioritizing mitigation actions to address identified risks.
5. Coordinating public meetings to develop the plan.
6. Identifying community resources available to support planning effort.
7. Submitting proposed plan to all appropriate departments for review and comment, and working with the city to incorporate the resulting comments into the proposed plan.

Table 2: Plan Schedule

Tasks	Proposed Timeline						
	December	January	February	March	April	May	June
Organize Resources and Identify Planning Team							
Create Outreach Strategy							
Review Community Capabilities							
Conduct Risk Assessment							
Identify Mitigation Goals and Actions							
Develop Action Plan for Implementation							
Identify Plan Maintenance Procedures							
Review Final Draft							
Submit Plan to State and FEMA							
Adopt Plan							3/20/19

Meetings							
Local Contact							
Planning Team							
Public Outreach							
Stakeholder Outreach							

2.1 Existing Plans, Reports, and Technical Information Sources

Each planning team member worked to collect and provide the input and information necessary to develop the hazard mitigation strategy. Research was coordinated and conducted by local planning team members. The local planning team reviewed the following documents during the planning process:

Table 3: Planning Team Data Sources

Data Source	Data Incorporation	Purpose
City of Texas City Flood Damage Prevention Ordinance	Flood damage prevention building requirements	Identifying building requirements and restrictions for structures in the floodplain
City of Texas City Building Regulations; Construction Ordinance	Housing standards requirements and restrictions	Identifying existing basic minimum housing standards and potential opportunities to further reduce vulnerability
City of Texas City Subdivision Ordinance	Subdivision requirements and restrictions	Identifying development restrictions to limit future hazard exposure
City of Texas City Vision 2020 Comprehensive Plan	Desired development types and locations	Identifying existing goals and desired outcomes that are relevant to or may be complemented by mitigation actions
City of Texas City Water Conservation and Drought Contingency Plan	Drought Stages and water restrictions	Review the measures already being taken to address the drought hazard and opportunities for additional measures
City of Texas City Zoning Ordinance	Zoning requirements and restrictions	Identifying zone locations and restrictions to limit future hazard exposure
Federal Emergency Management Agency (FEMA) Special Flood Hazard Areas	Flood zone maps	GIS mapping of flood zones
Galveston County Multi-Jurisdictional Hazard Mitigation Plan	County-wide planning approach, hazards addressed, and mitigation actions	County-wide planning team representatives and stakeholders, plan maintenance, hazard histories, and mitigation actions
National Centers for Environmental Information (NCEI)	Hazard occurrences	Previous event occurrences, damage dollars, and mapping for all hazards
National Flood Insurance Program	NFIP Policy and Loss Data	Identifying NFIP policies in force, paid losses, and repetitive and severe repetitive loss property data.
National Inventory of Dams	Dam information	High-hazard dam list
State of Texas Hazard Mitigation Plan 2013 Update	Hazard Descriptions	Official descriptions of hazards and their potential impacts

Texas Forest Service-Texas Wildfire Risk Assessment Summary Report	Wildfire Threat and Urban Interface	Mapping and wildfire vulnerability data
Texas State Data Center	Population and demographics	Population counts, parcel data, and land use data
United States Census Data	Population and demographics	Population counts, Average Household Income, Average Household Size

Additional information sources included: USDA Census of Agriculture, United States Geological Survey, Vaisala, and specific details about previous natural hazard events from planning team participants. Sources are noted throughout the document. Report titles and links to the most recently accessed websites hosting the related information are also noted, where appropriate.

Area stakeholders contacted to participate in the planning process included the following offices and departments within neighboring jurisdictions. In many cases of non-participation, the title listed is reflective of the office the planning team tried to contact:

Table 4: Local Stakeholders Contacted

Stakeholder	Title	Participated
Bayou Vista	Police Chief	N
Clear Lake Shores	Emergency Management Coordinator	N
Galveston County	Emergency Management Coordinator	N
Friendswood	Emergency Management Coordinator	N
Hitchcock	Emergency Management Coordinator	N
Jamaica Beach	Emergency Management Coordinator	N
Kemah	Emergency Management Coordinator	N
La Marque	Emergency Management Coordinator	N
League City	Emergency Management Coordinator	N
Santa Fe	Emergency Management Coordinator	N
Tiki Island	Emergency Management Coordinator	N

Area stakeholders were contacted by phone and email. In an effort to increase participation, each stakeholder was contacted at least twice. Area stakeholders who chose to participate provided important supplemental input and information that helped shape mitigation strategies for each hazard, in particular by making the planning team aware of hazard areas that had not been previously identified.

2.2 Project Meetings

The planning team met in December 2017 to come up with a plan to produce an annex to the Galveston County plan on an accelerated timeline. Planning team members primarily communicated by phone and email throughout the planning process.

During the December meeting, the planning team decided which hazards needed to be addressed in the mitigation plan and which were not relevant. To make these decisions, the planning team reviewed NCEI data, as well as the Galveston County plan, to identify previous occurrences of each hazard, associated deaths and injuries, and total dollar damages. Texas City's Emergency Manager provided additional knowledge and input to help the planning team's decision making process.

The team agreed to use the collected hazard data and the Galveston County plan as the foundation for Texas City's hazard risk assessment.

At the end of the meeting, planning team members agreed to compile relevant data, including city ordinances, and identify critical facilities and local stakeholders, and produce any required maps.

To facilitate an expedited process, planning team members agreed that email and phone calls would allow the process to move forward at the quickest possible pace, rather than try to schedule additional meetings.

2.3 Public Input

In an effort to provide an open process and collect any missing information related to hazard history, vulnerability, and impact, members of the public were given two weeklong opportunities to review and provide input on the in-progress plan draft.

Texas City posted copies of the plan draft in the local library and announced the public review and comment period on its website and through its social media accounts. The first draft was posted on Monday, June 4, 2018. The second draft was posted on Monday June 18, 2018.

Texas City did not receive any comments or input.

2.4 Plan Maintenance Procedures

Texas City will implement the strategies outlined within this plan and update and maintain the plan according to the guidelines below. Texas City will use the plan's goals, as well as continued analysis of hazard risks and capabilities, to weigh the available resources against the costs and benefits for each mitigation action. Texas City understands the value of this plan and its positive impact on mitigating hazards, and it intends to continue updating this plan and implementing the plan's strategies.

The methods of keeping this plan current are monitoring, evaluating and updating the plan. FEMA defines these the following way[1]

Monitoring: Tracking the implementation of the plan over time.

Evaluating: Assessing the effectiveness of the plan at achieving its stated purpose and goals.

Updating: Reviewing and revising the plan at least once every five years.

Incorporation

Texas City will be responsible for further development and/or implementation of its mitigation action plan. This process will be overseen by the City of Texas City Emergency Manager. The following describes the process by which the City will incorporate elements of the mitigation plan.

Process of Incorporation

Once the plan is adopted, Texas City will implement actions based on priority and the availability of funding. The City of Texas City already implements policies and programs to reduce losses to life and property from hazards as described in the Capability Assessment found in Section 16. The mitigation actions developed for this plan build upon that effort and will be implemented through other program mechanisms where possible.

Texas City will integrate implementation of its mitigation actions with other existing plans including those outlined in Table 3 above, as well as any future plans. They City will also participate in local and statewide studies, workshops, and committees that address hazards prone to affect Galveston County, to ensure mitigation concepts are included where applicable, and to increase awareness and further reduce or eliminate future impacts from hazards. Texas City's Emergency Manager will provide a copy of this plan to the local Mayor and/or applicable officials and assist in identifying key

[1] Local Mitigation Planning Handbook, FEMA March 2013.p.7-1

elements from this plan for incorporation into the plan updates, development/update of regulations and ordinances, and annual budgets.

Texas City will review its existing plans noted in Table 3 above in light of its mitigation plan, and it will incorporate any mitigation policies and actions into these plans, as appropriate. The City will ensure the actions in the mitigation plan are reflected in other planning efforts and advance mitigation strategies in Texas City.

Upon formal adoption of the updated plan, the Emergency Manager will coordinate with officials (Mayor and appropriate department heads) to integrate the updated hazard mitigation strategies into existing plans as indicated in Table 5 below.

Table 5: Process of Incorporation by Planning Mechanism

Planning Mechanism	Plan Incorporation
Grant Applications	The Emergency Manager will consult the plan whenever FEMA mitigation grant funding is sought for mitigation projects. If a project is not in the plan, an amendment may be necessary to include the action in the plan. There is no specific timeline for applying for grants. The Emergency Manager will inform the Mayor and/or applicable officials about upcoming funding opportunities to assess priorities and determine whether or not an application is feasible and/or desired.
Annual Budget Review	The City of Texas City will review the plan and mitigation actions therein when conducting its annual budget review with the Mayor and/or applicable officials. Allowances will be made in accordance with grant applications sought or mitigation actions that will be undertaken according to the implementation schedule of the specific action.

Regulatory Plans	The City of Texas City has various regulatory plans in place. Texas City will consult the mitigation plan when it reviews or revises its current regulatory planning mechanisms, and/or when it develops regulatory plans that are not currently in place. These regulatory plans should be reviewed annually by the Emergency Manager to ensure provisions are made to incorporate procedures for hazards of concern. The Emergency Manager will coordinate reviews of the regulatory plans with the Mayor and/or applicable officials.
Comprehensive Plans	Texas City has developed multiple comprehensive plans over the last 25 years. Comprehensive plans involve developing a unified vision for a community. Texas City's mitigation vision and goals will be informed by the City's comprehensive plan, as well as by revisions to the existing plan or the development of a new one. Texas City's comprehensive plan(s) will be reviewed every five years in conjunction with this plan.
Floodplain Management Plans	Floodplain management plans include preventative and corrective actions to address the flood hazard. Texas City developed mitigation actions to address vulnerabilities to inland and coastal flooding. Therefore the actions for flooding, and information found in Section 5 of this plan discussing the people and property at risk to flood, will be reviewed and/or revised when Texas City updates its Flood Damage Prevention Ordinance or develops a new one. The Emergency Manager will coordinate the review of the ordinance with the appropriate local officials to determine if an update is warranted. The flood damage prevention ordinance should be reviewed every five years in conjunction with the hazard mitigation plan update.

Monitoring

The City of Texas City's Emergency Manager is responsible for ensuring the plan is monitored for effectiveness. When necessary, the Emergency Manager will collect information to update the plan. The Emergency Manager is responsible for the plan's general upkeep and oversight as it relates to compliance with the hazard mitigation grant program requirements, all files, and necessary documentation, as well as conducting routine plan reviews. The City of Texas City's Emergency Manager will be responsible for coordinating the administrative decisions and plan integration with future planning initiatives with the appropriate local officials.

Texas City will independently implement its own jurisdiction-specific mitigation actions. Each mitigation action in this plan is prioritized and assigned to a specific department for implementation when opportunities and funding become available. Estimated timelines are given for each mitigation action where appropriate.

The role of the Emergency Manager includes the following tasks:

Schedule, at a minimum, a biannual meeting with the planning team;

Develop meeting agendas;

Invite other agencies/departments to participate in meetings;

Schedule post-disaster event meetings with the planning team for federally and/or state-declared disasters if significant damage was sustained or the hazard disclosed vulnerabilities within the planning area that need to be addressed;

Coordinate updates to the public when applicable (this may include but is not limited to plan amendments, completion of mitigation actions, notification of programs available to the public for mitigation, etc.).

During annual meetings, the planning team will address any issues that may have occurred since the last plan update, assess events impacting the planning area to determine if changes in the plan are required, and complete the evaluation and project implementation worksheets for documentation purposes.

If significant changes, updates, or amendments to the plan are suggested by the planning team, they will inform TDEM's Mitigation Section to determine the appropriate action that should be taken.

Evaluation

The Emergency Manager and the members of the planning team will use a Plan Evaluation Checklist provided to evaluate this plan and make recommendations for future plan updates and enhancements. The worksheet will be completed annually.

The Plan Evaluation Checklist includes the following components:

Evaluate the goals and objectives ensuring they address current and expected conditions;

Determine any changes in the nature or magnitude of risks identified in the plan;

Evaluate current resources for adequacy in implementing the plan;

Document any implementation problems with other agencies, including technical, political, legal or coordination issues;

Evaluate the effectiveness of the planning team;

Evaluate the effectiveness of local capabilities.

Updating

At any time, minor technical changes may be made to the plan to keep it updated. However, any material changes to the mitigation actions or major changes in the overall direction of the plan or the policies contained within it must undergo an open public process. The City of Texas City will seek public input on any material change to the plan during a formal review and comment period.

At the end of the comment period, the proposed amendment and all comments will be forwarded to the local planning team. If no comments are received within the specified review period, this will also be noted. The planning team will then review the proposed amendment and comments received and vote to accept, reject, or amend the proposed change. Upon ratification, the amendment will be transmitted to TDEM.

In determining whether to recommend approval or denial of a plan amendment request, the following factors will be considered:

Errors or omissions made in the identification of issues or needs during the preparation of the plan;

New issues or needs that were not adequately addressed in the plan; and

Changes in information, data, or assumptions from those on which the plan was based.

Five Year Review

The plan will be thoroughly reviewed by the local planning team every five years to determine whether there have been any significant changes in the area that may necessitate changes in the types of mitigation actions proposed.

As with the development of this plan, Texas City's Emergency Manager will oversee the review process.

New development in identified hazard areas, an increased exposure to hazards, disaster declarations, the increase or decrease in capability to address hazards, and changes in federal or state legislation are examples of factors that may affect the content of the updated plan.

The plan review provides Texas City with an opportunity to evaluate which actions have been successful and to explore documenting potential losses avoided due to the implementation of specific mitigation measures. The plan review also provides the opportunity to address mitigation actions that may not have been successfully implemented as assigned.

Following the five-year review, any revisions deemed necessary will be summarized and utilized according to the reporting procedures and plan amendment process outlined herein. Upon completion of the review and update/amendment process, the revised plan will be submitted to TDEM for final review and approval in coordination with FEMA.

2.5 Continued Public Involvement

Input from the public will be essential as the plan grows and changes. As noted above, a significant change to this plan will require opportunities for the public to make its views known. Recommendations for continued public involvement are also included as mitigation actions for public education and awareness campaigns.

Copies of the mitigation plan also will be kept for public review at City Hall.

Further, if necessary, the City can designate voluntary citizens or willing members of the private sectors as members of the Planning Team as well as utilize local media to notify the public of any maintenance or periodic review activities taking place.

3.0 Determining Risk

3.1 Risk Assessment

Throughout the plan, each hazard addressed will be considered in light of its history, likelihood of future events, extent, jurisdictional vulnerability, location and impact.

Likelihood of Future Events is measured based on a hazard's expected frequency of occurrence in light of its previous frequency. Each hazard's likelihood of future events will be considered using the following standardized parameters:

- **Highly likely** – event probable in the next year
- **Likely** – event probable in the next three years
- **Occasional** – event possible in the next five years
- **Unlikely** – event possible in the next 10 years

Given this plan's five-year duration, hazards likely to occur during that period will be given priority when selecting and prioritizing mitigation actions.

3.2 Distribution of Property by Parcel Count and Potential Damage Values

Table 6: Parcel County and Estimated Potential Damage Value in Texas City

Jurisdiction	Parcel Count	Estimated Potential Damage Value
City of Texas City	20,330	$4,286,398,656[2]

3.3 Distribution of Vulnerable Populations

The planning team identified a set of indicators it could use to identify each jurisdiction's vulnerable population. The indicators include demographic data like age and income, as well as geographic data including the location of low income or subsidized housing units, concentrations of manufactured and mobile homes, and concentrations of homes in substandard condition.

[2] Galveston County 2015 CAD Data

Age and Income

The populations of each jurisdiction were broken down into three categories: young residents, elderly residents, and low income residents. Residents falling into these categories were deemed most likely to suffer disproportionate losses due to natural hazards because of their potentially limited means to prepare for and recover from a hazard event.

Table 7: Vulnerable Populations in Texas City

Jurisdiction	Estimated Vulnerable Population Totals		
	Young[3]	Elderly[4]	Extremely Low Income (≤ $25,000 Annually)[5]
City of Texas City	9,811	5,796	12,780

In addition to identifying vulnerable population categories, the planning team worked to identify specific locations that are likely home to high concentrations of vulnerable residents.

[3] Table S1401, 2012-2016 ACS, nursery school through high school totals, unless otherwise noted.
[4] Table DP-1, 2010 Census, used to estimate current 65+ population
[5] https://www.huduser.gov/portal/datasets/il/il2017/2017summary.odn - Family of 4 income ≤ $24,600 – For clarity and approximate alignment with ACS data rounded to nearest $1,000. Household size selected as best approximation of average household size throughout Galveston County.
Households per jurisdiction from Table S1901, 2012-2016 ACS. Average household size from Table B25010, 2012-2016 ACS – City of Texas City 2.75.

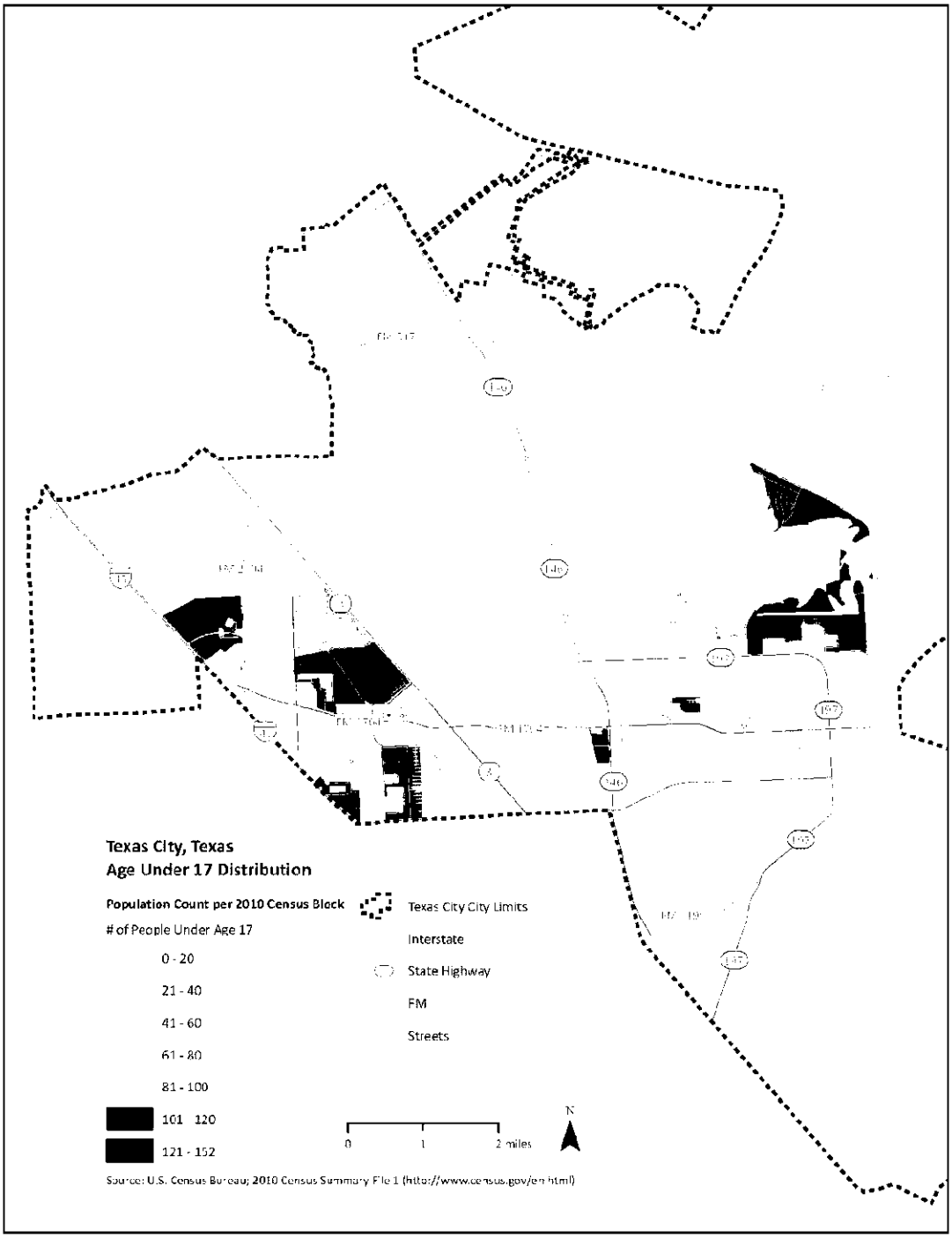


Figure 1: City of Texas City Age Distribution by Census Blockgroup, Under 17

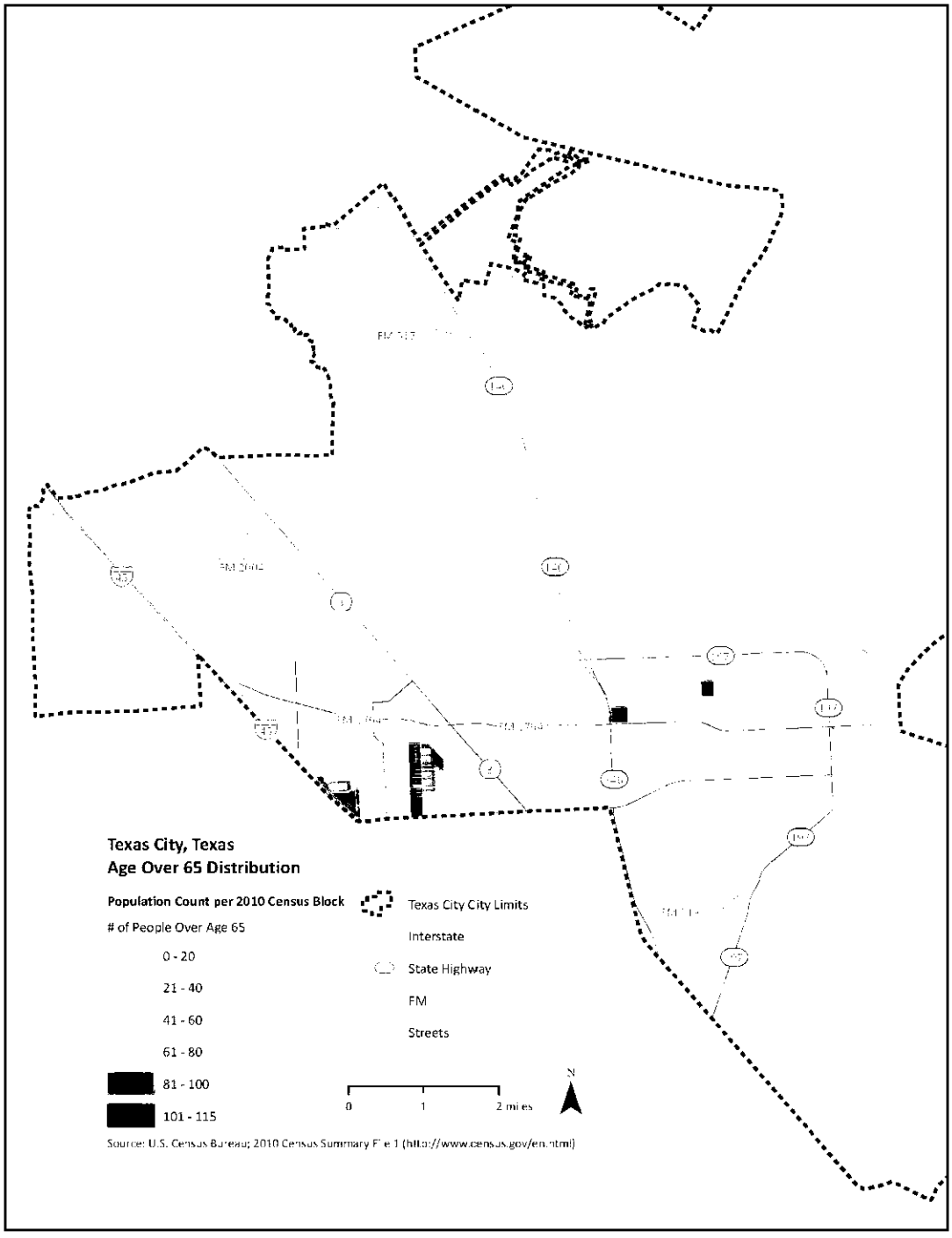


Figure 2: City of Texas City Age Distribution by Census Block Group, 65+

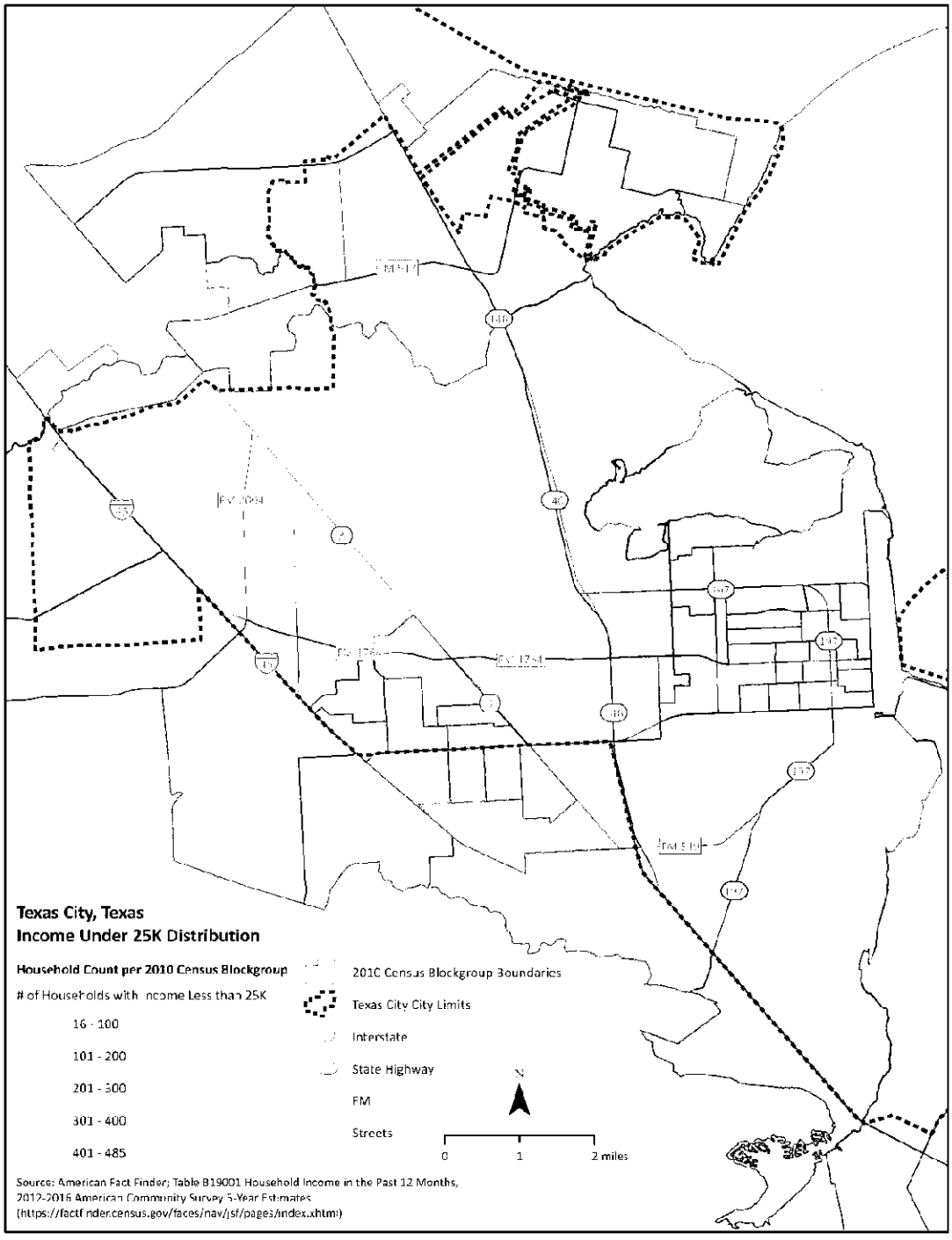


Figure 3: City of Texas City Low Income Household Distribution by Census Blockgroup

Low Income and Subsidized Housing

Residents of low-income housing and/or subsidized housing facilities are expected to suffer disproportionate losses due to natural hazards because of their potentially limited means to prepare for and recover from a hazard event.

The Texas City Housing Authority is the primary purveyor of low income and subsidized housing in the City of Texas City.

There are seven low income housing apartment complexes in the City. These complexes contain 918 affordable apartments. Roughly 175 units have rent based on income. Of those, 74 are public housing units operated directly by the Texas City Housing Authority.

An additional roughly 800 apartments aren't subsidized but are considered affordable for low income families.

Affordable apartment complexes include:

- Colonial Park Apartments
- Green Meadows Apartments
- Heritage Square Apartments
- Mansion at Moses Lake
- The Oaks at Blue Jay Drive

Housing Type and Condition

Texas City used housing type and housing conditions to identify additional vulnerable areas and concentrations of vulnerable residents.

A. Manufactured / Mobile Homes

In particular, Texas City identified areas with concentrations of mobile/manufactured housing as being disproportionately vulnerable to certain hazards including but not limited to: hurricanes and tropical storms, floods, tornados, droughts, and windstorms.

Mobile and manufactured homes can be found throughout Texas City. There are at least three mobile home communities in the City of Texas City:

- Coastal Housing Company Mobile Home Park
- Holiday Mobile Home Park
- Sunset Harbor Mobile Home Park.

Each contains between 15 and 60 manufactured and/or mobile homes. Recreational vehicles may also be present at each.

B. Homes in Substandard Condition

Texas City determined that homes in sub-standard condition, regardless of structure type, may indicate that residents are low-income or otherwise means-limited and thus more vulnerable to certain hazards.

To be considered standard condition, a home must show few or no minor visible exterior defects such as:

- cracked, peeling, or missing paint
- cracked, sagging, rotting, or missing siding, steps, porch planks, or other wooden surfaces
- cracked or broken window panes
- cracked masonry, brick, or mortar surfaces
- missing or damaged roof shingles
- small rust spots on mobile homes

The home must generally meet building codes, and there can't be any detriment to health and safety present.

Structures in sub-standard condition may provide less protection to residents during certain hazard events like tropical storms, tornados, or hurricanes. Furthermore, because they're already in a state of disrepair, additional damages due to hazard events may compound existing ones and potentially make these homes uninhabitable.

4.0 Hurricane/Tropical Storm

4.1 Description

Hurricanes, coastal storms and the associated wind and storm surge cause the most severe, common and geographically extensive impact on the Texas City planning area of any natural hazard.

Hurricanes and tropical storms are naturally occurring events that produce damaging high winds, generate dangerous storm surge flooding, cause pounding storm surf, spawn tornados, and produce torrential rainfall that can cause inland flooding.

On a recurring basis, hurricanes are the strongest natural hazard threat to human life and property. Tropical storms and hurricanes threaten the Texas City planning area with high winds, rain, and storm surge. Texas City participates with local media in educating the public about the dangers of hurricanes. Due to the size of hurricanes and tropical storms, the entire planning area can be impacted by these storms.

The Atlantic hurricane season begins June 1 and ends November 30, but hurricanes have developed outside of the designated season.

The following terms are used to describe tropical storms / hurricanes:

Tropical Wave: A trough or cyclonic curvature maximum in the trade-wind easterlies. The wave may reach maximum amplitude in the lower middle troposphere.

Tropical Depression: A tropical cyclone with maximum sustained surface wind speeds (using the U.S. 1-minute average) of 33 kts (38 mph or 62 km/hr) or less.

Tropical Storm: A tropical cyclone with maximum sustained surface wind speed (using the U.S. 1-minute average) ranges from 34 kts (39 mph or 63 km/hr) to 63 kts (73 mph or 118 km/hr).

Hurricane: A tropical cyclone with maximum sustained surface winds (using the U.S. 1-minute average) of 64 kts (74 mph or 119 km/hr) or more.

Storm Surge

According to the National Hurricane Center, along the coast, the greatest potential for loss of life related to a hurricane is from storm surge. Low pressure and strong circular winds "pile" the water into a dome shape that can be 50-100 miles wide. The surge travels with the storm and is most severe in the right quadrant of the storm; relative to the direction the storm travels. Surge can be 15 feet deep, topped by waves, and make landfall ahead of the center or "eye" of the hurricane. Wind-driven waves are superimposed on the storm tide. This rise in water level can cause severe flooding in coastal areas, particularly when the storm tide coincides with normal high tides.

Because much of the United States' densely populated Atlantic and Gulf Coast coastlines lie less than 10 feet above mean sea level, the danger from storm tides is tremendous. For example, Hurricane Ike produced storm surges up to 8 feet above the normal tide- level.

Hurricane Wind

Hurricane wind intensity is measured with the Saffir-Simpson Scale based on a 1-5 rating of a sustained wind speed at the time of measurement. This is used to estimate the potential property damage expected along the coast from a hurricane landfall. Hurricanes reaching Category 3 and higher are considered major hurricanes because of potential significant loss of life and damage. Category 1 and 2 storms are still dangerous, however, and require preventative measures. Wind speed is the determining factor in the scale. All winds are described using the U.S. 1-minute average. Previously, storm surge was described by the Saffir-Simpson Scale but is no longer included.

The following excerpt from the National Hurricane Center explains the revised definition of the Saffir-Simpson Hurricane Scale and the separation of storm surge from storm category followed by an explanation of the need to change the new range of wind speeds:

> *Earlier versions of the Saffir-Simpson Hurricane Scale incorporated central pressure and storm surge as components of the categories. The central pressure was used during the 1970s and 1980s as a proxy for the winds as accurate wind speed intensity measurements from aircraft reconnaissance were not routinely available for hurricanes until 1990. Storm surge was also quantified by category in the earliest published versions of the scale dating back to 1972. However, hurricane size (extent of hurricane-force winds), local bathymetry (depth of near-shore waters), topography, the hurricane's forward speed and angle to the coast also affect the surge that is produced. For example, the very large Hurricane Ike (with hurricane force winds extending as much as 125 mi from the center) in 2008 made landfall in Texas as a Category 2 hurricane and had peak storm surge values of about 20 feet. In contrast, tiny Hurricane Charley (with hurricane force winds extending at most 25 mi from*

the center) struck Florida in 2004 as a Category 4 hurricane and produced a peak storm surge of only about 7 feet These storm surge values were substantially outside of the ranges suggested in the original scale. Thus to help reduce public confusion about the impacts associated with the various hurricane categories as well as to provide a more scientifically defensible scale, the storm surge ranges, flooding impact and central pressure statements are removed from the Saffir-Simpson Hurricane Scale and only peak winds are employed in this revised version.

The Saffir-Simpson Hurricane Wind Scale (SSHWS) has undergone a minor modification for 2012 in order to resolve awkwardness associated with conversions among the various units used for wind speed in advisory products. The change broadens the Category 4 wind speed range by one mile per hour (mph) at each end of the range, yielding a new range of 130-156 mph. This change does not alter the category assignments of any storms in the historical record, nor will it change the category assignments for future storms.

4.2 Location

As a coastal community, Texas City is vulnerable to threats directly and indirectly related to a hurricane event, such as high winds, storm surge, and flooding. Beachfront communities face the primary impact of hurricane winds; however hurricanes and their secondary hazards can affect the entire planning area.

Low-lying coastal areas receive the most flooding, and communities along rivers, bays and estuaries, including Texas City, experience flooding earlier. The effects of a hurricane begin to diminish as it moves inland; although no part of the planning area is free of risk. For example, the winds alone from Hurricane Ike covered 120 miles, stretching across all of Texas City and greater Galveston County, and all parts of the planning area were impacted by high winds and flooding. Figure 4 displays the location of hurricane risk by storm category along the Texas Gulf

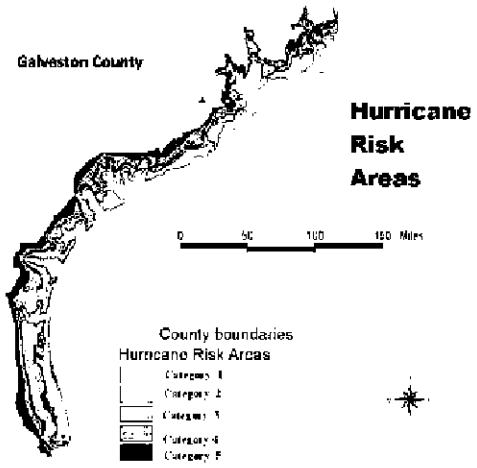


Figure 4: Hurricane Risk Areas

Coast.

4.3 Extent

Hurricanes are categorized according to the strength and intensity of their winds using the Saffir-Simpson Hurricane Scale (See Table 8 on the next page). A Category 1 storm has the lowest wind speeds while a Category 5 hurricane has the highest. This scale only ranks wind speed, but lower category storms can inflict greater damage than higher category storms depending on where they strike, other weather they interact with and how slow they move. As a prime example, Hurricane Ike, which struck Galveston County in 2008 and is discussed herein, was classified as a Category 2 storm, yet was one of the costliest natural disasters in Texas history.[6]

The ingredients for a hurricane include a pre-existing weather disturbance, warm tropical oceans, moisture and relatively light winds aloft. Persistent, favorable conditions can produce violent winds, destructive waves, torrential rains and powerful floods. In an average three-year period, roughly five hurricanes strike the US coastline, killing approximately 50 to 100 people anywhere from Texas to Maine. Of these, two are typically "major" or "intense" hurricanes (a Category 3 or higher storm on the Saffir-Simpson Hurricane Scale).

The Saffir-Simpson Hurricane Scale categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure and storm surge potential. Wind, pressure and surge are combined to estimate potential damage. Categories 3, 4 and 5 are classified as “major” hurricanes. Major hurricanes comprise only 20 percent of total tropical cyclone landfalls, but they account for over 70 percent of the damage in the United States. Damage from hurricanes can result from spawned tornados, coastal flooding from storm surge, and inland flooding from heavy rainfall.

[6] FEMA. 2008. Hurricane Ike Impact Report. Department of Homeland Security, Federal Emergency Management Agency, Mitigation Division. Washington, D.C.

Table 8: Saffir-Simpson Hurricane Wind Scale (revised 2012)

Category	Previous Range	New Range	Effects on Land
1	74-95 mph	No change	**Very dangerous winds will produce some damage:** Well-constructed frame homes could have damage to roof, shingles, vinyl siding, and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph	No Change	**Extremely dangerous winds will cause extensive damage:** Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3	111-130 mph	111-129 mph	**Devastating damage will occur:** Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable several days to weeks after the storm passes.
4	131-155 mph	130-156 mph	**Catastrophic damage will occur:** Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5	Greater than 155 mph	Greater than 157 mph	**Catastrophic damage will occur:** A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: National Hurricane Center

Hurricane-force winds can easily destroy poorly constructed buildings and mobile homes. Debris such as signs, roofing material, and small items left outside become extremely hazardous in hurricanes. Extensive damage to trees, towers, water and underground utility lines (from uprooted trees), and fallen poles cause considerable civic disruption.

Future hurricanes and tropical storms that affect Texas City may be as bad as Category 5 on the Saffir- Simpson Scale.

4.4 Historical Occurrences

It is significant to note that the deadliest hurricane disaster in U.S. history, known as "the Galveston Hurricane of 1900," made landfall and inundated the entire island city of Galveston, Texas, around September 8, 1900. More than 8,000 people died when hurricane storm tides (the surge plus the astronomical tide) of 8 to 15 feet covered the city. More than half of all the homes and buildings were destroyed. Property damage has been estimated at $700 million (in today's dollars).

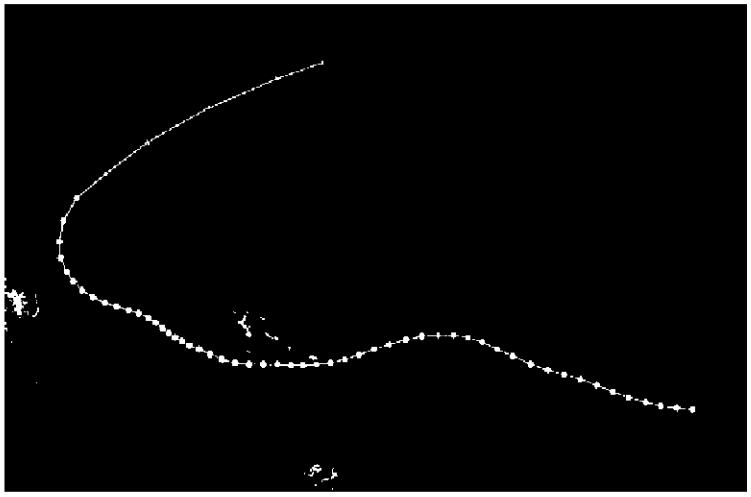


Figure 5: Hurricane Ike Path

Even though only a Category 2 Storm at landfall, Hurricane Ike, which hit Galveston on September 13, 2008, is ranked as the fourth most destructive ever to make landfall in the United States. Maximum sustained winds were 100 mph, with hurricane-force winds extending outward up to 120 miles from the center and tropical storm force winds extending outward up to 275 miles.

The majority of the housing damage in the Galveston Bay area was to buildings constructed in the 1960s and 1970s. Hurricane Ike demonstrated that enforced modern building and floodplain codes work well to reduce damage to the built environment. Many homes that were built since the 1990s that were properly elevated did not sustain serious damages, whereas winds devastated homes on Galveston Island that were built under older building codes. Modern homes that were constructed to 130 mph wind codes required by the International Residential Building Code were still standing the morning after Ike.

In August 2017, Galveston County sustained nearly $112 million in damages to public facilities alone from Hurricane Harvey, the second costliest hurricane to ever make landfall in the United States. Damages to public facilities in Texas City exceeded $6 million.

Other significant historical hurricane events that have impacted Galveston County include a large and violent hurricane on August 16, 1915 and Hurricane Alicia on August 18, 1983, which moved over the Texas coast about 25 miles southwest of Galveston causing a total of over $2.4 billion in

damages (in today's dollars).[7] Table 9 provides a summary of hurricane/tropical storms from 1998 to 2015 as recorded by the NCEI. The data for hurricane/tropical storms is recorded on a countywide level and therefore includes Texas City.

In spring 2018, total damages from Hurricane Harvey were still being tallied, so although referenced above, the hurricane is not included in Table 9.

Table 9: Galveston County Hurricane/Tropical Storm Events

Date	Event Type/Name	Deaths	Injuries	Property Damage	Event Summary
8/21/1998	Tropical Storm Charley	0	0	$ 5,000	Damage was minimal across the area, with beach erosion accounting for the damage estimates.
9/7/1998	Tropical Storm Frances	2	0	$200,000,000	Impact and resultant damage occurred in Galveston, Harris, Brazoria and Matagorda counties of Texas. All four of these counties received a Presidential Disaster Declaration to help in the relief and recovery efforts. In these four counties, total damage exceeded $286 million dollars. Most of this damage was along the coast and around Galveston Bay where high tides and winds destroyed dunes and personal property.
6/5/2001	Tropical Storm Allison	0	0	$31,740,000	Major flooding across the county.
9/5/2002	Tropical Storm	0	0	$0-	No details provided
7/14/2003	Hurricane (Typhoon) Claudette	0	0	$8,300,000	In Galveston County, 38 single family homes were destroyed, 25 received major damage, and 964 received minor damage. 33 businesses were affected

[7] Hurricane history based on National Hurricane Center summaries.

Date	Event Type/Name	Deaths	Injuries	Property Damage	Event Summary
					with damage costs of an estimated $970,000. Total damage, including beach erosion, was estimated at $8.3 million. The highest recorded tide level, 7.56 feet above mean low-lower water, was recorded at Pleasure Pier.
8/30/2003	Tropical Storm Grace	0	0	$7,000	Heavy rainfall between 6 and 12 inches was observed from extreme eastern Galveston County to across the Bolivar Peninsula. Beach erosion was minor. Some of the higher rainfall amounts (August 30th to August 31st) included 6.19 inches in League City, and 2.09 inches at Jamaica Beach.
9/1/2003	Tropical Storm Grace	0	0	$7,000	Storm tide damage on the Bolivar Peninsula was confined to the Gilchrist area. Ten single family homes experienced flooding up to eighteen inches deep inside the home. Fifteen single family homes and two mobile homes experienced flooding up to six inches deep inside the home.
9/23/2005	Hurricane (Typhoon) Rita	0	3	$15,000,000	In Galveston County, tropical storm force sustained winds with gusts to hurricane force were reported across the county, especially on the Bolivar Peninsula. Numerous power poles and road signs were blown down on Bolivar. Many of the beach homes received roof

Date	Event Type/Name	Deaths	Injuries	Property Damage	Event Summary
					damage. Numerous trees were down with small structure damage on High Island. Power was out to most of the county on Saturday. Total damage across the county was around $15 million.
8/5/2008	Tropical Storm Edouard and Storm Surge/Tide	0	0	$95,000	Storm tide damage on the Bolivar Peninsula was confined to the Gilchrist area. Ten single family homes experienced flooding up to eighteen inches deep inside the home. Fifteen single family homes and two mobile homes experienced flooding up to six inches deep inside the home.
9/12/2008	Storm Surge/Tide Ike	12	0	$4,000,000,000	Storm tide ranged from 10 to 15 feet above mean sea level along the Galveston Bay, Clear Lake and associated tributaries which caused major flooding of coastal areas. Some higher surge levels up to 17 feet were indicated on the Bolivar Peninsula. At least 10 direct fatalities occurred in Galveston County. Number of injuries unknown. Some towns hit hard by surge include Galveston, San Leon, Kemah, and all towns on Galveston Island and the Bolivar Peninsula.
6/15/2015	Tropical Storm Bill	0	0	$0-	There was minor coastal flooding on the Bolivar peninsula with some debris removal required off of State Highway 87. High surf

Date	Event Type/Name	Deaths	Injuries	Property Damage	Event Summary
					caused erosion of Galveston Island beaches. Sand and debris washed up on the streets of various west end island communities. There was minor flooding damage to downstairs garages in Jamaica Beach with two temporarily closed roads.
Total		**14**	**3**	**$4,255,154,000**	

Source NCEI

4.5 Probability of Future Events

The return period in years for a hurricane passing within 50 nautical miles of Galveston County planning area is 9 years. Taking into account the previous occurrences and return period, a hurricane event for Texas City is likely within the next five years.

4.6 Vulnerability Assessment

Population

As described in Section 3 of Chapter 3 above, Texas City is home to many vulnerable residents. Increased vulnerability may be due to many factors including but not limited to: age, physical ability, financial means, housing type, and housing condition. Many of these vulnerabilities often overlap.

Texas City recognizes that vulnerable populations may need additional help preparing for and recovering from a hurricane or tropical storm.

Residents of mobile / manufactured housing are of particular concern. These structures are never considered safe during a hurricane, and depending on tie-down methods, may also be unsafe during strong tropical storms.

Residents of sub-standard structures are also of particular concern. Structures in sub-standard condition ahead of a tropical storm or hurricane, whether due to structural damages, missing windows or doors, holes in exterior walls or the roof, may be less safe during a hurricane or tropical storm than structures in standard condition. Existing structural weaknesses may mean increased damages, injuries, or loss of life.

Critical Facilities

The planning team identified 11 critical facilities spread across Texas City. Because of Galveston County's proximity to the Gulf coast and status as a Tier I county, the planning team determined that all critical facilities, no matter their location, are equally vulnerable to a hurricane or tropical storm.

Table 10: Critical Facilities Vulnerable to Hurricanes / Tropical Storms

Texas City	Potential Hurricane / Tropical Storm Impacts									
	Loss of Power	Flying Debris	Uprooted Trees	Flooding	Flooding Due to Physical Damages	Damaged or Destroyed Roofs	Damaged or Broken Windows	Wind Damage	Injuries	Death
City Engineer	x	x	x		x	x	x	x	x	x
City Hall	x	x	x		x	x	x	x	x	x
College of the Mainland	x	x	x		x	x	x	x	x	x
Fire Station - 1	x	x	x		x	x	x	x	x	x
Fire Station - 2	x	x	x		x	x	x	x	x	x
Fire Station - 3	x	x	x	x	x	x	x	x	x	x
Fire Station - Main	x	x	x		x	x	x	x	x	x
Nessler Center / Doyle Convention Center	x	x	x		x	x	x	x	x	x
Police Department	x	x	x		x	x	x	x	x	x
Pump Station A	x	x		x	x	x	x	x	x	x
Pump Station B	x	x		x	x	x	x	x	x	x

Vulnerable Parcels

Central Appraisal District data was used to estimate potential damage values for Texas City. Given the broad nature of vulnerability, damage values were calculated on the jurisdictional level.

Table 11: Parcels Vulnerable to Hurricanes / Tropical Storms

Jurisdiction	Parcel Count	Estimated Potential Damage Value
City of Texas City	20,330	$4,286,398,656[8]

4.7 Impact

The planning team determined that Texas City is uniformly exposed to tropical storms and hurricanes.

Impacts from a hurricane or tropical Storm in Texas City may include but are not limited to: loss of power due to downed lines caused by flying debris or fallen trees, flooding, flooding due to damaged or destroyed roofs, damaged or broken windows, damage due to flying debris, wind damage, and escaped, injured or killed pets. In the worst storms, people may be injured or killed.

[8] Galveston County 2015 CAD Data

5.0 Flood

5.1 Description

Floods result from excessive precipitation. The severity of a flooding event is typically determined by a combination of several major factors, including stream and river basin topography and physiography; urban drainage systems; precipitation and weather patterns; recent soil moisture conditions; and the degree of vegetative clearing and impervious surface. Floods may result from long-term rain events that may last for days and weeks, or they may be caused by short term excessive rainfall.

In this plan, the types of flooding are described in association with their area of impact. Inland flooding may occur due to flash flooding, urban flooding, and/or riverine flooding. Coastal flooding is considered to be storm surge or other wind driven flooding, although excessive rainfall in river basins and drainage systems do amplify the impacts of these events.

- ***FLASH FLOODING*** Flash floods are the product of heavy localized precipitation falling in a short time period over a given location. Flash floods occur within a few minutes or hours of heavy amounts of rainfall, from a dam or levee failure, or from a sudden release of water held by an ice jam. Flash floods can destroy buildings and bridges, uproot trees, and scour out new drainage channels. Most flash flooding is caused by slow-moving thunderstorms in a local area or by heavy rains associated with hurricanes and tropical storms.

- ***URBAN FLOODING*** ponding of water of streets, low-lying areas, highways, underpasses, urban storm drains, and elevation of creek and small stream levels is occurring or imminent. Urban and small stream flood advisories are issued for flooding that occurs within 3 hours after the excessive rainfall.

- ***RIVERINE FLOODING*** is a function of excessive precipitation levels and water runoff volumes within the watershed.

- ***COASTAL FLOODING*** is typically a result of storm surge, wind-driven waves, and heavy rainfall. These conditions are produced by hurricanes during the summer and fall, and other large coastal storms during the winter and spring. Storm surges may overrun barrier islands and push sea water up coastal rivers and inlets, blocking the downstream flow of inland runoff.

Inland flooding is a function of excessive precipitation levels and water runoff volumes within the drainage systems or watershed of a stream or river. Some river floods occur seasonally when winter or spring rains fill river basins with too much water, too quickly. Torrential rains from hurricanes or tropical storms can also produce riverine flooding. Inland flooding also occurs during flash floods which develop in under an hour and tend to occur in low-lying areas with poor drainage.

Coastal flooding is typically a result of storm surge, wind-driven waves and heavy rainfall produced by hurricanes, tropical storms, and other large coastal storms. Flooding in the coastal environment can be further exacerbated by tidal influence in the low-lying coastal areas. Higher tides will increase stream and river stage heights from the mouth while floodwaters rush in from upland areas. Flooding in coastal areas is defined by recurrence intervals and flood zones are determined. Coastal flood zones consider the velocity of wave action.

5.2 Location

At the time of writing in spring 2018, Galveston County was in the process of updating its FIRM data. Due to ongoing changes, preliminary map data showing updated Special Flood Hazard Area boundaries could not be used to illustrate flood location in the figure below. Instead, the planning team relied on data currently in effect. Once the new data goes into effect, the plan will be updated to reflect changes in local flood risk.

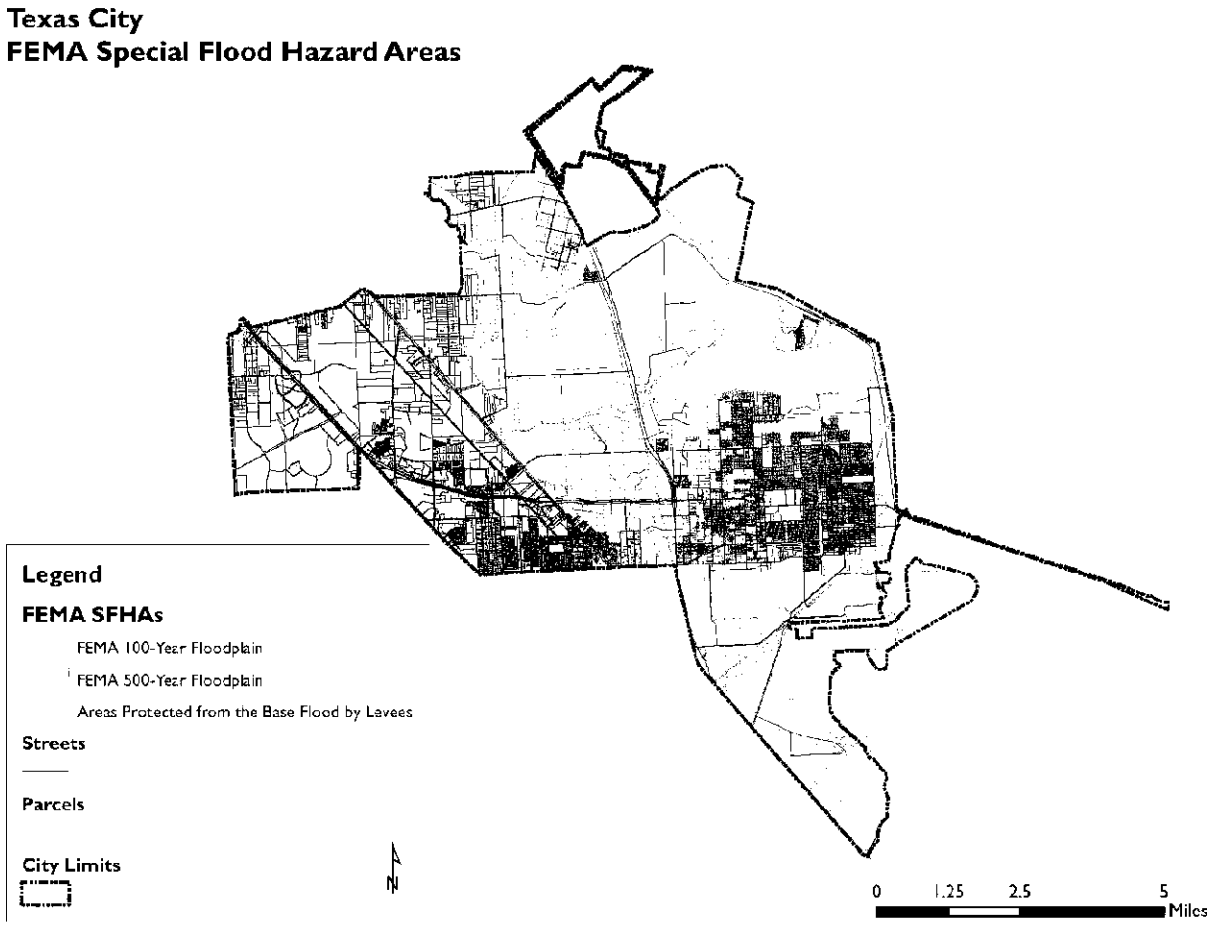


Figure 6: Texas City FEMA Special Flood Hazard Areas

5.3 Extent

Determining the intensity and magnitude of a flood event is dependent upon the flood zone and location of the flood hazard area. Figure 7 describes the flood impact in terms of severity or potential harm while Figure 6 depicts the flood location and potential magnitude of an event in Texas City. To determine the intensity of an event, the figures should be read together.

A 100-year flood constitutes a threat to Texas City. Structures built in Special Flood Hazard Areas (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 scour around solid objects. Utility systems, such as heating, ventilation, air conditioning, fuel, electrical systems, sewage maintenance systems and water systems, if not elevated above base flood elevation, may also be damaged.

Flood Zones		
Zone A	The 100-year or Base Floodplain. There are six types of A zones:	
	A	The base floodplain mapped by approximate methods, i.e., BFEs are not determined. This is often called an unnumbered A zone or an approximate A 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 BFE (old format).
	AE	The base floodplain where base flood elevations are provided. AE zones are now used on new format FIRMs instead of A1-30 zones.
	AO	The base floodplain with sheet flow, ponding, or shallow flooding. Base flood depths (feet above ground) are provided.
	AH	Shallow flooding base floodplain. BFE's are provided.
	A99	Area to be protected from base flood by levees or Federal flood protection systems under construction. BFEs are not determined.
	AR	The base floodplain that results from the de-certification of a previously accredited flood protection system that is in the process of being restored to provide a 100-year or greater level of flood protection
Zone V and VE	V	The coastal area subject to velocity hazard (wave action) where BFEs are not determined on the FIRM.
	VE	The coastal area subject to velocity hazard (wave action) where BFEs are provided on the FIRM.
Zone B and Zone X (shaded)	Area of moderate flood hazard, usually the area between the limits of the 100-year and the 500-year floods. B zones are also used to designate base floodplains or lesser hazards, such as areas protected by levees from the 100-year flood, or shallow flooding areas with average depths of less than one foot or drainage areas less than 1 square mile.	
Zone C and Zone X (unshaded)	Area of minimal flood hazard, usually depiction FIRMs as exceeding the 500-year flood level. Zone C may have ponding and local drainage problems that do not warrant a detailed study or designation as base floodplain. Zone X is the area determined to be outside the 500-year flood.	
Zone D	Area of undetermined but possible flood hazards.	
Source: Understanding Your Risks, Identifying hazards and estimating losses, FEMA 386-2		

Figure 7: Description of Flood Zones

To determine the extent of rainfall for the Texas City planning area, data retrieved from the National Weather Service was reviewed to determine the level of impact recorded for the

Houston/Galveston Area). The greatest 24-hour rainfall event occurred on July 25, 1979 with a total of 43 inches recorded in nearby Alvin, TX.

Since rainfall typically impacts a wide area, Texas City can expect the same impact. Below is a summary of the events recorded.

Table 12: Rain Totals (Inches) - 2011 to 2015

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
2015	5.44	0.70	7.69	5.30	3.05	2.75	0.23	6.40	11.13	9.80	5.55	3.49	61.53
2014	1.36	1.69	1.82	0.10	3.72	1.53	1.08	4.95	6.11	1.75	3.91	3.87	31.89
2013	7.18	2.24	0.72	3.46	1.12	3.26	2.40	3.85	5.06	6.85	2.45	0.65	39.24
2012	3.01	7.32	4.96	1.99	4.22	4.10	5.60	6.14	5.63	0.51	0.86	2.87	47.21
2011	3.86	0.67	2.70	0.12	0.38	0.94	1.11	0.10	1.70	4.60	2.36	4.41	22.95

Table 13: Normal Rainfall (Inches) - 1981 to 2010

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
4.20	2.57	3.16	3.05	4.32	5.69	3.80	4.39	6.03	5.52	4.51	3.52	50.76

Source: http://www.weather.gov/hgx/climate_gls_normals_summary

The worst flood events in Texas City have had estimated flood depths greater than 10' and caused over $200,000 in damages. Flood events in surrounding Galveston County have exceeded $350,000 in damages. Future flood events may result in flooding as deep as 10'.

5.4 Historical Occurrences

Rainfall averages 50.76 inches annually. When 50 inches fall periodically throughout the year, flooding is not an issue. However, when rain falls in less frequent rain events, flash flooding can result.

Previous occurrences for inland and coastal flood are depicted in Table 14. In most cases, the data reported to the NCEI was documented as countywide or general areas within the county (i.e. northern and southern portions, etc.). Texas City has experienced historical flood occurrences.

Table 14: Historic Flood Occurrences in Galveston County

Location	Date	Type	Death	Injury	Property Damage	Crop Damage
Clear Lake Shores	5/30/1995	Flash Flood	0	0	$50,000	$0
Galveston	12/17/1995	Flash Flood	0	0	$20,000	$0
Galveston	12/18/1995	Flash Flood	0	0	$5,000	$0
Northern County	1/26/1996	Flash Flood	0	0	$30,000	$0
Coastal County	11/16/1996	Coastal Flood	0	0	$250,000	$0
Countywide	1/27/1997	Flash Flood	0	0	$5,000	$0
Countywide	4/25/1997	Coastal Flood	0	0	$350,000	$0
East Portion	11/5/1997	Flash Flood	0	0	$20,000	$0
Central Portion	12/8/1997	Flash Flood	0	0	$14,000	$0
North Portion	1/4/1998	Flash Flood	0	0	$3,000	$0
South Portion	6/29/1998	Flash Flood	0	0	$0	$0
South Portion	9/10/1998	Flash Flood	0	0	$0	$0
South Portion	10/4/1998	Flash Flood	0	0	$35,000	$0
South Portion	10/4/1998	Flash Flood	0	0	$10,000	$0

Location	Date	Type	Death	Injury	Property Damage	Crop Damage
Friendswood	10/18/1998	Flash Flood	0	0	$3,000	$0
Northwest Portion	6/25/1999	Flash Flood	0	0	$50,000	$0
Countywide	9/13/2000	Flash Flood	0	0	$100,000	$0
Countywide	6/5/2001	Flash Flood	0	0	$0	$0
Central Portion	6/8/2001	Flash Flood	0	0	$0	$0
Northern Portion	6/9/2001	Flash Flood	0	0	$0	$0
Northern Portion	6/9/2001	Flash Flood	0	0	$0	$0
Texas City	8/28/2001	Flash Flood	0	0	$30,000	$0
Texas City	8/30/2001	Flash Flood	0	0	$80,000	$0
League City	4/8/2002	Flash Flood	0	0	$5,000	$0
League City	5/17/2002	Flash Flood	0	0	$2,000	$0
Texas City	5/17/2002	Flash Flood	0	0	$150,000	$0
South Portion	8/15/2002	Flash Flood	0	0	$75,000	$0
Countywide	8/15/2002	Flash Flood	0	0	$100,000	$0
Jamaica Beach	9/10/2002	Flash Flood	0	0	$45,000	$0
League City	9/19/2002	Flash Flood	0	0	$25,000	$0
East Portion	10/8/2002	Flash Flood	0	0	$15,000	$0
North Portion	10/24/2002	Flash Flood	0	0	$75,000	$0
Countywide	11/5/2002	Flash Flood	0	0	$55,000	$0
Central Portion	12/4/2002	Flash Flood	0	0	$20,000	$0

Location	Date	Type	Death	Injury	Property Damage	Crop Damage
League City	8/31/2003	Flash Flood	0	0	$3,000	$0
Countywide	9/1/2003	Flash Flood	0	0	$4,000	$0
Friendswood	11/17/2003	Flash Flood	0	0	$5,000	$0
Santa Fe	6/23/2004	Flash Flood	0	0	$3,000	$0
League City	11/2/2004	Flash Flood	0	0	$3,000	$0
Coastal County	10/16/2006	Coastal Flood	0	0	$75,000	$0
Friendswood	10/16/2006	Flash Flood	0	0	$250,000	$0
Texas City	7/6/2007	Flash Flood	0	0	$0	$0
League City-Arpt	9/14/2008	Flash Flood	0	0	$0	$0
League City-Arpt	4/18/2009	Flash Flood	0	0	Unknown	$0
League City-Arpt	4/24/2009	Flash Flood	0	0	$5,000	$0
League City	10/1/2009	Flash Flood	0	0	$5,000	$0
League City-Arpt	10/22/2009	Flash Flood	0	0	$0	$0
Coastal County	11/8/2009	Coastal Flood	0	0	$0	$0
Coastal County	12/1/2009	Coastal Flood	0	0	$0	$0
GLS-Airport	5/14/2010	Flash Flood	0	0	$0	$0
Coastal County	1/9/2011	Coastal Flood	0	0	$5,000	$0
League City	5/12/2012	Flash Flood	0	0	$5,000	$0
Friendswood	10/31/2013	Flash Flood	0	0	$10,000	$0
League City-Arpt	9/18/2014	Flash Flood	0	0	$0	$0

Location	Date	Type	Death	Injury	Property Damage	Crop Damage
Texas City Gulf Arpt	4/12/2015	Flash Flood	0	0	$0	$0
League City-Arpt	4/17/2015	Flash Flood	0	0	$2,000	$0
League City	5/12/2015	Flash Flood	0	0	$0	$0
League City	6/13/2015	Flash Flood	0	0	$0	$0
Texas City Gulf Arpt	12/3/2016	Flash Flood	0	0	$50,000	$0

Source: NCEI

No losses of lives or injuries were reported for historical occurrences of flooding according to the National Centers for Environmental Information (NCEI). The approximate total amount of property damage in Galveston County was $1.73 million dollars.

In addition to the events listed above, Texas City experienced flooding during Hurricane Harvey beginning on August 25, 2017. Damage totals are still being calculated.

National Flood Insurance Program

Texas City is responsible for enforcing floodplain management regulations and ensuring regulations meet or exceed the minimum NFIP requirements. The Chief Building Official is responsible for floodplain management.

Texas City's floodplain management ordinance and any future updates will guide the City as it continues to comply with NFIP requirements through local permitting, inspection, and recordkeeping, especially for new and substantially redeveloped construction. Texas City will continue to encourage residents to purchase flood insurance to reduce their flood risk.

The 13 current FIRM maps covering Texas City became effective on May 2, 1983 and May 4, 1992.

There have been three letters of amendment to the current FIRM maps. The amendments were made to Map Panel 4855140025C on 5/28/04, Map Panels 4855140013C and 4855140035C on 4/12/07, and Map Panels 4855140013C and 4855140035C on 5/22/07.

At the time of writing in spring 2018, Galveston County, including Texas City, was in the process of updating its FIRM panels.

The flood mitigation actions outlined in Chapter 16 below were developed with flood mitigation and NFIP compliance in mind. Public awareness in particular will be an ongoing effort in each participating jurisdiction to reduce future losses due to flooding, and it will continue even after recommended corrective actions have been implemented.

As of January 31, 2018, there are 4,493 NFIP policies in force in the City of Texas City covering property worth $1,226,689,100.

Table 15: NFIP Claims and Payments

Jurisdiction Name	Total Losses	Closed Losses	Open Losses	Losses Closed Without Payment	Total Payments
City of Texas City	3,765	2,679	30	1,056	$42,277,834.58

A Repetitive Loss (RL) property is any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling ten-year period, since 1978.

In the City of Texas City, there are 298 repetitive loss properties responsible 1,120 paid claims worth $12,418,170.75. Three are classified as "2-4 Family", five are classified as "ASSMD CONDO", eight are classified as "OTHER RESID", 39 are classified as "OTHR-NONRES", and 243 are classified as "SINGLE FMLY".

A severe repetitive loss property is: "a single family property (consisting of 1 to 4 residences) that is covered under flood insurance by the NFIP and has incurred flood-related damage for which 4 or more separate claims payments have been paid under flood insurance coverage, with the amount of each claim payment exceeding $5,000 and with cumulative amount of such claims payments exceeding $20,000; or for which at least 2 separate claims payments have been made with the cumulative amount of such claims exceeding the reported value of the property. According to the best information available, 10 of the repetitive loss properties mentioned above are validated severe repetitive loss properties. Those 10 are all classified as "SINGLE FMLY" and are responsible for 96 paid claims worth $1,598,211.06

5.5 Probability of Future Events

Although the intensity of a flood event can become lower as building codes and ordinances are made stronger or properties are "flood proofed," given the frequency of historical events, it is highly likely that the area will flood again. On average there is a flood event each year.

5.6 Vulnerability Assessment

Population

As described in Section 3 of Chapter 3 above, Texas City is home to many vulnerable residents. Increased vulnerability may be due to many factors including but not limited to: age, physical ability, financial means, housing type, and housing condition. Many of these vulnerabilities often overlap.

Texas City recognizes that vulnerable populations may need additional help preparing for and recovering from a flood.

Residents of mobile / manufactured housing are of particular concern. These structures are never considered safe during a flood, and depending on tie-down methods, may threaten surrounding structures.

Residents of sub-standard structures are also of particular concern. Structures in sub-standard condition ahead of a flood, whether due to structural damages, missing windows or doors, holes in exterior walls or the roof, may be less safe during a flood than structures in standard condition. Existing structural weaknesses may mean increased damages, injuries, or loss of life.

Critical Facilities

The planning team identified 11 critical facilities spread across the City. Three are located in a known FEMA Special Flood Hazard Area (SFHA). Due to their location in a FEMA SFHA, these three are considered especially vulnerable to flooding:

Table 16: Texas City Critical Facilities Vulnerable to Flooding

Texas City	Potential Flood Impacts						
	Flooding	Damage Due to Debris Flow	Damage Due to Flood-borne Contaminants	Total Destruction	Loss of Power	Injuries	Death
Fire Station - 3	x	x	x	x	x	x	x
Pump Station A	x	x	x	x	x	x	x
Pump Station B	x	x	x	x	x	x	x

Vulnerable Parcels

Table 17: Vulnerable Parcels by Flood Zone and Land Use Type

Jurisdiction	Total Parcels	Estimated Potential Damage Value - Single Family Parcels
FEMA 100-Year Floodplain		
Texas City	1,093	$128,927,865
FEMA 500-Year Floodplain		
Texas City	16,967	$1,615,190,481

Jurisdiction	Total Parcels	Estimated Potential Damage Value - Multi Family Parcels
FEMA 100-Year Floodplain		
Texas City	NA	NA
FEMA 500-Year Floodplain		
Texas City	33	$112,953,270

Jurisdiction	Total Parcels	Estimated Potential Damage Value - Commercial Parcels
FEMA 100-Year Floodplain		
Texas City	117	$80,334,630
FEMA 500-Year Floodplain		
Texas City	1,832	$759,146,798

Jurisdiction	Total Parcels	Estimated Potential Damage Value - Industrial Parcels
FEMA 100-Year Floodplain		
Texas City	46	$40,841,960
FEMA 500-Year Floodplain		
Texas City	159	$1,326,065,820

5.7 Impact

Based on the vulnerability assessment, a coastal flooding or storm surge event will have a greater impact on the area than an inland flood event. With a strong hurricane storm surge, the total value at risk in Texas City is over $4 billion.

Based on the relative exposure and history of previous occurrences, the potential severity and impact of a major flood event are substantial. A major event or storm surge could result in multiple fatalities, a complete shutdown of facilities for 30 or more days, leaving more than half of all property destroyed or substantially damaged.

6.0 Extreme Heat

6.1 Description

Severe, excessive summer heat is characterized by a combination of exceptionally high temperatures and humidity. When these conditions persist over a period of time, it is called a heat wave. Many areas of the country are susceptible to heat waves, including the Texas Gulf Coast and the City of Texas City.

Major human risks associated with severe summer heat include heatstroke, heat exhaustion, and heat cramps. Most at risk are outdoor workers, the elderly, children, and people in poor physical health. The effects of severe summer heat are always more pronounced in urbanized areas than in rural areas. Within urbanized areas, pervasive heat is exacerbated by what is known as the heat island effect, in which concrete and metal infrastructure absorbs radiant heat energy from the sun during the day and emits that heat energy during the night. This cyclical process essentially traps the heat in urbanized areas and makes it as much as 10 degrees warmer than surrounding areas.

During summer months, Texas City is frequently affected by severe heat hazards. Daily high temperatures range into the upper 90's and low 100's. Moderate to high relative humidity levels are prevalent in the county. The heat index can move into dangerous levels. A heat index of 105 degrees is where many people begin to experience extreme discomfort or physical distress.

Severe summer heat is an invisible killer. Although a heat wave does not happen with the spectacle of other hazards such as tornados and floods, the National Center for Environmental Health[9] reports that from 1999-2009, excessive heat exposure caused 7,233 deaths in the United States. Heat-related deaths were reported most frequently among males (69 percent) and 36 percent were adults aged 65 years and older. Ninety-four percent of heat-related deaths occurred during May–September, with the highest numbers reported during July (39 percent) and August (27 percent).

[9] http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6222a1.htm Kochanek K, Xu J, Murphy S, Minino A, Kung H. Deaths: final data for 2009. Natl Vital Stat Rep 2011;60(3).

6.2 Location

There is no distinct geographic boundary to excessive summer heat. Excessive heat can occur throughout Texas City.

6.3 Extent

Extreme summer heat is measured not only in terms of excessive high temperatures, but also on relative humidity with regard to temperature. Texas City has experienced periods of extreme summer heat, which leads to injury and even death. Due to its location, the entire planning area also experiences high humidity along with high temperatures. Temperatures can often climb above 100 degrees during the summer months. This high heat combined with a high percentage of humidity increases the Heat Index as shown in Figure 8.

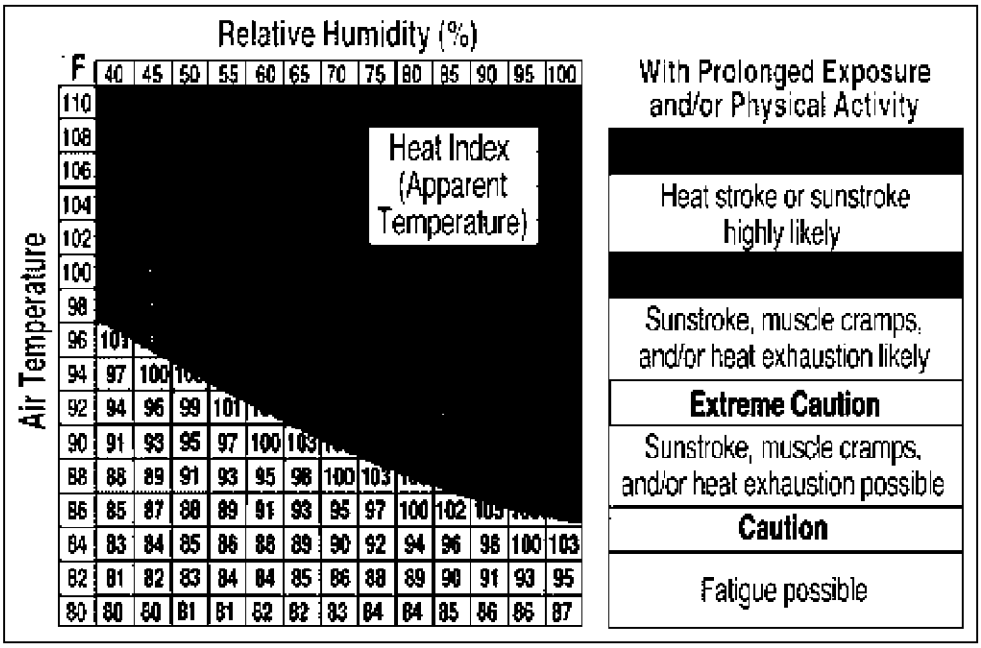


Figure 8: Extent Scale for Extreme Summer Heat

Based on the extent scale in Figure 8 an extreme summer heat event could occur with an air temperature as low as 80°F if the percentage of humidity was equal to or greater than 40 percent. Even though this temperature seems relatively low, given the high humidity, fatigue is possible. Citizens, especially children and the elderly should exercise caution by staying out of the heat for prolonged periods at this temperature and relative humidity. As the chart indicates, fatigue is possible, but can also occur with prolonged exposure or physical activity. Citizens who work outdoors should exercise caution even at the lower temperature if the humidity is at a high level.

With prolonged exposure or physical activity, fatigue could result in causing dizziness, headaches or nausea.

Because Texas City is affected seasonally by extreme summer heat, the extent scales provide a means for better targeting mitigation actions to protect lives. For example, it is important to note that heat stroke and associated fatigue are possible even when the temperature is not at a high peak. Using the extent scale in Figure 8 to combine heat and humidity allows officials to better predict events and more accurately warn citizens of danger.

Texas City can expect the intensity of future extreme heat events to range from caution to extreme danger as noted in Figure 8.

Table 18 displays the National Weather Service's heat advisory and warning descriptions.

Table 18: Extreme Summer Heat Warnings

Intensity	Detailed Description
Heat Advisory	Extreme heat index making it feel hot, typically between 105 °F to 110 °F (41 °C to 43 °C) for 3 hours or more during the day and at or above 75 °F (24 °C) at night.
Excessive Heat Warning	Extreme heat index making it feel very hot, typically above 105 °F (41 °C) for 3 hours or more during the day and at or above 80 °F (27 °C) at night.

Source: National Weather Service

6.4 Historical Occurrences

In other parts of the country and the world, severe summer heat hazards have had devastating consequences. For instance, in 1995 a two-week-long heat wave hit Chicago and the heat index peaked at 119°F. There were 465 deaths directly attributable to the heat wave and more than half of the victims were 75 years of age or older.

In June 2013, scorching heat, caused by a dome of hot air trapped by a high pressure ridge, pushed temperatures above 100°F in parts of Texas, California, Arizona, Idaho, Colorado, Nevada, and Utah. This event claimed the life of one man in California and numerous illness/injuries throughout the impacted area.[10]

[10] http://www.reuters.com/article/us-usa-weather-heat-idUSBRE95S0AS20130630

According to the National Centers for Environmental Information, a strong heat wave effected Texas in the summers of 1999 and 2000. This increases the importance of increased public awareness regarding the danger of extreme heat. Specific occurrences for Galveston County are listed in Table 19. These events are only captured on a countywide basis and are considered historical occurrences for Texas City as well. They reflect the most recent extreme heat events in the planning area.

Table 19: Historical Excessive Heat Events in Galveston County

Event Date	Deaths	Injuries	Property Damage	Crop Damage
7/21/1995	2	200	0	0
6/26/1999	3	0	0	0
8/01/1999	6	0	0	0
7/06/2000	19	0	0	0
8/29/2000	3	0	0	0
9/01/2000	5	0	0	0
06/24/2009	0	0	0	0
07/09/2009	0	0	0	0

Source: Events from 1995 to 2000 were reported in the 2011-2016 Galveston County Hazard Mitigation Plan
Events from 2009 were reported on the NCEI database

6.5 Probability of Future Events

Excessive summer heat in Texas City is likely to occur within the next four to five years. Extreme drought conditions and above-average temperatures in 2009 affected all of Central Texas as far southeast as Galveston County. In the past, multiple counties throughout the region have issued burn bans to prevent the occurrence of wildfires due to extreme heat and dry conditions.

6.6 Vulnerability Assessment

Population

As described in Section 3 of Chapter 3 above, Texas City is home to many vulnerable residents. Vulnerable populations may feel greater impacts from extreme heat due to these populations' limited ability to properly address the hazard due to deficiencies including but not limited to: lack of air conditioning in their homes or vehicles, lack of access to air conditioned public spaces during the hottest part of the day, insufficient numbers of box or ceiling fans, or lack of access to other means of cooling. The consequences for these populations' exposure to extreme heat can include but are not limited to: heat cramps, sunburn, dehydration, fatigue, heat exhaustion, heat stroke, or death.

Critical Facilities

Although Texas City is exposed to extreme temperatures, existing buildings, infrastructure, and critical facilities are not considered vulnerable to damages significant enough to interrupt or stop normal operations. Therefore, any estimated property losses associated with the hazard are anticipated to be minimal across the area.

6.7 Impact

The potential impact of excessive summer heat is normally minor, resulting in few, if any, injuries. No property damage specifically tied to extreme heat events has been recorded in Texas City in over 15 years. No injuries or deaths related to extreme heat have been reported in Texas City, but two deaths were linked to extreme heat in Galveston County in 2000, and previous events have injured up to nine people in Galveston County.

Based on the hazard's potential, in the worst cases, especially if combined with drought conditions, the hazard may inflict property or crop damages, and it can even be deadly. Any shutdown of facilities due to extreme heat is expected to be temporary.

7.0 Tornado

7.1 Description

Tornados are nature's most violent storms, spawned from powerful thunderstorms, causing fatalities and devastating properties in seconds. A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 300 miles per hour. Damage paths can exceed one mile wide and 50 miles long. Some tornados are clearly visible while rain or nearby low-hanging clouds obscure others. Occasionally, tornados develop so rapidly little, if any, advance warning is possible. Before a tornado hits, the wind may die down, and the air may become very still. A cloud of debris can mark the location of a tornado even if a funnel is not visible. Tornados generally occur near the trailing edge of a thunderstorm. It is not uncommon to see clear, sunlit skies behind a tornado.

Galveston County, which borders the Texas Gulf Coast, is known for frequent severe weather and thunderstorms. In addition, tornados occasionally accompany tropical storms and hurricanes that move over land. Tornados are the most common to the right and front of the storm center path as it comes ashore.

7.2 Location

Although only four of Galveston County's 92 previous tornados affected Texas City (Table 21), tornado locations are random and unpredictable. All of Texas City is vulnerable to tornados.

7.3 Extent

The Enhanced Fujita Scale, or EF Scale (Table 20), is the current scale for rating the strength of tornados in the United States; magnitude is estimated via the damage left behind. Implemented in February 2007, it replaced the Fujita Scale. The scale has the same basic design as the original Fujita Scale, six categories from zero to five, representing increasing degrees of damage. The new scale takes into account how most structures are designed, and is thought to be more accurate representation of the surface wind speeds in the most violent tornados.

Future tornados in Texas City may be as bad as EF5.

Table 20: Enhanced Fujita Scale

Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
EF0	65-85	**Light damage.** Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	**Moderate damage.** Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	**Considerable damage.** Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	**Severe damage.** Entire stories of well-constructed houses destroyed; severe damage to large buildings, such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	**Devastating damage.** Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd.); high-rise buildings have significant structural deformation; incredible phenomena will occur.

7.4 Historical Occurrences

The NCEI database was reviewed from 1950 through December 2017. Tornados can result from severe thunderstorm activity or may occur during a tropical storm or hurricane. Table 21 shows aggregated historical information for Texas City.

Table 21: Historical Tornado Impacts in Texas City

Jurisdiction	Property Damage	No. of Events	Magnitude (Fujita Scale)						Magnitude (Enhanced Fujita Scale)					
			F0	F1	F2	F3	F4	F5	EF0	EF1	EF2	EF3	EF4	EF5
Texas City	$342,733	4	1	2					1					

Source: National Centers for Environmental Information

7.5 Probability of Future Events

It is important to note that the range used to calculate the probability of future occurrence begins with the first occurrence recorded by the NCEI, and takes into consideration all tornadic activity in Galveston County. Based on this historical average, tornados are highly likely in Texas City. While some years have no recorded events, a tornado-to-year average indicates a tornado occurs every year (1.6 per year).

7.6 Vulnerability Assessment

Tornados have the potential to impact the entire planning area. Texas City's population, as well as all existing and future buildings, critical facilities, critical infrastructure, and improved property are considered vulnerable to this hazard.

Population

As described in Section 3 of Chapter 3 above, Texas City is home to many vulnerable residents. Increased vulnerability may be due to many factors including but not limited to: age, physical ability, financial means, housing type, and housing condition. Many of these vulnerabilities often overlap.

Texas City recognizes that vulnerable populations may need additional help preparing for and recovering from a tornado.

Residents of mobile / manufactured homes are of particular concern. These structures are never considered safe during a tornado.

Residents of sub-standard structures are also of particular concern. Structures in sub-standard condition ahead of a tornado, whether due to structural damages, missing windows or doors, holes in exterior walls or the roof, may be less safe during a tornado than structures in standard condition.

Existing structural weaknesses, due to housing type or existing damages, may lead to compounded damages, injuries, or loss of life.

Critical Facilities

Certain critical facilities and infrastructure in Texas City may be particularly vulnerable to tornados. These facilities have been identified for reasons including: the number of people who use the facility or infrastructure, the facility's role in providing basic services to begin the cleanup process and get the jurisdiction running again, and the facility's ability to offer goods and materials residents will need to resume normalcy as quickly as possible. The selected critical facilities are built from a variety of materials with varying levels of resistance to tornadic damages. Additionally, their varying ages mean they weren't constructed to uniform building standards. Given tornados' violent nature, these facilities may experience increased levels of vulnerability to the hazards. Damage to any of these facilities may have a disproportionately negative impact on Texas City's recovery from a tornado if that damage affects the facility's ability to reopen and resume normal business right away.

Table 22: Critical Facilities Vulnerable to Tornados

Texas City	Potential Tornado Impacts								
	Loss of Power	Flying Debris	Uprooted Trees	Flooding Due to Physical Damages	Damaged or Destroyed Roofs	Damaged or Broken Windows	Wind Damage	Injuries	Death
City Engineer	x	x	x	x	x	x	x	x	x
City Hall	x	x	x	x	x	x	x	x	x
College of the Mainland	x	x	x	x	x	x	x	x	x
Fire Station - 1	x	x	x	x	x	x	x	x	x
Fire Station - 2	x	x	x	x	x	x	x	x	x
Fire Station - 3	x	x	x	x	x	x	x	x	x
Fire Station - Main	x	x	x	x	x	x	x	x	x
Nessler Center / Doyle Convention Center	x	x	x	x	x	x	x	x	x
Police Department	x	x	x	x	x	x	x	x	x
Pump Station A	x	x		x	x	x	x	x	x
Pump Station B	x	x		x	x	x	x	x	x

Vulnerable Parcels

Table 23: Parcels Vulnerable to Tornados and Estimated Potential Damage Value

Jurisdiction	Parcel Count	Estimated Potential Damage Value
City of Texas City	20,330	$4,286,398,656[11]

7.7 Impact

Impacts from a tornado may include but are not limited to damaged or destroyed personal property including vehicles, damaged or destroyed residential, commercial, and industrial buildings. Pets may be injured or killed by tornados or flying debris. Pets may escape due to damaged or destroyed structures and fences.

In the worst cases, tornados may cause injuries and/or be deadly.

[11] Galveston County 2015 CAD Data

8.0 Windstorm

8.1 Description

Windstorms are a byproduct of thunderstorms which are associated with frontal boundaries and surface heating of the earth. Every year approximately 100,000 thunderstorms occur in the United States. Though they are most likely in the spring and summer months and during the afternoon and evening, thunderstorms can occur year round and at any given hour. The strongest of these storms can cause damage to property and threaten lives with strong winds. The National Weather Service (NWS) wind speed threshold for a severe thunderstorm is a surface wind speed of 58 miles per hour (93 km/h) or greater.

Thunderstorm wind events fall into the following categories:

Straight-line wind is a term used to define any thunderstorm wind that is not associated with rotation, and is used mainly to differentiate from tornadic winds.

A downdraft is a small-scale column of air that rapidly sinks toward the ground.

A downburst is a result of a strong downdraft. A downburst is a strong downdraft with horizontal dimensions larger than 4 km (2.5 mi) resulting in an outward burst of damaging winds on or near the ground. (Imagine the way water comes out of a faucet and hits the bottom of the sink.) Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder.

A microburst is a small concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally small (less than 4km across) and short-lived, lasting only 5-10 minutes, with maximum wind speeds up to 168 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.

A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up the air above them, forming a shelf cloud or detached roll cloud.

A derecho is a widespread, long-lived wind storm that is associated with a band of rapidly moving showers or thunderstorms. A typical derecho consists of numerous microbursts, downbursts, and downburst clusters. By definition, if the wind damage swath extends more than 240 miles (about

400 kilometers) and includes wind gusts of at least 58 mph (93 km/h) or greater along most of its length, then the event may be classified as a derecho.

Source: http://www.nssl.noaa.gov/education/svrwx101/wind/types/

In addition to windstorms directly related to thunderstorms, strong winds can also be produced by strong arctic cold fronts that plunge southward across the Plains from Canada. After the cold front has passed extreme differences in air pressure and temperature, they have a history of producing local winds at wind advisory levels with higher gusts. The NWS recognizes and defines three levels of wind-related advisories as follows:

- ***Wind Advisory*** – Sustained winds of 30 mph or more or gusts of 45 mph or greater for a duration for one hour or longer.
- ***High Winds*** – Sustained winds of 40 mph or greater for at least one hour, or frequent gusts of wind to 58 mph or greater.
- ***Extreme Wind Warnings*** – Sustained winds of 115 mph or greater during a land-falling hurricane.

Another potential source of local windstorms is a phenomenon known as a gravity wave. High winds from gravity waves are caused by rapid warming and drying on the back edge of a trailing region of rain usually associated with weakening thunderstorms. If conditions are right, this process can lead to falling pressure, which in turn may cause dramatic increases in wind speeds.

8.2 Location

Windstorms vary in terms of size, intensity, duration, and impacts. High winds associated with thunderstorms are frequent occurrences throughout Texas City. Windstorms produced by arctic cold fronts and gravity waves are infrequent, however, they are often more expansive. All of Texas City is uniformly exposed to windstorm events.

8.3 Extent

The strength of thunderstorm winds can vary from a light breeze to over 100 mph. Windstorms produced by cold fronts and gravity waves have been known to produce winds over 60 mph. The Beaufort wind scale exhibits the range in impacts of wind speeds as shown in Table 24. Texas City is subject to all the World Meteorological Organization (WMO) classifications listed below. Future wind events in Texas City may be as strong as Force 12.

Table 24: Beaufort Wind Scale

Force	Wind (Knots)	WMO Classification	Appearance of Wind Effects	
			On the Water	On Land
0	Less than 1	Calm	Sea surface smooth and mirror-like	Calm, smoke rises vertically
1	1-3	Light Air	Scaly ripples, no foam crests	Smoke drift indicates wind direction, still wind vanes
2	4-6	Light Breeze	Small wavelets, crests glassy, no breaking	Wind felt on face, leaves rustle, vanes begin to move
3	7-10	Gentle Breeze	Large wavelets, crests begin to break, scattered whitecaps	Leaves and small twigs constantly moving, light flags extended
4	11-16	Moderate Breeze	Small waves 1-4 ft. becoming longer, numerous whitecaps	Dust, leaves, and loose paper lifted, small tree branches move
5	17-21	Fresh Breeze	Moderate waves 4-8 ft. taking longer form, many whitecaps, some spray	Small trees in leaf begin to sway
6	22-27	Strong Breeze	Larger waves 8-13 ft., whitecaps common, more spray	Larger tree branches moving, whistling in wires
7	28-33	Near Gale	Sea heaps up, waves 13-20 ft., white foam streaks off breakers	Whole trees moving, resistance felt walking against wind
8	34-40	Gale	Moderately high (13-20 ft.) waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks	Whole trees in motion, resistance felt walking against wind
9	41-47	Strong Gale	High waves (20 ft.), sea begins to roll, dense streaks of foam, spray may reduce visibility	Slight structural damage occurs, slate blows off roofs
10	48-55	Storm	Very high waves (20-30 ft.) with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	56-63	Violent Storm	Exceptionally high (30-45 ft.) waves, foam patches cover sea, visibility more reduced	
12	64+	Hurricane	Air filled with foam, waves over 45 ft., sea completely white with driving spray, visibility greatly reduced	

Source: NOAA Storm Prediction Center

8.4 Historical Occurrences

The NCEI database was reviewed from 1950 through December 2017. Table 25 shows aggregated historical information on windstorm events in Texas City.

At the county level, historical evidence shows countywide vulnerability to windstorms. Of the 116 windstorms identified, there was one gravity wave and one arctic cold front.

A strong cold front swept into the area on November 15, 2006 with estimated wind gusts of 55 kts and a gravity wave impacted the area on April 24, 2004 with a measured gust of 69 mph at Galveston Scholes Airport. Also, a severe thunderstorm occurred on May 2, 1993 which caused an estimated 50 million dollars in damages across the County.

Table 25: Historical Windstorm Impacts in Texas City

Jurisdiction	Number of Events	Maximum Wind (mph)	Property Damage	Crop Damage
Texas City	6	61	$94,554.78	$0

8.5 Probability of Future Events

Because windstorms can occur across the entire planning area, it is important to note that the range used to calculate the probability of future occurrence begins with the first occurrence recorded by the NCEI for Galveston County.

Based on the historical analysis high wind events are highly likely. On average, windstorm events occur in the planning area 4 times per year. The NWS issues watches and warnings for severe thunderstorms and the lead times can vary from minutes to hours. However, the impacts of thunderstorm winds can occur with little to no warning.

8.6 Vulnerability Assessment

Windstorms have the potential to impact the entire planning area. Therefore, all of Texas City is equally exposed to the hazard. Improved property, critical facilities, critical infrastructure, and the entire population are considered vulnerable to windstorms.

Based on windstorm data collected for Galveston County, including Texas City, windstorms primarily damage physical structures. However, there is no uniformity with respect to the type of structures that have been damaged by windstorms. Windstorm damages can be directly caused by the wind itself, flying debris, and falling trees, or indirectly by damages like power outages.

Population

As described in Section 3 of Chapter 3 above, Texas City is home to many vulnerable residents. Increased vulnerability may be due to many factors including but not limited to: age, physical ability, financial means, housing type, and housing condition. Many of these vulnerabilities often overlap.

Texas City recognizes that vulnerable populations may need additional help preparing for and recovering from a windstorm.

Residents of mobile / manufactured homes are of particular concern. These structures may not be safe during a windstorm.

Residents of sub-standard structures are also of particular concern. Structures in sub-standard condition ahead of a windstorm, whether due to structural damages, missing windows or doors, holes in exterior walls or the roof, may be less safe during a windstorm than structures in standard condition.

Existing structural weaknesses, due to housing type or existing damages, may lead to compounded damages, injuries, or loss of life.

Critical Facilities

Similar to hurricanes and tornados, certain critical facilities and infrastructure in Texas City may be particularly vulnerable to windstorms. These facilities have been identified for reasons including: the number of people who use the facility or infrastructure, the facility's role in providing basic services to begin the cleanup process and get the jurisdiction running again, and the facility's ability to offer goods and materials residents will need to resume normalcy as quickly as possible. The selected critical facilities are built from a variety of materials with varying levels of resistance to wind damages. Additionally, their varying ages mean they weren't constructed to uniform building standards. Given wind's potentially violent nature, these facilities may experience increased levels of

vulnerability to the hazards. Damage to any of these facilities may have a disproportionately negative impact on Texas City's recovery from a windstorm if that damage affects the facility's ability to reopen and resume normal business right away.

Table 26: Critical Facilities Vulnerable to Windstorms

Texas City	Potential Windstorm Impacts								
	Loss of Power	Flying Debris	Uprooted Trees	Flooding Due to Physical Damages	Damaged or Destroyed Roofs	Damaged or Broken Windows	Wind Damage	Injuries	Death
City Engineer	x	x	x	x	x	x	x	x	x
City Hall	x	x	x	x	x	x	x	x	x
College of the Mainland	x	x	x	x	x	x	x	x	x
Fire Station - 1	x	x	x	x	x	x	x	x	x
Fire Station - 2	x	x	x	x	x	x	x	x	x
Fire Station - 3	x	x	x	x	x	x	x	x	x
Fire Station - Main	x	x	x	x	x	x	x	x	x
Nessler Center / Doyle Convention Center	x	x	x	x	x	x	x	x	x
Police Department	x	x	x	x	x	x	x	x	x
Pump Station A	x	x		x	x	x	x	x	x
Pump Station B	x	x		x	x	x	x	x	x

Vulnerable Parcels

Table 27: Parcels Vulnerable to Windstorms

Jurisdiction	Parcel Count	Estimated Potential Damage Value
City of Texas City	20,330	$4,286,398,656[12]

8.7 Impact

The impacts of windstorms are considered to be moderate. Minor injuries can be expected and are typically treatable with first aid. Damages to property can vary from minimal; shutting down critical facilities and services for 24 hours or less to significant in higher windstorm events.

[12] Galveston County 2015 CAD Data

9.0 Hailstorm

9.1 Description

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. Frozen droplets gradually accumulate into ice crystals until they fall as precipitation that is round or irregularly shaped masses of ice. 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 suspended where it can grow in size. The strength of the updraft is a byproduct of heating on the earth's surface. Higher temperature gradients above the earth's surface result in increased suspension time and hailstone size.

9.2 Location

Hailstorms vary tremendously in terms of size, location, intensity, and duration but are considered frequent occurrences throughout Texas City. The entire planning area is uniformly exposed to hail events just as it is exposed to the thunderstorms that produce the hail events.

9.3 Extent

The severity of hail events ranges are based on the size of hail, winds, and structures in the path of a hail storm. A scale showing intensity categories was developed by the National Centers for Environmental Information (NCEI) and is included in Table 28. Future hailstorms in Texas City may reach H10 on the Hail Intensity and Magnitude scale.

Table 28: Hail Intensity and Magnitude

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
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

Source: NCEI

9.4 Historical Occurrences

The NCEI database was reviewed from 1950 through December 2017. Table 29 shows the aggregated historical information on hailstorms in Texas City.

Historical evidence shows county-wide vulnerability to hail events. Typically, hail results from severe thunderstorm activity. The largest hail recorded within Galveston County had a measured diameter of 4.5". The event occurred on April 2, 2013, and caused an estimated 1.1 million dollars in damages.

Table 29: Historical Hail Impacts in Texas City

Jurisdiction	Number of Events	Maximum hail size (inches)	Property Damage
Texas City	7	1.75	$78,010

Source: National Centers for Environmental Information

9.5 Probability of Future Events

Based on the historical occurrences of hailstorms for Galveston County, including Texas City, hail events are highly likely to occur on a yearly basis. On average an event occurs every 1.09 years. Most hailstorms occur during the spring (March, April, and May) and in the fall during the month of September. The warning time for a hailstorm is generally minimal, or there is no warning. The National Weather Service classifies a storm as severe if hail of 1 inch in diameter or greater occurs or is imminent based on observers or radar intensity.

9.6 Vulnerability Assessment

Population

As described in Section 3 of Chapter 3 above, Texas City is home to many vulnerable residents. Increased vulnerability may be due to many factors including but not limited to: age, physical ability, financial means, housing type, and housing condition. Many of these vulnerabilities often overlap.

Since hailstorms arise with little to no warning, Texas City recognizes that vulnerable populations may primarily need additional help recovering from a hailstorm.

Residents of sub-standard structures are of particular concern. Structures in sub-standard condition ahead of a hailstorm, whether due to structural damages, missing windows or doors, holes in exterior walls or the roof, may sustain more damages than structures in standard condition.

Existing weaknesses, especially those related to the condition of a structure's roof, due to housing type or existing damages, may lead to compounded damages, injuries, or loss of life.

Critical Facilities

Due to the presence of structures with flat roofs and the increased vulnerability a flat roof creates, the presence of older structures that have not been hardened against hailstorms, and / or the presence of metal buildings that may be more susceptible to hail, the following critical facilities were determined to be especially vulnerable to hailstorms:

Table 30: Critical Facilities Vulnerable to Hailstorms

Texas City	Potential Hailstorm Impacts		
	Damaged or Destroyed Roof	Damaged Windows	Water damage due to Physical Damages
City Engineer	x	x	x
City Hall	x	x	x
College of the Mainland	x	x	x
Fire Station - 1	x	x	x
Fire Station - 3	x	x	x
Fire Station - Main	x	x	x
Nessler Center / Doyle Convention Center	x	x	x
Police Department	x	x	x
Pump Station B	x	x	x

Vulnerable Parcels

Table 31: Parcels Vulnerable to Windstorms

Jurisdiction	Parcel Count	Estimated Potential Damage Value
City of Texas City	20,330	$4,286,398,656[13]

9.7 Impact

The severity of a hailstorm's impact is considered to be limited since they generally result in injuries treatable with first aid, shut down critical facilities and services for 24 hours or less, and less than ten percent of affected properties are destroyed or suffer major damage. All existing and future buildings, facilities, and populations in Texas City are considered to be exposed to this hazard and could potentially be impacted.

[13] Galveston County 2015 CAD Data

10.0 Lightning

10.1 Description

Lightning is one of the top three storm-related killers in the United States. It is also one of the least understood weather phenomena. Below is a description of lightning and thunder as defined by NOAA:[14]

- ***Lightning*** is a giant spark of electricity in the atmosphere or between the atmosphere and the ground. In the initial stages of development, air acts as an insulator between the positive and negative charges in the cloud and between the cloud and the ground; however, when the difference in charges become too great, the insulating capacity of the air breaks down, and there is a rapid discharge of electricity known as lightning.

  Lightning can occur between opposite charges within the thunderstorm cloud (Intra-Cloud Lightning) or between opposite charges in the cloud and on the ground (Cloud-To-Ground Lightning). Cloud-to-ground lightning is divided into two different types of flashes depending on the charge in the cloud where the lightning originates.

- ***Thunder*** is the sound made by a flash of lightning. As lightning passes through the air, it heats the air quickly. This causes the air to expand rapidly and creates the sound wave we hear as thunder. Normally, you can hear thunder about 10 miles from a lightning strike. Since lightning can strike outward 10 or more miles from a thunderstorm, if you hear thunder, you are likely within striking distance of a storm.

10.2 Location

Lightning strikes in association with thunderstorms vary in terms of size, intensity, duration, and impacts, but are considered frequent occurrences throughout Galveston County. Texas City is uniformly exposed to thunderstorm events and the associated impact lightning. According to information calculated from the NOAA Severe Weather Data Inventory (SWDI), there were nearly 10,000 cloud-to-ground lightning strikes within the county between January 1986 and May 2013; this information indicates an average of 378 lightning strikes per year within the county. Texas City expects the dispersion of lightning strikes to be uniform across the planning area although elevation and local topography may play a role.

[14] http://www.lightningsafety.noaa.gov/science/science-overview.shtml

Figures 9 and 10 depict cloud to ground lightning strikes from 2005 to 2014.

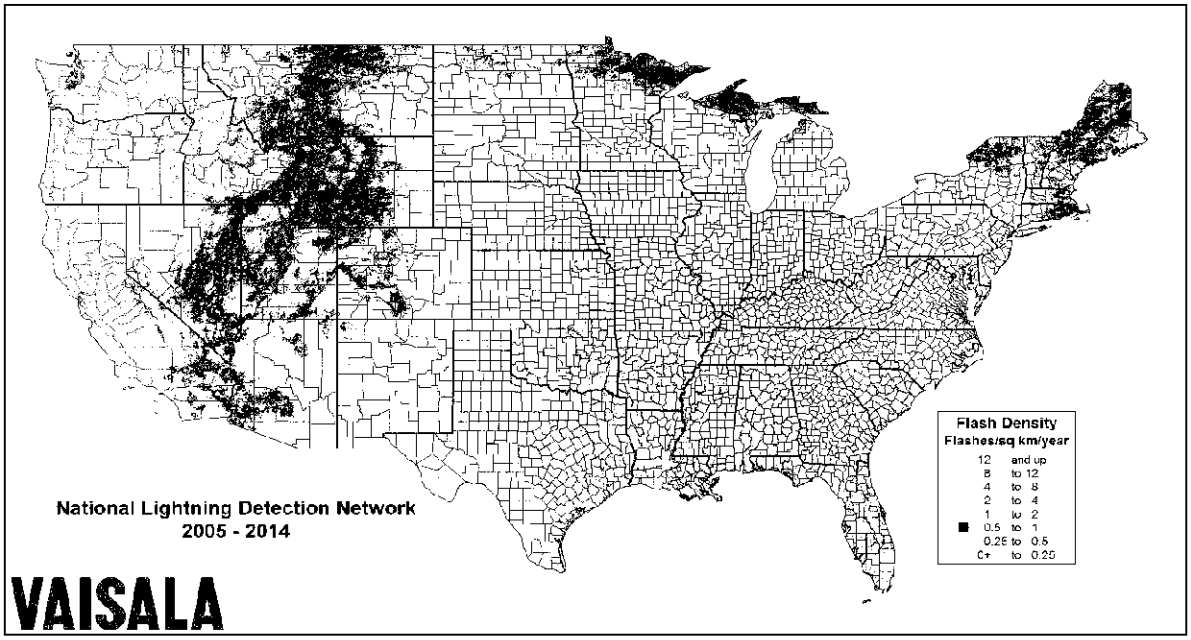


Figure 9: Vaisala Flash Density 2005 to 2014

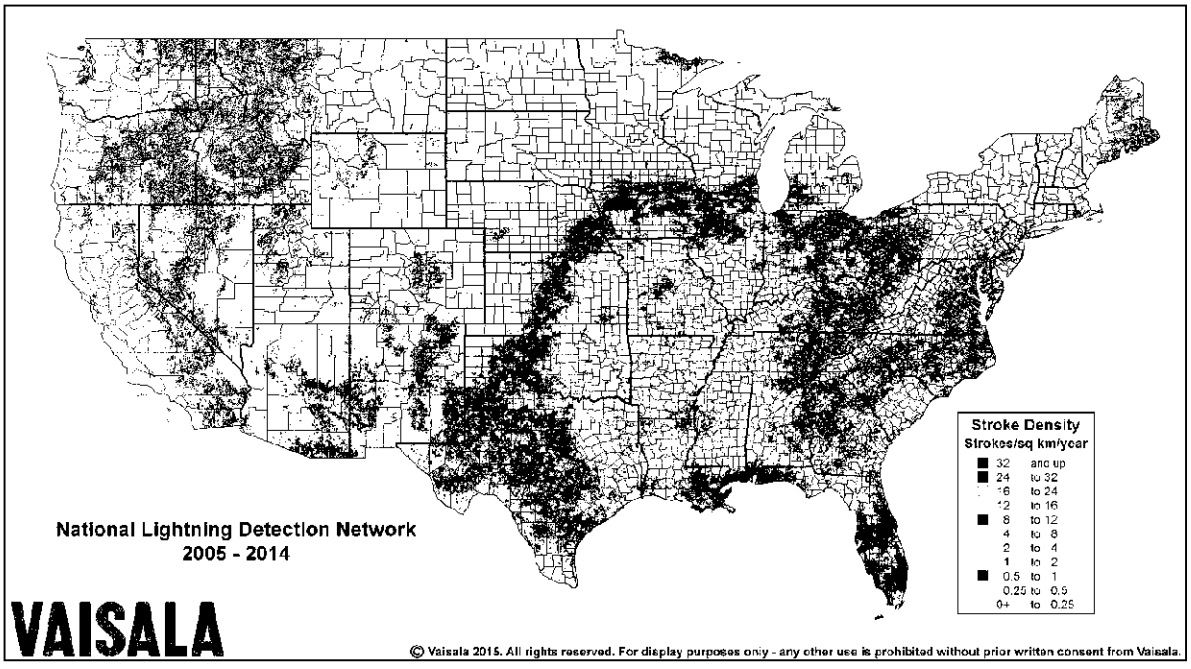


Figure 10: Vaisala Stroke Density 2005 to 2014

10.3 Extent

The extent for lightning can be expressed in terms of the number of strikes in an interval. NOAA utilizes lightning activity levels (LALs) on a scale from 1-6. LAL rankings reflect the frequency of cloud-to-ground lightning either forecast or observed as defined below in Table 32.

Table 32: NOAA Lightning Activity Levels (LAL)

LAL	Cloud and Storm Development	Lightning Strikes / 15 Minutes
1	No thunderstorm	0
2	Cumulus clouds are common but only a few reach the towering cumulus stage. A single thunderstorm must be confirmed in the observation area. The clouds produce mainly virga, but light rain will occasionally reach the ground. Lightning is very infrequent.	1-8
3	Towering cumulus covers less than two-tenths of the sky. Thunderstorms are few, but two to three must occur within the observation area. Light to moderate rain will reach the ground, and lightning is infrequent.	9-15
4	Towering cumulus covers two to three-tenths of the sky. Thunderstorms are scattered and more than three must occur within the observation area. Moderate rain is common and lightning is frequent.	16-25
5	Towering cumulus and thunderstorms are numerous. They cover more than three-tenths and occasionally obscure the sky. Rain is moderate to heavy and lightning is frequent and intense.	>25
6	Dry lightning, similar to LAL 3 except thunderstorms are dry.	

The NCEI does not include the LAL for the historical lightning events included in Table 33. In order to determine the extent of lightning strikes, the yearly average of estimated number of lightning strikes within the county (378) and the comparison of the flash density of 4 to 8 per year and the stroke density of 12 to 24, indicates lightning strikes have a moderate frequency and will more than likely fall within the LAL range of 2 to 5. Future lightning events in Texas City may register as high as LAL 5.

10.4 Historical Occurrences

According to a review of NCEI database information between January 1950 and December 2017, Texas City has had one injury caused by lighting, but no fatalities. Galveston County has seen three lightning-caused injuries, including the one in Texas City, and five lightning-caused fatalities. NCEI information is passively collected; the actual coverage of detected strikes in Figure 9 and 10 shows the extensive nature of the hazard, and Table 33 captures the reported occurrences with associated damages in Texas City.

Table 33: Historical Lightning Impacts in Texas City

Jurisdiction	Number of E vents	Property Damage
Texas City	3	$3,179,896

Source: NCEI

10.5 Probability of Future Events

On average, several hundred strikes occur each year within the planning area. Based on historical occurrences of thunderstorms and associated impacts of lightning, lightning events are highly likely to occur on an annual basis.

According to NCEI data, Texas City averages about 1 damaging lightning event every year. Most thunderstorms occur during the spring (March, April, and May) and in the fall during the month of September. The NWS issues watches and warnings for severe thunderstorms; however, lightning is not criteria for issuance and the lead times can vary from minutes to hours. The impacts of thunderstorms can occur with little to no warning and lightning strikes can occur as far as 10-15 miles away from a thunderstorm.

10.6 Vulnerability Assessment

According to the Lightning Protection Institute, it is a myth[15] that lightning always strikes the tallest objects. Given lightning's indiscriminate nature, it is impossible to identify buildings that are at an increased risk of being struck by lightning. All existing and future buildings, critical facilities, critical infrastructure, improved property, and the population are exposed to this hazard. However, structures without adequate lightning protection and those with large concentrations of electronic equipment like computers, servers, and printers, are most vulnerable, as are locations that may have outside crowds during a lightning event.

[15] http://lightning.org/wp-content/uploads/2015/06/LPI_lightning_infographic_2015.jpg

Critical Facilities

Table 34: Critical Facilities Vulnerable to Lightning

Texas City	Potential Lightning Impacts			
	Physical Damage	Electrical Damage	Data Damage or Loss	Fire
City Engineer	x	x	x	x
City Hall	x	x	x	x
College of the Mainland	x	x	x	x
Fire Station - 1	x	x	x	x
Fire Station - 2	x	x	x	x
Fire Station - 3	x	x	x	x
Fire Station - Main	x	x	x	x
Nessler Center / Doyle Convention Center	x	x	x	x
Police Department	x	x	x	x
Pump Station A	x	x	x	x
Pump Station B	x	x	x	x

Vulnerable Parcels

Table 35: Parcels Vulnerable to Lightning

Jurisdiction	Parcel Count	Estimated Potential Damage Value
City of Texas City	20,330	$4,286,398,656[16]

10.7 Impact

Impacts from lightning in Texas City may include but are not limited to loss of power due to electrical surges, damaged or destroyed personal property including computers and other electronics, damaged or destroyed agricultural, residential, commercial, and industrial buildings. In the worst cases, lightning may cause injuries or death.

[16] Galveston County 2015 CAD Data

11.0 Severe Winter Weather

11.1 Description

A severe winter storm event is identified as a storm with snow, ice, or freezing rain—all of which can cause significant problems for area residents. Although rare in southeast Texas, winter weather does occasionally occur. January is the month when snow, sleet, or freezing rain is most likely to be observed; yet, winter weather conditions can occur at any time during the winter and early spring months. The leading cause of death during winter storms is transportation accidents. Hypothermia and frost bite are other dangers from very cold winter temperatures.

The National Weather Service (NWS) defines a winter storm as having three factors: cold air, moisture, and lift. These three factors acting together create conditions suitable for a winter storm. Below is a listing of definitions for winter weather events that could impact the planning area:

- ***Snow Flurries*** - Intermittent light snowfall of short duration (generally light snow showers) with no measurable accumulation.
- ***Snow Showers*** - A snow shower is a short duration of moderate snowfall. Some accumulation is possible.
- ***Sleet*** -Pellets of ice composed of frozen or mostly frozen raindrops or refrozen partially melted snowflakes.
- ***Freezing Rain*** - Rain that falls as a liquid but freezes into glaze upon contact with the ground.
- ***Wind Chill*** - The combination of wind and temperature that serves as an estimate of how cold it actually feels to exposed human skin. Wind chill values below -19 degrees are considered dangerous.

11.2 Location

Winter storms vary in location, intensity and duration but are considered rare occurrences in Galveston County and the upper Texas Gulf Coast. All of Texas City is equally susceptible to winter storm events.

11.3 Extent

Figures 11 and 12 display scales/indices that factor the amount of snow recorded, wind (mph), estimated ice accumulations, and temperature to determine the extent of impact from severe winter weather events. Future severe winter weather in Texas City may be as bad as Category One on the Martin Winter Storm scale and as bad as Category 2 on the Sperry-Piltz Ice Accumulation Index.

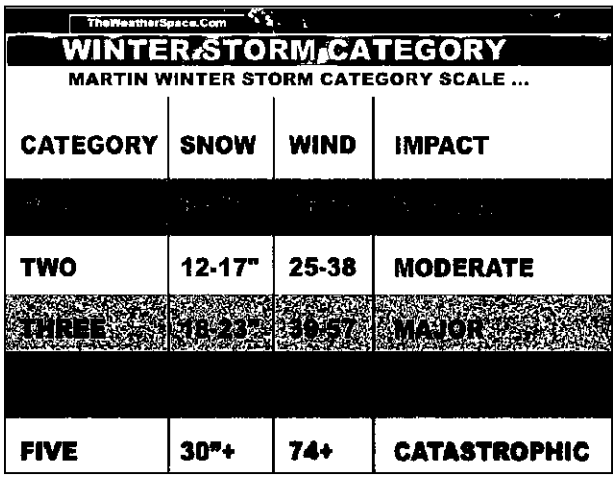


Figure 11: Martin Winter Storm Category Scale

The Sperry-Piltz Ice Accumulation Index, or "SPIA Index" – Copyright, February, 2009

ICE DAMAGE INDEX	* AVERAGE NWS ICE AMOUNT (in inches) *Revised-October, 2011	WIND (mph)	DAMAGE AND IMPACT DESCRIPTIONS
0	< 0.25	< 15	Minimal risk of damage to exposed utility systems; no alerts or advisories needed for crews, few outages.
1	0.10 – 0.25	15 - 25	Some isolated or localized utility interruptions are possible, typically lasting only a few hours. Roads and bridges may become slick and hazardous.
	0.25 – 0.50	> 15	
2	0.10 – 0.25	25 - 35	Scattered utility interruptions expected, typically lasting 12 to 24 hours. Roads and travel conditions may be extremely hazardous due to ice accumulation.
	0.25 – 0.50	15 - 25	
	0.50 – 0.75	< 15	
4	0.25 – 0.50	> = 35	Prolonged & widespread utility interruptions with extensive damage to main distribution feeder lines & some high voltage transmission lines/structures. Outages lasting 5 – 10 days.
	0.50 – 0.75	25 - 35	
	0.75 – 1.00	15 - 25	
	1.00 – 1.50	< 15	
5	0.50 – 0.75	> = 35	Catastrophic damage to entire exposed utility systems, including both distribution and transmission networks. Outages could last several weeks in some areas. Shelters needed.
	0.75 – 1.00	> = 25	
	1.00 – 1.50	> = 15	
	> 1.50	Any	

(Categories of damage are based upon combinations of precipitation totals, temperatures and wind speeds/directions.)

Figure 12: Sperry–Piltz Ice Accumulation Index

Wind chill temperature is a measure of how cold the wind makes real air temperature feel to the human body, similar to the heat index for extreme heat (Figure 8). Since wind can dramatically accelerate heat loss from the body, a blustery 30° day would feel just as cold as a calm day with 0° temperatures.

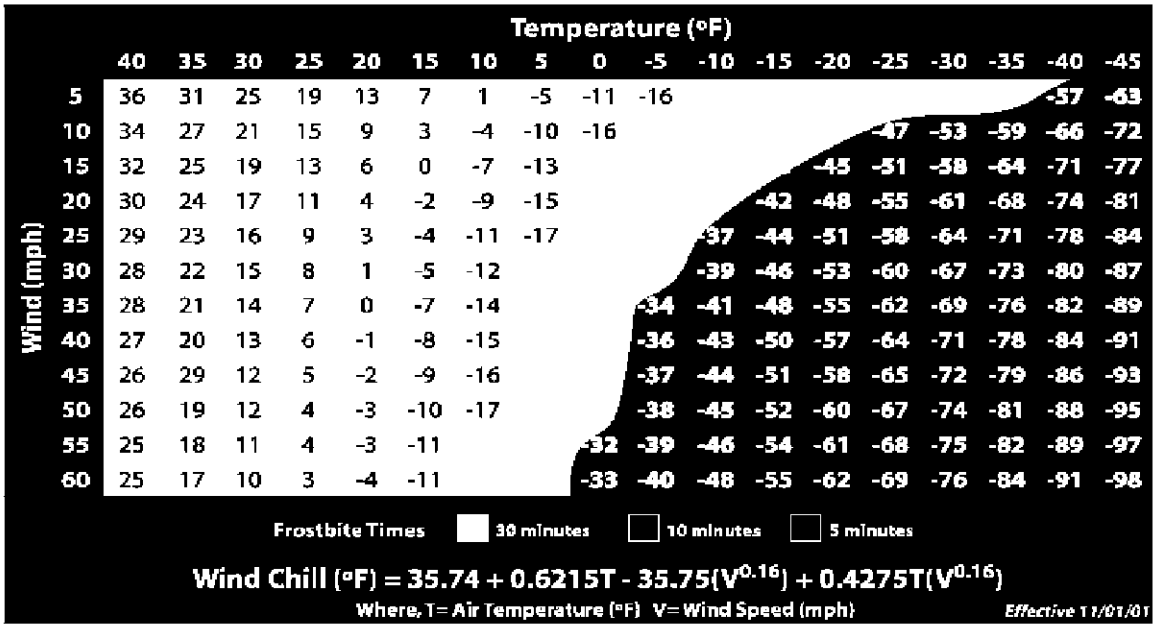


Figure 13: Wind Chill Chart

Countywide, Galveston County has never experienced a blizzard, but based on previous occurrences, Texas City has been subject to winter storm watches, warnings, freezing rain, sleet, snow and wind chill.

11.4 Historical Occurrences

Texas City reviewed NCEI data from 1950 through December 2017. The data was primarily captured at the county level and includes the jurisdiction of Texas City. During this period of time a severe ice storm occurred in 1997 and 2011, and one heavy snow fall occurred in 2004. The 1997 ice storm effected trees, power lines and roadways. The weight of the ice caused trees and power lines to snap and fall. Glazed roadways posed hazardous driving conditions. Schools were closed for two to three days to prevent additional traffic collisions. Over 1,100 traffic accidents were reported in Southeast Texas which accounted for three deaths in 1997 and $800,000 in property damages. In 2004, snowfall totals ranged from 1-12 inches across the region. The heavier snowfall occurred over the coastal counties south of Houston because this area had more moisture in the atmosphere (being closer to the Gulf), and was also closer to the track of the upper level low. Table 36 depicts historical occurrences for the county.

Table 36: Historical Winter Storms Countywide

Date	Type	Deaths	Injuries	Property Damage	Description
Jan. 12-13, 1997	Ice Storm	3	0	$800,000	Trees, power lines and roadways were all affected by freezing rain and sleet. Glazed roadways posed hazardous driving conditions. Over 1,100 traffic accidents were reported in southeast
Dec. 24-25, 2004	Heavy Snow	0	0	$0	A rare and record breaking snowfall occurred across southeast Texas. Snowfall totals ranged from 1-12 inches across the region. Approximately 4 inches fell on Galveston Island.
Feb. 3, 2011	Ice Storm	0	0	$0	A period of freezing rain and freezing drizzle led to icy roads, especially bridges and overpasses, and numerous accidents. Between one and two tenths of an inch of ice accumulated.

Source: National Centers for Environmental Information

Although not recorded in the NCEI, a cold core upper level low pressure system moved across southeast Texas on December 10, 2008. An inch of snow fell on Galveston Island with generally an inch to two inches over the inland portions of county. This is the earliest accumulating snow that has affected southeast Texas and the planning area.

11.5 Probability of Future Events

It is important to note that the range used to calculate the probability of future occurrence begins with the first occurrence recorded by the NCEI. Based on the historical analysis a winter storm occurs once every 7-8 years. Significant winter weather events are likely to occur in Texas City.

11.6 Vulnerability Assessment

Infrastructure

While all of Texas City is exposed to extreme temperatures, existing buildings, infrastructure, and critical facilities are not considered vulnerable to significant damage caused by severe winter storm events. This determination was made based on the expectation that most roofs can support 20 lbs. / square foot of snow. The worst snow storm in Texas City dropped 2". Although it's not impossible for that much snow to cause structural damage, given that the snow weight is well below the threshold where damage is likely, structural damages are not expected. Additionally, 1" of ice is roughly equivalent in weight per square foot to 10" of snow. Considering the worst ice storms in Texas City cause ice accumulations of ½", it's unlikely, but not impossible, that an ice storm causing structural ice accumulations of less than 4" will cause significant structural damages.

Population

As described in Section 3 of Chapter 3 above, Texas City is home to many vulnerable residents. Areas with concentrations of young, elderly, and low-income residents may feel greater impacts from severe winter weather due to those populations' limited ability to properly address the hazard. Deficiencies may include but aren't limited to: lack of heating in their homes or vehicles, lack of access to heated public spaces during the coldest part of the day or night, and frozen pipes that may jeopardize access to drinking water, and in the worst cases, lead to severe structural damage that can render a home unlivable. The consequences for these populations' exposure to severe winter weather can include but are not limited to: complications for those suffering from hypertension, hypothyroidism, and diabetes, as well as exhaustion, hypothermia, trench foot, or death.

Critical Facilities

Any shutdown of critical facilities due to severe winter weather is expected to be temporary. However, based on the proximity of trees and power lines on their properties, the following critical facilities may be at a higher risk of losing power due to falling limbs.

Table 37: Critical Facilities Vulnerable to Severe Winter Storms

Texas City	Potential Severe Winter Storm Impacts
	Power Outages due to Falling Tree Limbs
City Engineer	x
City Hall	x
College of the Mainland	x
Fire Station - 1	x
Fire Station - 2	x
Fire Station - 3	x
Fire Station - Main	x
Nessler Center / Doyle Convention Center	x
Police Department	x

11.7 Impact

The potential impact of a severe winter storm is normally minor, resulting in few, if any, injuries. Because of the rarity of winter storm events in Texas City drivers, especially those unfamiliar with or unable to drive in icy conditions, may be at the highest risk of crashing their vehicle and sustaining injuries.

Beyond accidents caused by icy conditions, severe winter weather has the potential to cause widespread power outages. Trees and other vegetation that grow along or near power lines and utility lines can become overburdened by ice and snow accumulation. Falling limbs or trees can easily take down power and utility lines. Neglected vegetation is especially at risk of failure due to increased weight loads. Power outages can create a cascading effect depending on residents' ability to heat their homes without electricity, especially for those young, elderly, and low-income

residents as identified in Section 3 of Chapter 3 above. Although no deaths related to severe winter storms have been reported in the planning area, in the worst cases, the hazard has the potential to be deadly.

Severe winter storms will likely cause only minor property damage and minimal disruption to the quality of life in the planning area.

12.0 Drought

12.1 Description

Drought is a period of time without substantial rainfall that persists from one year to the next. Drought is a normal part of 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. Drought can be classified as meteorological, hydrologic, agricultural, and socioeconomic. Table 38 presents definitions for these different types of drought.

Drought is one of the most complex of all natural hazards as it is difficult to determine their precise beginning or end. In addition, drought 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. Consequently, a heat wave combined with a drought is a very dangerous situation.

Table 38: Drought Classification Definitions

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

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

12.2 Location

Drought occurs regularly in the Texas Gulf Basin and is a normal condition. However, droughts can vary greatly in their intensity and duration. On average, a year-long drought takes place somewhere in Texas once every three years and a major drought every 20 years. There is no distinct geographic boundary to drought; therefore, it can occur throughout Texas City.

12.3 Extent

The Palmer Drought Indices are used to measure the extent of drought. The Z Short-Term Conditions Index measures short-term drought on a weekly scale. The Meteorological Drought

Index attempts to measure the duration and intensity of the 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 levels, groundwater levels, etc.) take longer to develop. The Hydrological Drought Index in Table 39 is used to quantify the long term hydrological effects while Table 40 depicts magnitude of drought indices. Future drought events in Texas City may be as bad as D4.

Table 39: Palmer Drought Classification Indices

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	-125 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 +2.00	+3.00 to +3.00	+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 +2.00	+3.00 to +3.00	+4.00 and above

Table 40: Palmer Drought Category Descriptions

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
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

Source: National Drought Mitigation Center

Drought is a slow-onset hazards, but over time can have damaging effects on crops, municipal water supplies, recreation, and wildlife. If drought extends over a number of years, the direct and indirect economic impact can be significant.

Drought warnings are issued by the State Drought Preparedness Council, as directed by H.B. 2660, based upon input from NOAA, the Office of the State Climatologist, the U.S. Geological Service, the Texas Water Development Board, Texas Commission on Environmental Quality, and the Texas Agricultural Statistics Service. Warnings utilize five "levels of concern" and take into account assessments of climatology, agriculture, and water availability for each of 10 climatic regions of the state.

Drought is monitored nationwide by the National Drought Mitigation Center (NDMC). Indicators are used to describe broad scale drought conditions across the U.S. Indicators correspond to the intensity of drought. A snapshot of the region from December 2015 is included as Figure 14.

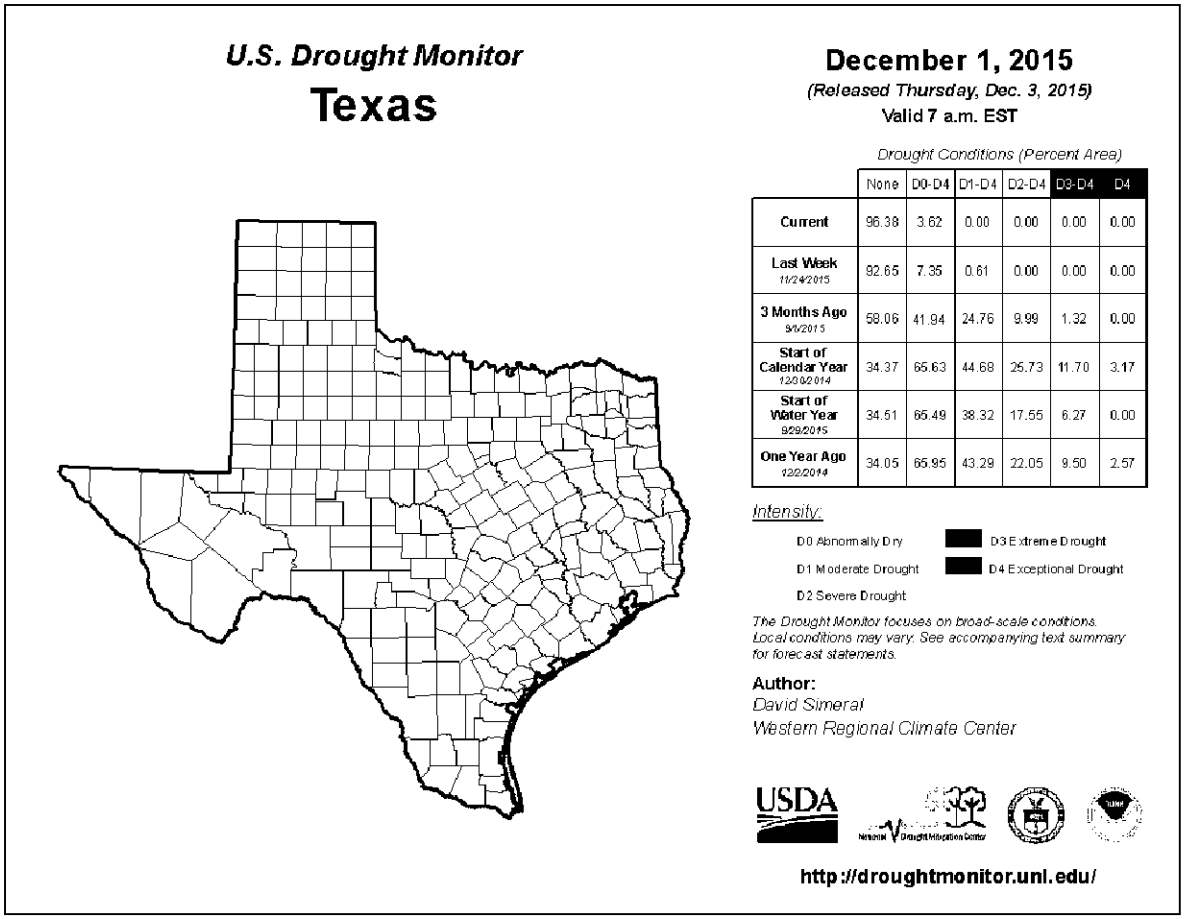


Figure 14: U.S. Drought Monitor Indices, December 2015

12.4 Historical Occurrences

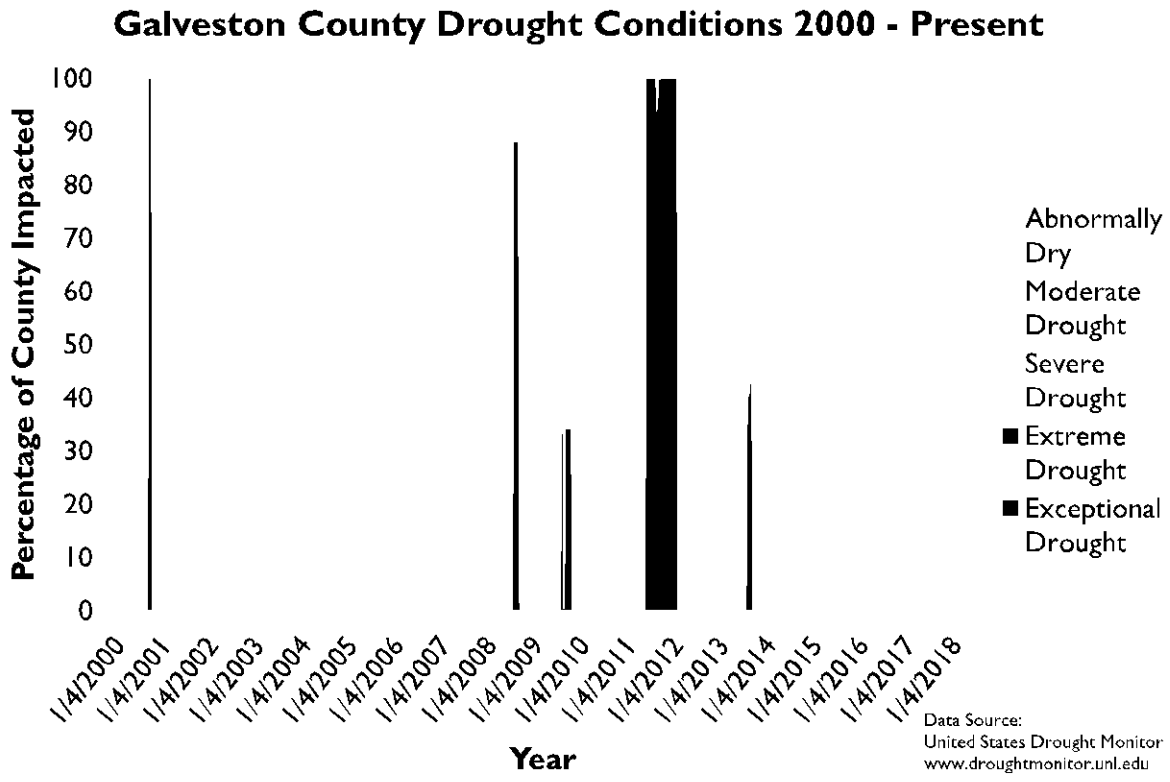


Figure 15: Galveston County Drought History

Although the Galveston County area does not typically experience severe or extreme drought due to its proximity to the coast, it has been affected by key historic events. The NCEI collects drought data on a countywide level and therefore the summary of events provided below include Galveston County and Texas City, followed by a summary of damages sustained in Table 41.

1996 Drought

From April to June of 1996, Southeast Texas, including Galveston County, experienced moderate to severe drought due to below normal precipitation that fell in the winter of 1995 to 1996. Some areas received only about 30 percent of their normal rainfall. Although exact county estimates are not available, total property damage across Southeast Texas reached $2 million with approximately $8 million in agricultural losses.

1998 Drought

Galveston County experienced another period of severe drought in 1998, beginning in May and ending in August. Rainfall levels were nine inches below normal, yet the area experienced temperatures at or above 96 degrees for months. Total crop and property damages reached $8.3 million for the county.

2000 Drought

High heat and dry conditions brought moderate to extreme drought to the area. Rainfall levels were down from 30 to 50 percent from their normal levels for the months of August and September. Wildfires broke out in neighboring counties, and the total crop damages for Southeast Texas were estimated at $102.3 million.

2005 Drought

Texas experienced record drought from 2005 to 2006 with a shortage of rainfall that lasted from May to December. Although the Galveston area was not affected as much as counties in North and Central Texas, it did experience abnormally dry conditions and moderate drought. The statewide drought losses from this event were estimated at $4.1 billion.

2009 Drought

Like the 2005 drought, this period of high heat coupled with a lack of rainfall affected the entire state. The drought began in March and did not lessen in intensity until the fall months of 2009. Galveston County experienced abnormally dry conditions, moderate and severe drought, with conditions improving in October of 2009.

2011 Drought

This drought was the most severe one-year drought on record for the State. Most of the State, including Galveston County, experienced D-4 Extreme Drought conditions. July of 2011 was the warmest month on record statewide; coastal portions of Galveston County did see some relief with slightly lower high temperatures due to the proximity to the Gulf of Mexico.

As reflected in Figure 15 above, varying levels of drought have affected Texas City, since 2000, with the worst conditions occurring between 2011 – 2012. Previous drought conditions have ranged from abnormally dry to exceptional drought.

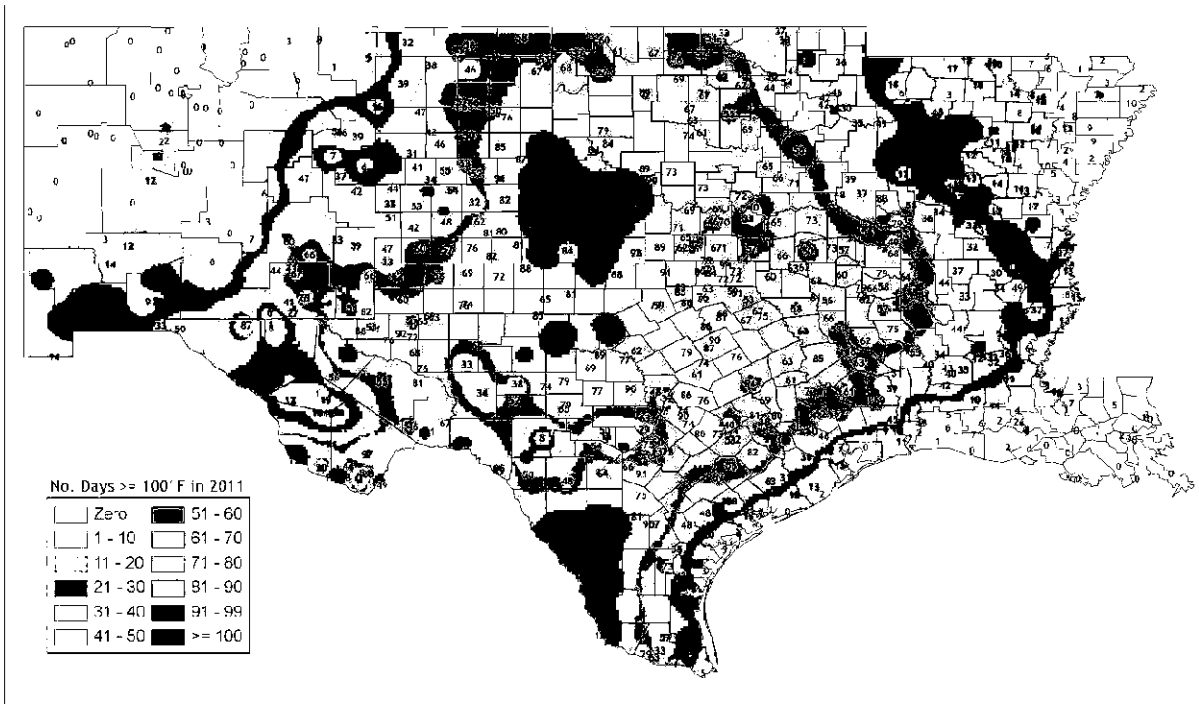


Figure 16: Number of Days with Maximum Temperatures Equaling or Exceeding 100° in 2011

Note: Graphic created by Brent McRoberts, Office of the State Climatologist, from Applied Climate Information System data in the 2011 Texas Drought Briefing Packet.

Table 41: Galveston Countywide Summary of Drought Events

Date	Deaths	Injuries	Property Damage	Crop Damage
April 1, 1996	0	0	0	0
May 1, 1996	0	0	0	0
June 1, 1996	0	0	0	0
May 1, 1998	0	0	0	0
June 1, 1998	0	0	0	0
July 1, 1998	0	0	0	0
August 1, 1998	0	0	$1,000,000	$7,300,000
August 1, 2000	0	0	0	0
September 1, 2000	0	0	0	$102,300,000
Total	**0**	**0**	**$1,000,000**	**$109,600,000**

Source: NCEI

12.5 Probability of Future Events

Based on the historical frequency, it is likely that Texas City will experience at least one drought season in the next five years, with an average of 2 occurring every 6 years (1996-2014). Historical frequencies from 1895 to 1995 reveal that the entire Texas Gulf Coast Basin suffered drought conditions every 10 or 20 years and half of the basin suffered drought every five years.

12.6 Vulnerability Assessment

Because drought has the potential to impact the entire planning area equally, all improved property and the entire population is exposed to this hazard. Foundations of all buildings are vulnerable; however, older structures or those built under less stringent foundation code requirements are most vulnerable. Critical infrastructure like water and wastewater lines, roads, and railroads are also vulnerable. Drought is likely to require increased output from the local power company, TNMP, in order to keep up with electrical demand. Depending on factors like time of year, temperature, and duration, increased electrical demand may cause brownouts that would impact healthcare providers like Mainland Medical Center and area nursing homes. Lower income populations who may not have the resources to buy large quantities of bottled water in the event of a shortage may be more vulnerable than other populations.

Population

As described in Section 3 of Chapter 3 above, Texas City is home to many vulnerable residents. Increased vulnerability may be due to many factors including but not limited to: age, physical ability, financial means, housing type, and housing condition. Many of these vulnerabilities often overlap.

Texas City recognizes that vulnerable populations may need additional help preparing for and recovering from a drought.

Lower income populations who may not have the resources to buy large quantities of bottled water in the event of a shortage may be more vulnerable than other populations.

Residents of sub-standard structures are also of particular concern. Structures in sub-standard condition ahead of a drought may be more likely to suffer additional damages, including irreparable damage to building foundations as soils shift and shrink. Depending on their financial means, these residents may require additional assistance recovering from drought-caused damages.

Critical Facilities

In addition to triggering various components of Texas City's Drought Contingency plan, drought conditions may affect local critical facilities. Area fire departments may see increased demand for controlling wildland fire due to dry conditions. Structural damage to all critical facilities, based on the rarity of previous instances of structural damage, is expected to be limited. However, in the worst cases such damage is possible, and may include cracked building foundations, damages to water and wastewater lines that serve the facilities, and in certain cases, these physical damages may create economic damages for the broader community.

Table 42: Critical Facilities Vulnerable to Drought

Texas City	Potential Drought Impacts			
	Structural Damage	Water / Wastewater Line Damages	Increased Demand for Services	Economic Damages
City Engineer	x	x	x	
City Hall	x	x	x	x
College of the Mainland	x	x	x	x
Fire Station - 1	x	x	x	
Fire Station - 2	x	x	x	
Fire Station - 3	x	x	x	
Fire Station - Main	x	x	x	
Nessler Center / Doyle Convention Center	x	x	x	x

Police Department	x	x	x	
Pump Station A	x	x	x	
Pump Station B	x	x	x	

Vulnerable Parcels

Given drought's geographic reach, all parcels within Texas City are equally vulnerable to the hazard. However, given the limited damages inflicted by previous droughts, future damages are expected to be similarly limited.

Table 43: Parcels Vulnerable to Drought

Jurisdiction	Parcel Count	Estimated Potential Damage Value
City of Texas City	20,330	$4,286,398,656[17]

Vulnerable Infrastructure

Water and Wastewater Systems

Water and wastewater systems rely on underground pipe networks to function properly. During extreme droughts, as the ground shifts and shrinks, these pipes become vulnerable to cracks and breaks.

Damage to water and wastewater systems, especially during a drought, may be severe enough exceed Texas City's ability to immediately fund repairs without outside assistance. Delays to returning these systems to normal functionality will require emergency alternatives.

Road and Railroad Networks

Drought conditions may damage road and railroad networks in various ways. Depending on usage and temperature, as soil shifts and shrinks, roadbeds and railroad beds may subside. In the case of railroads, subsidence may lead to failure. A combination of shifting ground, high temperatures, and heavy usage may cause asphalt roads to become rutted.

[17] Galveston County 2015 CAD Data

The City of Texas City is served by two class one railroads: Union Pacific and Burlington Northern/Santa Fe.

The Texas City Terminal Railway Company operates more than 32 miles of track in Texas City, provides all switching, and connects to the main lines with two switching terminals within six miles of the main classification yard. Damages to the rail lines could be catastrophic if they were to cause a derailment.

Although surface streets may be most vulnerable to drought's effects due to variations in street construction requirements, damages to Interstate Highway 45 and SH 146 would create the greatest impact in the planning area because they also function as hurricane evacuation routes.

12.7 Impact

Infrastructural impacts may include damage to the foundations of all building types. Road and railroad networks in the planning area may be damaged to the point of failure as the ground shifts and shrinks. Local water and wastewater systems may fail due to cracks and breaks in underground tanks and pipe networks.

Economic impacts may include: increased prices for food, unemployment, and reduced tax revenues.

13.0 Wildland Fire (Urban and Rural)

13.1 Description

Wildland fire is defined as any fire burning wildland vegetation-fuels; it includes prescribed fire, wildland fire use, and wildfire. Prescribed fires are planned fires started by land managers to accomplish specific natural resource objectives. Fires that occur from natural causes, such as lightning, that are then used to achieve management purposes under carefully controlled conditions with minimal suppression costs are known as wildland fire use (WFU).

Wildfires are unwanted and unplanned fires that result from natural ignition, unauthorized human-caused fire, escaped WFU, or escaped prescribed fire.

A **wildland-urban interface (WUI) fire** is a wildfire occurring in the wildland urban interface. 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 from wildfire.

Prescribed burning, also known as controlled burning, is the deliberate use of fire under specified and controlled conditions. Prescribed burning is used by forest management professionals and individual landowners to accomplish one or more of the following tasks:

- ***Fuel Reduction*** – The reduction of accumulated grass, weeds, pine needles, and hardwood leaves. This type of vegetation can encourage wildfires in young stands and hinder regeneration of older stands.
- ***Hardwood Control*** – Prevents hardwood trees from competing with pines for nutrients and moisture; impeding visibility and access through the stands; and interfering with natural regeneration in areas better suited for growing pines.

The wildland interface problem has grown due to increases in population, urban expansion, land-management decisions, parks, greenbelts and the ever-present desire to intermingle with nature.

13.2 Location

Figure 17 graphically illustrates the wildfire hazard areas and provides an indication of where there is potential for damage to property and loss of life in Texas City. Figure 18 depicts wildfire threat levels and previous wildfire locations in Texas City.

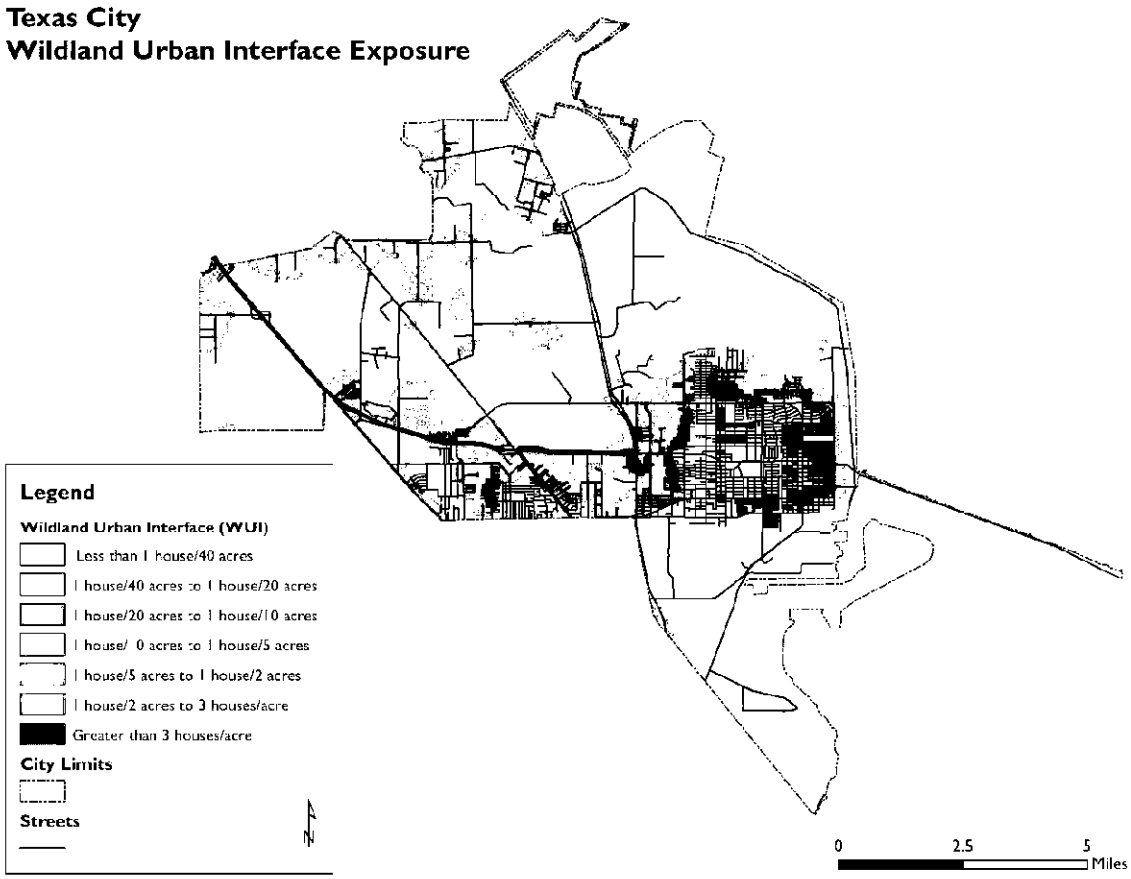


Figure 17: Texas City WUI Exposure

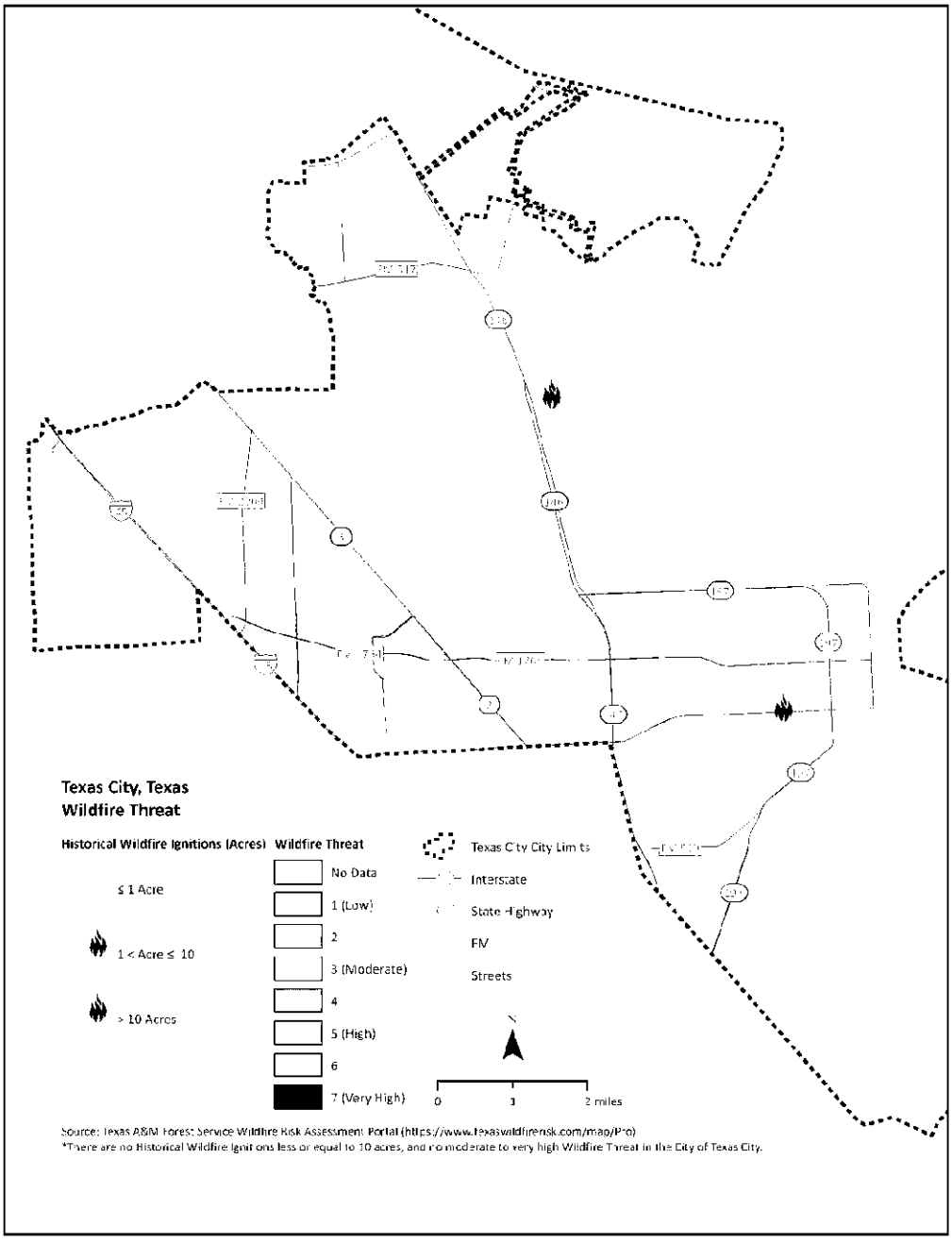


Figure 18: Wildfire Threat Levels and Historic Wildfire Locations

13.3 Extent

Fire risk 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 water balance, where a drought factor is balanced with precipitation and soil moisture (assumed to have a maximum storage capacity of 8 inches) and is expressed in hundredths of an inch of soil moisture depletion.

Figure 19 represents a current KBDI for the state of Texas with the drought index noted to correspond with the index range as shown in the legend. The drought index ranges from 0 to 800, where a drought index of 0 represents no moisture depletion, and an index of 800 represents absolutely dry conditions. Galveston County, including Texas City, is within the 400 – 500 range. Table 44 provides the fire behavior categories for the four levels defined.

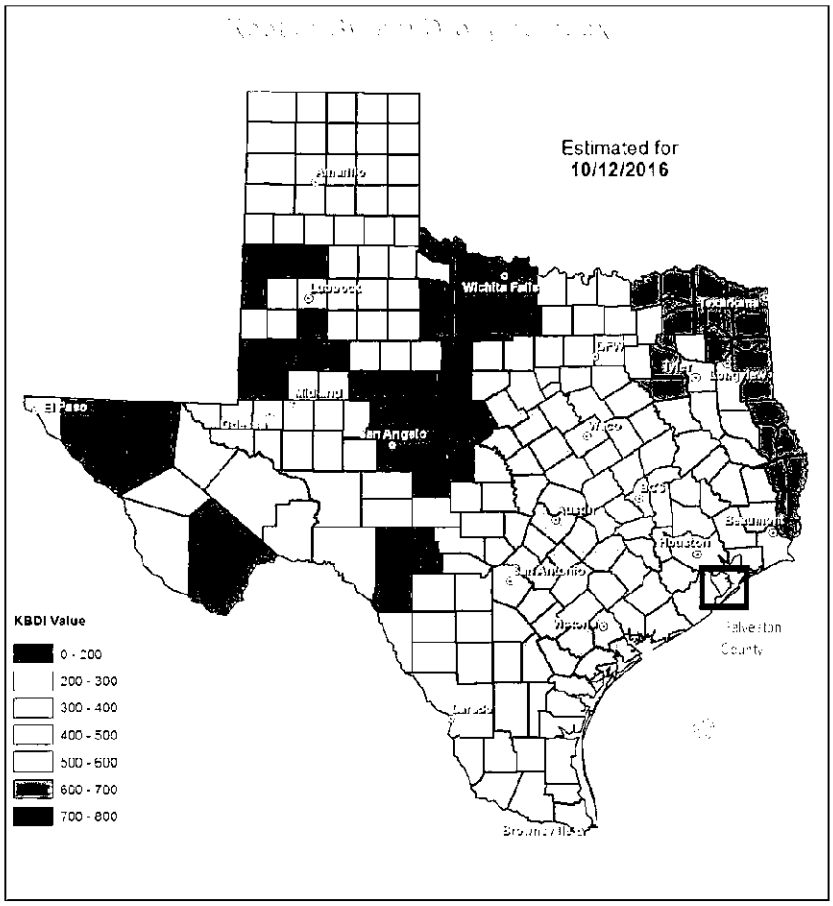


Figure 19: KBDI for the State of Texas (Galveston County Highlighted)

Table 44: Keetch-Byram Drought Index Values for Drought and Fire Potential

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

Texas City can expect future wildfire events that range from 0 to 600 KBDI.

13.4 Historical Occurrences

The Texas A&M Forest Service TxWRAP database was reviewed to collect information about previous wildfires in Texas City.

Table 45: Historical Wildfire Impacts in Texas City

Jurisdiction	Number of Events	Maximum Acres Burned	Property Damage
Texas City	2	200	NA

Texas City has not experienced a wildfire event since 2011.

13.5 Probability of Future Events

Climatic conditions such as severe freezes and drought can significantly increase the probability of wildland fires since these conditions kill vegetation, creating a prime fuel source for these types of fires. The intensity of fires and the rate at which they spread are directly related to wind speed, temperature, and relative humidity.

The threat of wildland fire changes with the season, but given the frequency of previous fires within Galveston County, including Texas City, the probability of future occurrence of a wildland fire is likely within in the next 4-5 years.

13.6 Vulnerability Assessment

Population

As described in Section 3 of Chapter 3 above, Texas City is home to many vulnerable residents. Increased vulnerability may be due to many factors including but not limited to: age, physical ability, financial means, housing type, and housing condition. Many of these vulnerabilities often overlap.

Texas City recognizes that vulnerable populations may need additional help preparing for and recovering from a wildfire.

Residents of mobile homes, specifically those built before HUD's Manufactured Housing and Standards requirements were introduced in 1976, are of particular concern. These structures are more prone to fire and have a higher incidence of occupant death than modern manufactured homes.

Residents of sub-standard structures are also of particular concern. Structures in sub-standard condition ahead of a wildfire, whether due to structural damages, missing windows or doors, holes in exterior walls or the roof, may be less safe during a wildfire than structures in standard condition. Exterior damages may make the homes more prone to fire by more readily exposing flammable materials to flame. Missing windows and other exterior gaps may leave residents and structures prone to smoke inhalation and smoke damage.

All of these issues may increase damages and lead to injuries or loss of life.

Critical Facilities

None of Texas City's critical facilities are located within the wildland urban interface. However, given the density of local development and their proximity to wildland urban interface areas, all are considered vulnerable to the hazard.

Table 46: Critical Facilities Vulnerable to Wildfire

Texas City	Potential Wildfire Impacts				
	Destruction	Partial Destruction	Heat Damage	Smoke Damage	Water Damage
City Engineer	x	x	x	x	x
City Hall	x	x	x	x	x
College of the Mainland	x	x	x	x	x
Fire Station - 1	x	x	x	x	x
Fire Station - 2	x	x	x	x	x

Fire Station - 3	x	x	x	x	x
Fire Station - Main	x	x	x	x	x
Nessler Center / Doyle Convention Center	x	x	x	x	x
Police Department	x	x	x	x	x
Pump Station A	x	x	x	x	x
Pump Station B	x	x	x	x	x

Vulnerable Parcels

Table 47: Parcels Vulnerable to Wildfire

Jurisdiction	Total	Estimated Potential Damage Value
Texas City	8,162	$1,198,151,802

13.7 Impact

Wildland fires are more likely to occur during periods of high wind and low humidity; warning time is minimal to none. Due to the humid climate of the Galveston County planning area, the amount of previous occurrences and the potential property at risk, the impact of an event would be minor with few injuries and minimal property affected, damaged or destroyed.

14.0 Expansive Soils

14.1 Description

Expansive soils are soils that expand when water is added, and shrink when they dry out. This continuous change in soil volume can cause structures to move unevenly and crack and roads and sidewalks to buckle. Soils with a high clay content exhibit high expansive properties. Slab on grade construction is the most susceptible to damage from expansive clays.

14.2 Location

As shown in the maps below, expansive soils exist across Texas City and Galveston County. They have the potential to affect the entire planning area. Areas within Texas City may be more affected by expansive soils depending on both building location and building type.

14.3 Extent

According to the State of Texas Mitigation Plan Update 2013, determining the extent of the expansive soils hazard requires measuring a soil's swelling potential or volumetric swell. To test the soil for these properties, the State outlined the following procedure:

> Soil material is disaggregated and passed through the #4 sieve and then brought to approximately the optimum moisture content (as determined by American Society for Testing and Materials [ASTM-D-1557]). The optimum moisture content equates to approximately 80 to 85% of saturation. After setting for 6 to 30 hours, the moisture-conditioned soil is compacted into a 4-in diameter mold. The moisture content is then adjusted, if necessary, to bring the sample to 50% saturation. A 144 psf surcharge is applied and the sample is wetted and monitored for 24 hours, measuring the volumetric swell. The Expansion Index is calculated as follows:
>
> $EI = 100 \times \Delta h \times F$
>
> Where Δh = percent swell and F = fraction passing No. 4 sieve
>
> The following "ratings" can be accepted examples expected for "extent" when a risk is identified as Expansive Soils:

Table 48: ASTM D4729-11 Expansive Soils Index (in %)

0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

Texas City instead decided to rely on the county-wide soil studies produced by the United States Department of Agriculture (USDA), Soil Conservation Service[18] as well as the USDA's Web Soil Survey[19] data. The Web Soil Survey in particular offers both soil maps and USDA guidance on soil suitability for various types of development.

For the purposes of this plan, Texas City decided to consider the ratings of Galveston County soils for the construction of both residential dwellings on concrete slab and small commercial buildings.

As shown in Figure 20 below, nearly half (43.8%) of Galveston County contains soils that are "Very Limited" for the construction of dwellings on concrete slab, the State's most prevalent dwelling foundation. Additionally, a small portion (12.5%) of the County's soils are considered "Somewhat Limited" for the construction of dwellings on concrete slab. Texas City is primarily composed of soils that are considered "Very Limited" for the construction of dwellings on concrete slab. The City also contains areas that are considered "Somewhat Limited" as well as areas that have no current rating.

[18] https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/texas/jimwellsTX1979/jimwells.pdf
[19] http://websoilsurvey.nrcs.usda.gov/app/

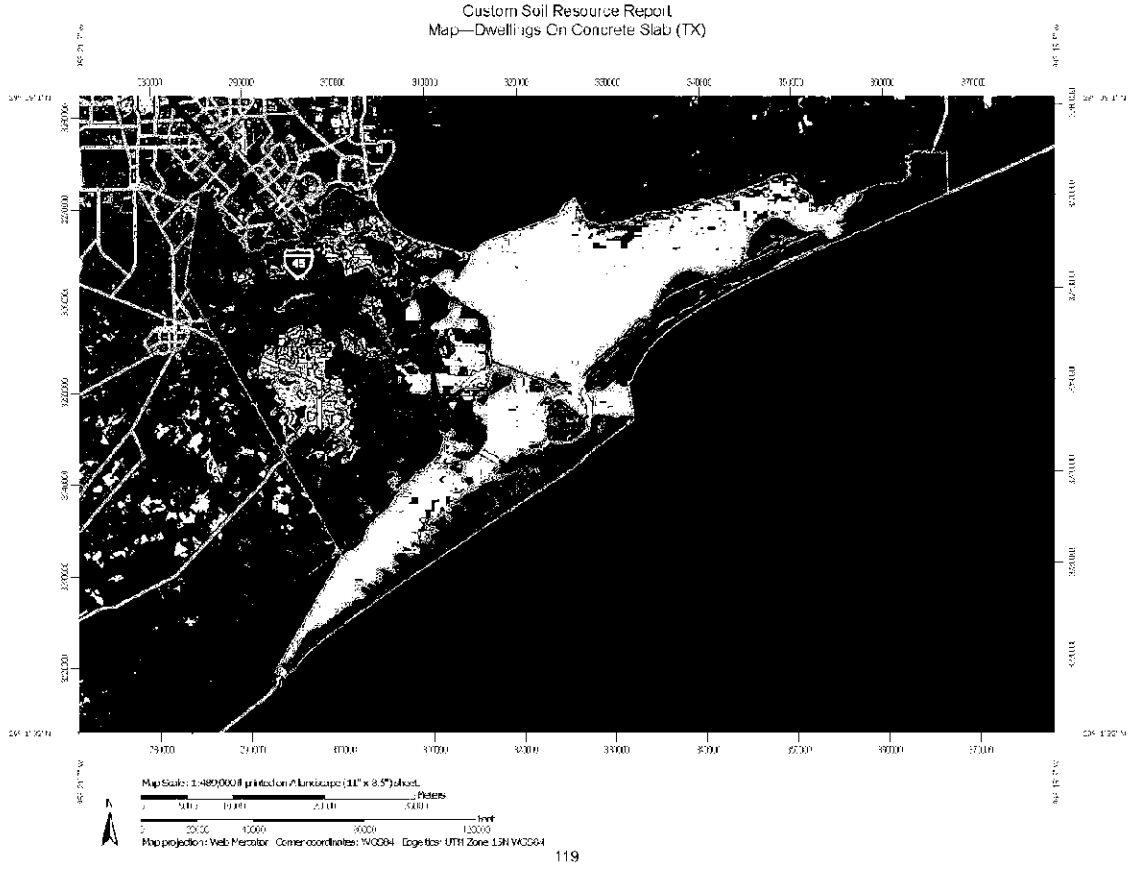
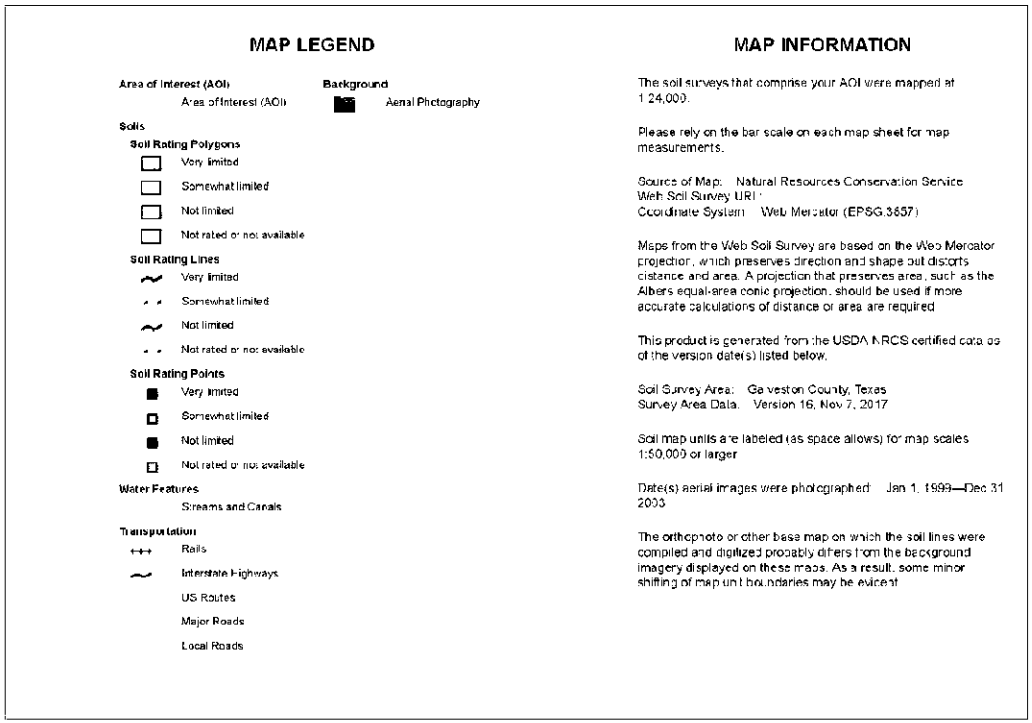


Figure 20: Galveston County Soil Ratings for the Construction of Dwellings on Concrete Slab

Figure 21: Texas City Limits on Galveston County Soil Ratings for the Construction of Dwellings on Concrete Slab

Custom Soil Resource Report



As shown in Figure 22 below, Galveston County, including Texas City, is primarily comprised of soils that are "Very Limited" (55.2% of the County) for the construction of small commercial buildings, defined as structures less than three stories high, without basements, and constructed on foundations consisting of spread footings or reinforced concrete built on undisturbed soil at a depth of 2' or at the depth of maximum frost penetration, whichever is deeper.

The areas considered very limited for the construction of small commercial buildings are spread throughout the planning area.

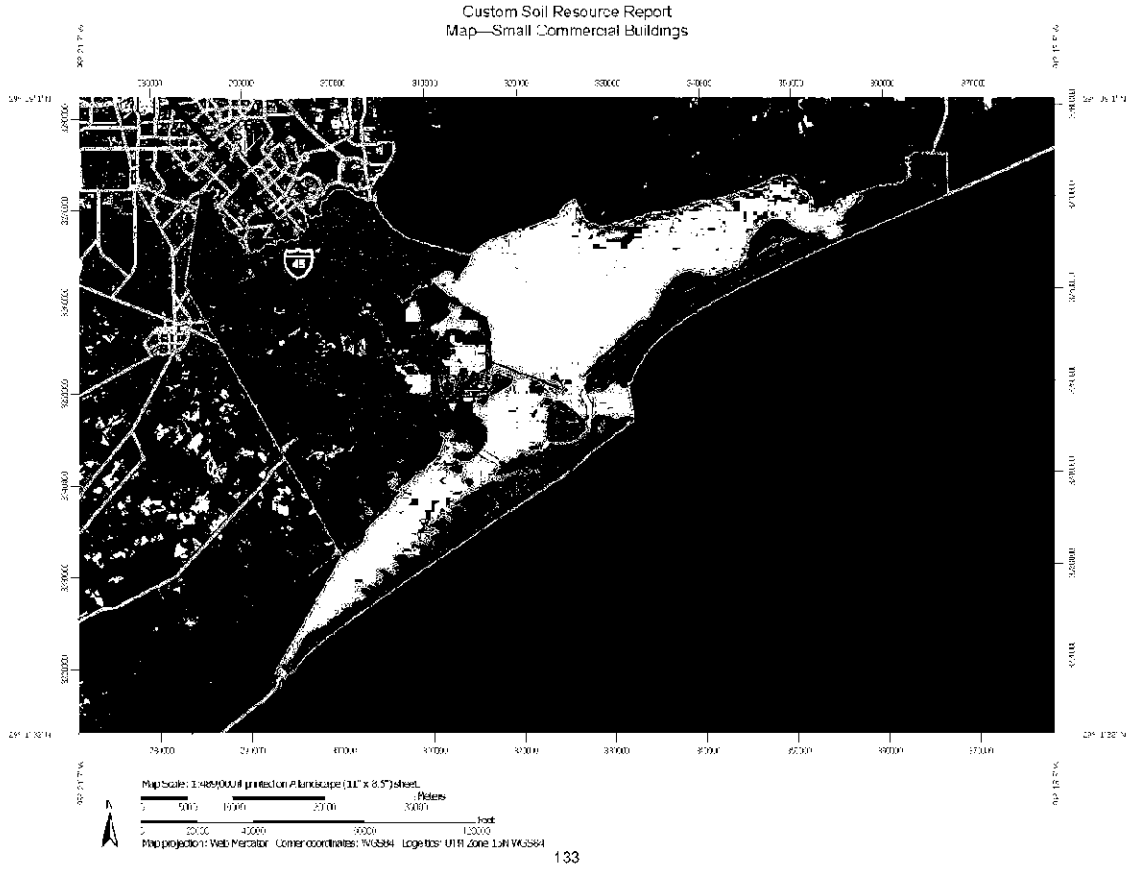
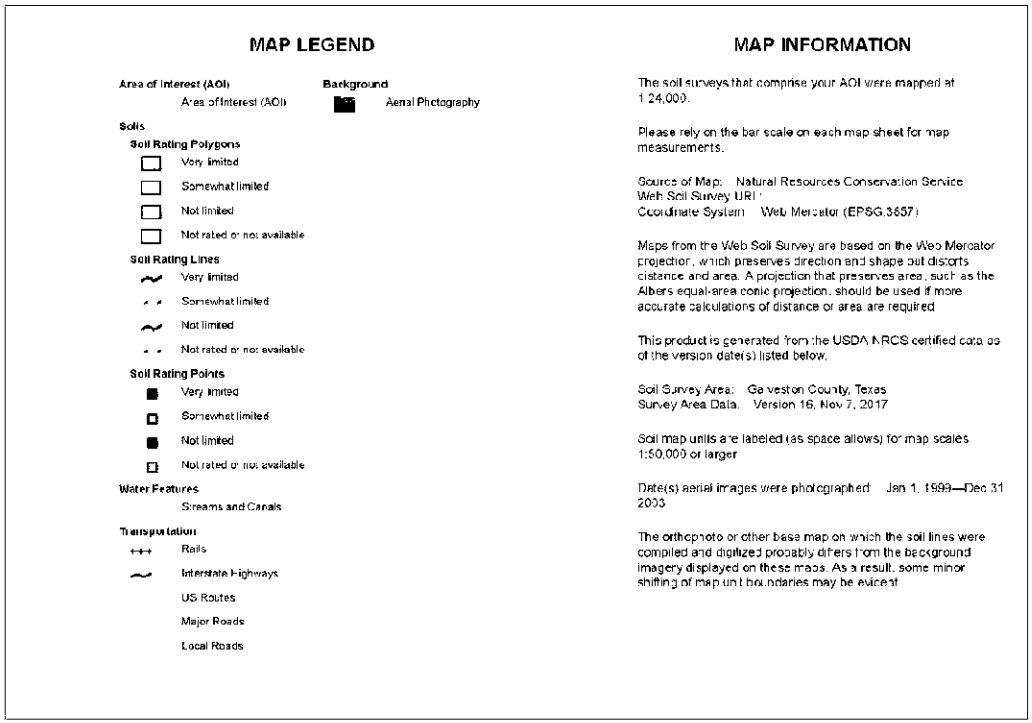


Figure 22: Galveston County Soil Ratings for the Construction of Small Commercial Buildings

Figure 23: Texas City Limits on Galveston County Soil Ratings for the Construction of Small Commercial Buildings

Custom Soil Resource Report



14.4 Historical Occurrences

There were no documented losses due to expansive soils for Galveston County, including Texas City. Sources verified included the USGS, GCOEM, Texas General Land Office, and NCEI. However, the planning team has determined that the hazard is known to affect structures and infrastructure in the planning area. Moving forward, Texas City will make an effort to track instances of damages due to expansive soils to begin developing a comprehensive history of the hazard and its effects.

14.5 Probability of Future Events

Galveston County receives approximately 50 inches of rain annually. Given the high average annual rainfall and the areas propensity for drought, expansive soils will likely continue to impact the areas with a high expansive soil rating found in Texas City.

14.6 Vulnerability Assessment

The entire planning area is exposed to expansive soils to varying degrees based on both soil type and building type, as shown in Figures 20-23 above. At this time, given the combination of the hazard's ability to inflict unpredictable damages, the lack of officially reported data, and the diversity of building ages, types, and foundations in Texas City, it's unfeasible to identify which buildings, infrastructure, and critical facilities are vulnerable to damages significant enough to interrupt or stop normal operations. Therefore, all are considered equally vulnerable to the hazard.

Critical Facilities

Table 49: Critical Facilities Vulnerable to Expansive Soils

Texas City	Potential Expansive Soil Impacts			
	Structural Damage	Water / Wastewater Line Damages	Increased Demand for Services	Economic Damages
City Engineer	x	x	x	
City Hall	x	x	x	x
College of the Mainland	x	x	x	x
Fire Station - 1	x	x	x	
Fire Station - 2	x	x	x	
Fire Station - 3	x	x	x	
Fire Station - Main	x	x	x	
Nessler Center / Doyle Convention Center	x	x	x	x
Police Department	x	x	x	

Pump Station A	x	x	x	
Pump Station B	x	x	x	

Vulnerable Parcels

Table 50: Parcels Vulnerable to Drought

Jurisdiction	Parcel Count	Estimated Potential Damage Value
City of Texas City	20,330	$4,286,398,656[20]

[20] Galveston County 2015 CAD Data

Vulnerable Infrastructure

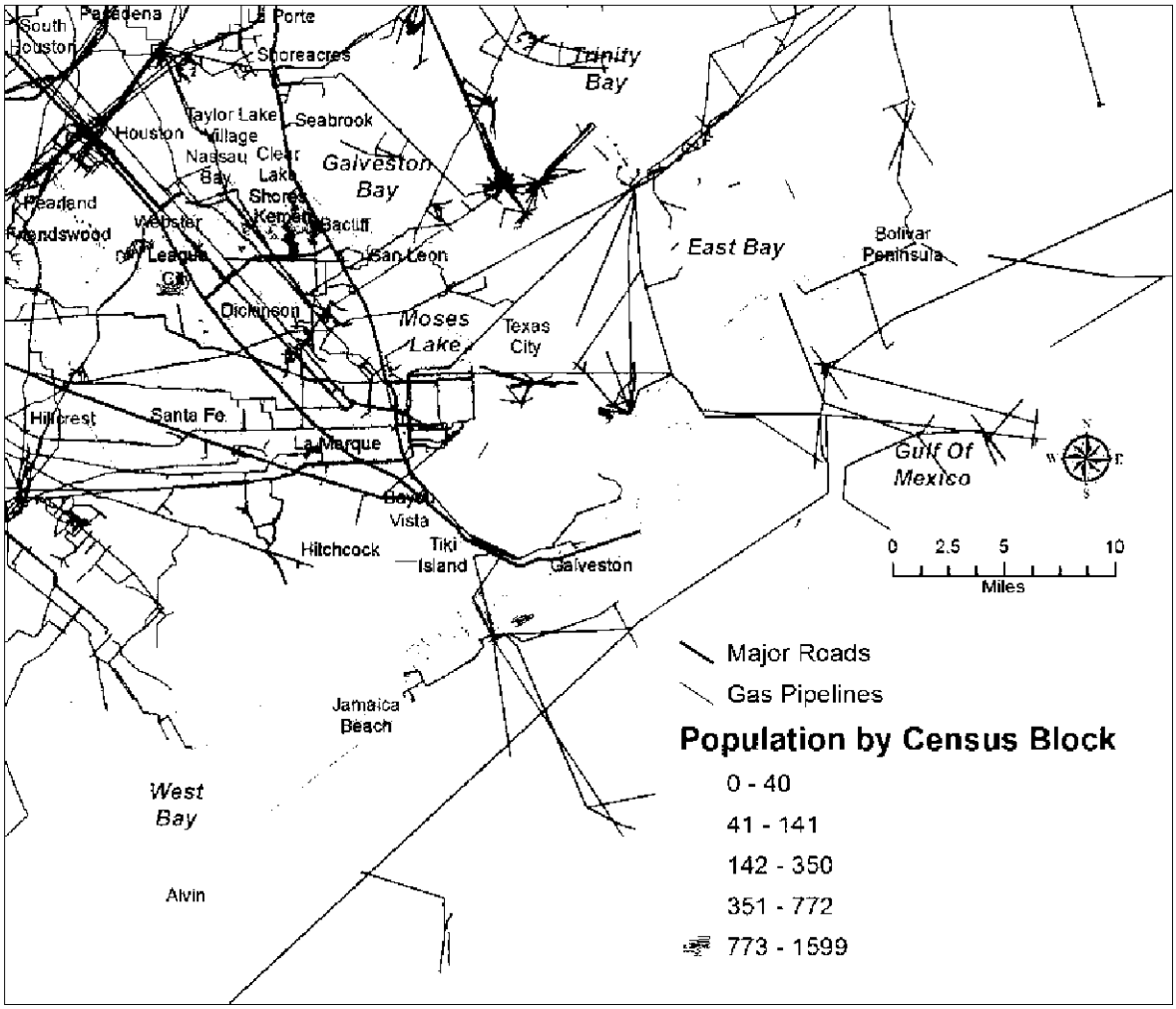


Figure 24: Planning Area Gas Pipelines

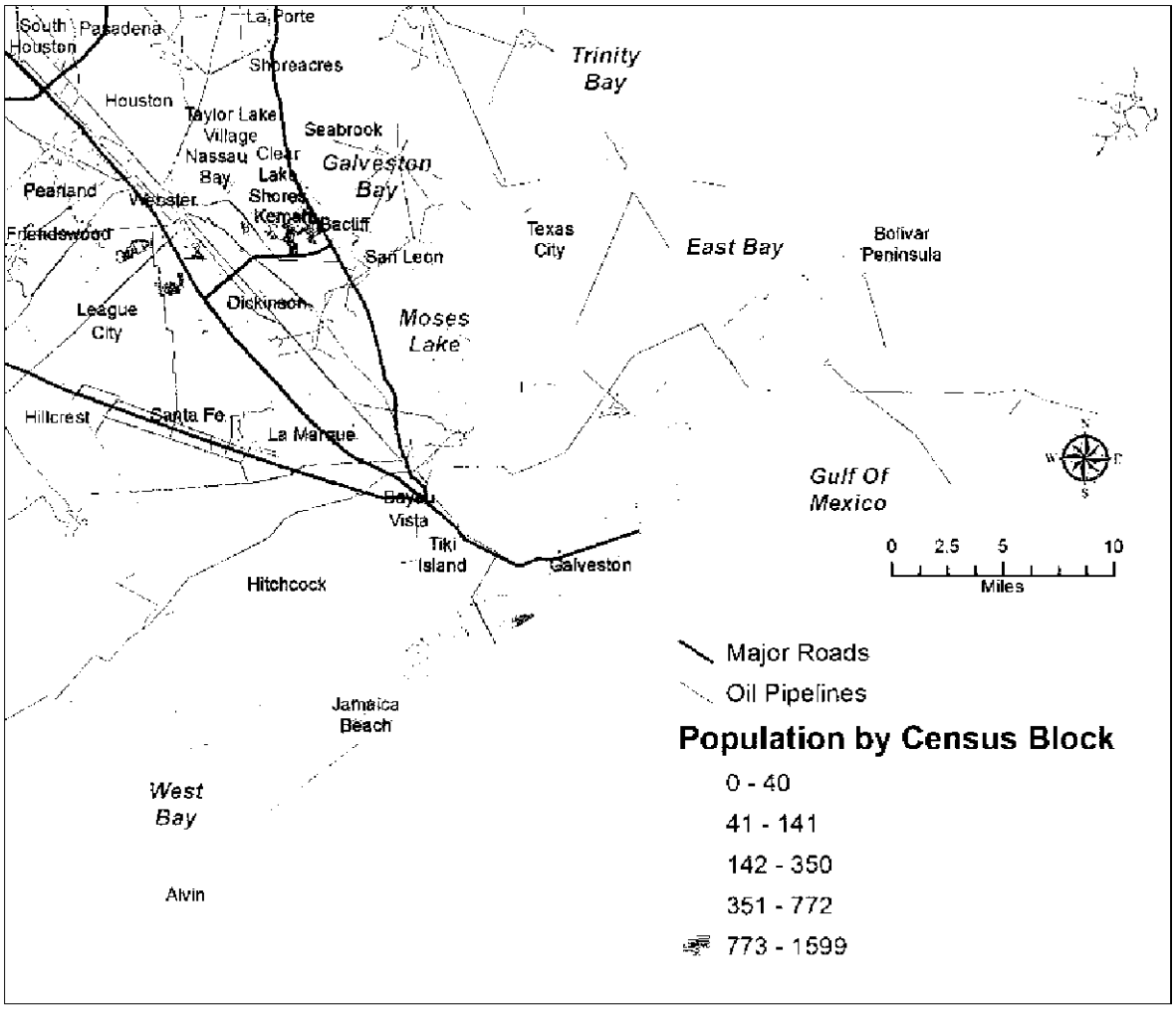


Figure 25: Planning Area Oil Pipelines

14.7 Impact

The potential impact of expansive soils in Texas City is unknown at this time. Future hazard events are expected to result in few, if any, injuries.

However, as outlined in the State of Texas Mitigation Plan Update 2013, the combination of expansive soils and Texas homebuilders' propensity for installing concrete slab foundations, often results in cracked foundations that can literally halve a home's value. In such cases, economic losses are not limited to those borne by the homeowner. Instead, halved property values result in lower property values, and therefore, lower property tax revenues.

Potential ripple effects make it difficult to estimate how wide-reaching expansive soils' impact could be. Under the right circumstances, expansive soils may wreak havoc on local economies by depleting homeowners' bank accounts and decimating municipal budgets. In the worst cases, building owners may choose to walk away, rather than make costly repairs, thus saddling local governments with abandoned properties and the incumbent challenges they pose.

15.0 Dam and Levee Failure

15.1 Description

Dam

Dams are water storage, control, or diversion structures that impound water upstream in reservoirs. Dam failure can take several forms, including a collapse of, or breach in, the structure. While most dams have storage volumes small enough that failures have few or no repercussions, dams storing large amounts can cause significant flooding downstream. Dam failures can result from any one, or a combination, of the following causes:

- Prolonged periods of rainfall and flooding, which cause most failures;
- Inadequate spillway capacity, resulting in excess overtopping of the embankment;
- Internal erosion caused by embankment or foundation leakage or piping;
- Improper maintenance, including failure to remove trees, repair internal seepage problems, or maintain gates, valves, and other operational components;
- Improper design or use of improper construction materials;
- Failure of upstream dams in the same drainage basin;
- Landslides into reservoirs, which cause surges that result in overtopping;
- High winds, which can cause significant wave action and result in substantial erosion; and
- Destructive acts of terrorism.

Benefits provided by dams include water supplies for drinking, irrigation and industrial uses; flood control; hydroelectric power; recreation; and navigation. At the same time, dams also represent a risk to public safety. Dams require ongoing maintenance, monitoring, safety inspections, and sometimes even rehabilitation to continue safe service.

In the event of a dam failure, the energy of the water stored behind the dam is capable of causing rapid and unexpected flooding downstream, resulting in loss of life and great property damage. A devastating effect on water supply and power generation could be expected as well. The terrorist attacks of September 11, 2001, generated increased focus on protecting the country's infrastructure, including the safety of dams.

Levee

Levees (also "floodwalls") are human-made structures designed to contain, control or deflect the flow of water to provide protection from temporary flooding. Levees usually protect from seasonal flooding, and may be subject to water loading for periods of only a few days or weeks each year.

Many of the nation's levees were first put in place by farmers to protect agricultural areas from frequent flooding. They date back as much as 150 years, but in that time, land use has changed and development has taken place where these farms were once located. Levees are earthen berms and/or concrete walls built to keep storm surge or other water from flooding the land behind it and can decay over time. Accurate mapping of the risks of flooding behind levees depends on knowing the condition and level of protection the levees provide.

15.2 Location

Dam

The state of Texas currently lists 7,126 non-federal dams. According to the American Society of Civil Engineers-Texas Section Report Card (2012), there are 1,046 high hazard dams in Texas. The state of Texas has more dams than any other state in the Union (See Figure 26).

According to the National Inventory of Dams, there is one major dam in Galveston County, which is the Galveston County Water Reservoir Dam located at Dickinson Bayou in Texas City This dam, operated and maintained by the Gulf Coast Water Authority, is classified as a "High" hazard dam. Texas City and the neighboring jurisdictions of Clear Lake Shores, Kemah, La Marque, and unincorporated areas of Galveston County could be impacted should this dam experience a breach. Figure 27 provides the location of the dam in relation to these communities.

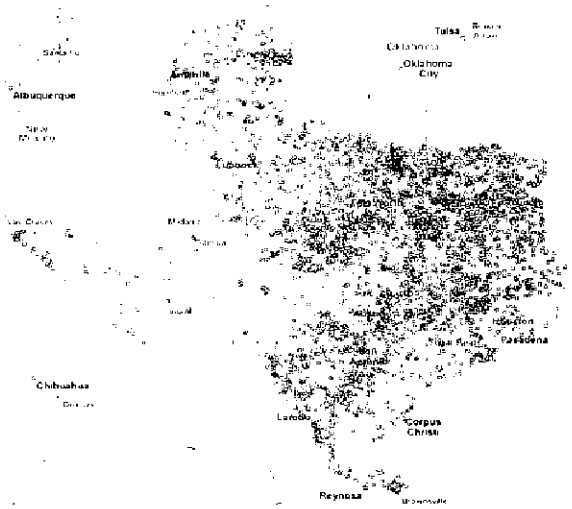
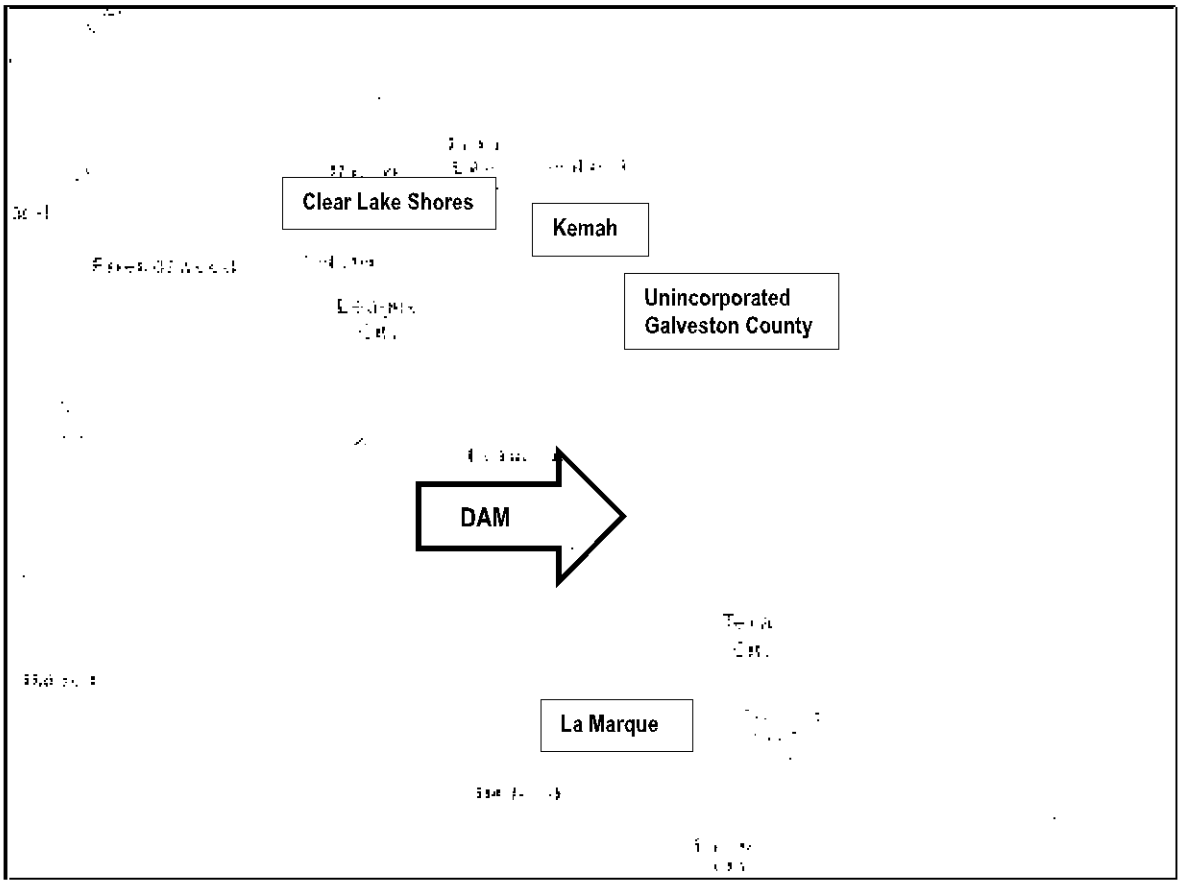


Figure 26: Location of Texas Dams

Data Deficiency

The US Army Corp of Engineers is developing a study to determine the potential location, extent, and impact of a breach from the

Galveston County Water Reservoir Dam and levee system. This study is expected to be completed in 2018 and will include a projected inundation area map. The location of the inundation area is not known at this time. Details regarding the data deficiency are provided on page 15-5.



National Geospatial-Intelligence Agency (NGA); Delta State University; Esri | scott.mcafee@fema.dhs.gov | Texas Parks & Wildlife, Esri, HERE, DeLorme, USGS, NGA, EPA, USDA, NPS

Figure 27: Galveston County Water Reservoir Dam Area

Levee

The Galveston County hurricane flood protection levee protects the cities of Texas City and La Marque and their more than 50,000 residents and almost $7.5 billion of property, which represents more than 40 percent of Galveston County's tax base.

The levee is comprised of 15.7 miles of an earthen berm and 1.3 miles of concrete wall, offering a total of 17 miles of protection. Hurricane flood protection efforts in the Texas City area began in 1928 when some 13,500 feet of earthen levees were constructed by Galveston County in the

general area of the port and industrial section of Texas City. These levees reached an elevation of about 14.5 feet. In 1932, construction began on an additional 8,300-foot-long concrete wall and a 3,800-foot-long earthen levee. Both of these structures were built to an elevation of 12.5 feet. The Texas City/La Marque Hurricane Flood Protection Levee has numerous appurtenant structures. The project is designed to provide protection for about 36 square miles of residential and industrial development from tropical hurricanes of magnitudes up to and including a Standard Project Hurricane Tide of 15 feet. The location and potential impact for the levee are displayed in Figure 28.

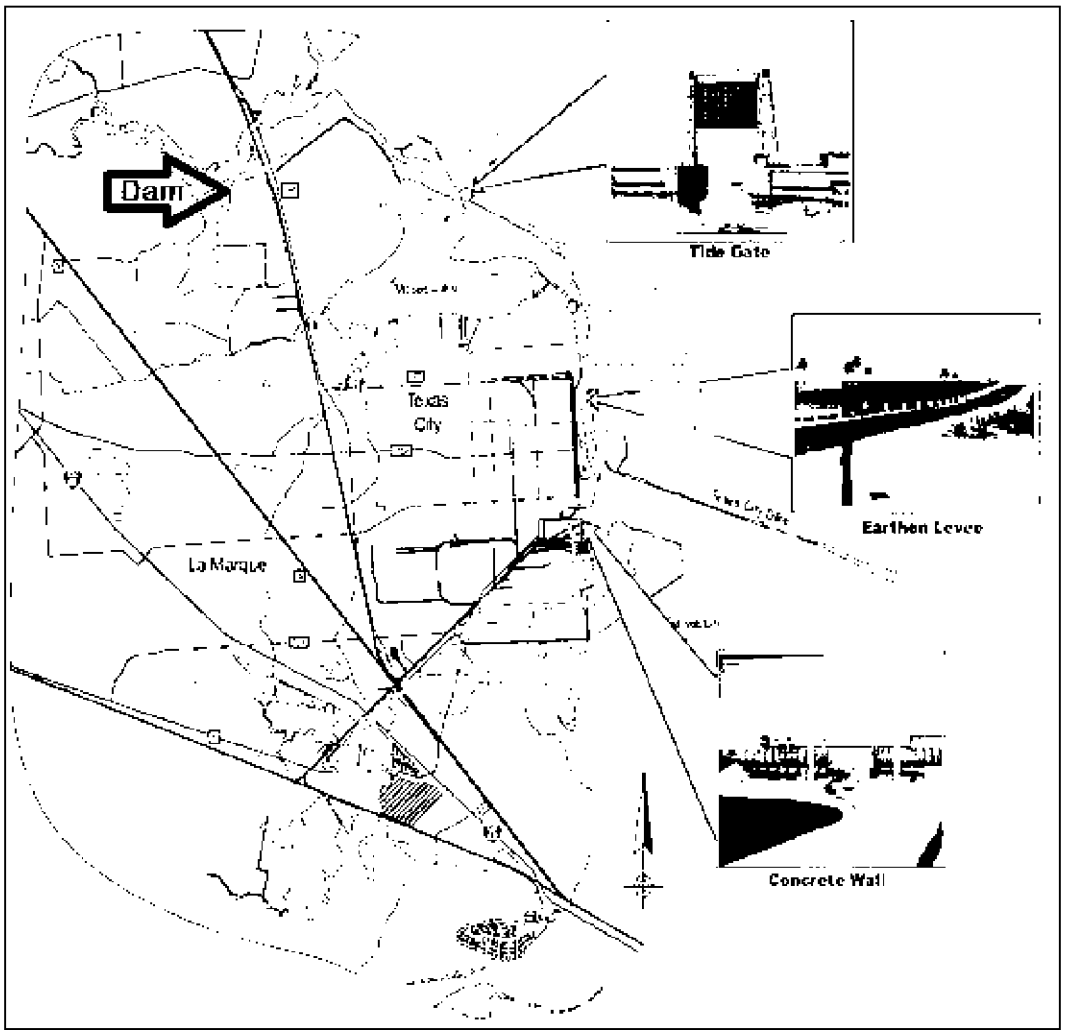


Figure 28: Map of the Texas City/La Marque Hurricane Flood Protection Levee System

15.3 Extent

Data Deficiency

The US Army Corps of Engineers and URS Group, Inc. completed two Project Information Reports (PIR) on the Texas City Levee and Galveston Seawall following Hurricane Ike in Jan 2009. The PIRs examined the dam and levee damages from the storm and surge as well as the extent of flooding in the surrounding areas caused by the failure of the structures. When Hurricane Ike made landfall in Galveston County on September 13, 2008, it brought a storm surge of 15+ feet above mean sea level. The combined storm surge and wave action from Hurricane Ike caused costly damages to the dam and levee. The Corps of Engineers reported that failure to repair these prior to the next hurricane season would increase the risk of structural failure during a significant storm event and threaten the protected community and property. Although both structures needed (and received) repairs due to the hurricane, both served their purposes during the surge and protected the communities they were built to support. **While the dam and levee benefited the areas in close proximity to the structures since neither failed, the Corps is in the process of researching the location, extent, and impact if either the dam or levee completely fails and will release the information in 2018. They are unable to release the information during this plan update because it's still changing significantly but it will be reviewed and implemented as appropriate in accordance with mitigation actions GC-2016-11, CLS-2016-5, K-2016-6, and LM-2016-6 (see Section 21 for details).**

Best available data is presented below to describe the general observation of extent for dam/levee failure.

Dam

Effective January 1, 2009, the Texas Commission on Environmental Quality (TCEQ) adopted the revised dam classifications as shown in Table 51. The new classifications place a greater emphasis on high and significant hazard dams. Now a significant classification indicates a probable loss of life, whereas before no loss of life was expected in the event of dam failure. A High Hazard dam breach is now indicative of an expected loss of life of seven or more persons versus a probable chance in pre-2008 classifications.

The Galveston County Water Reservoir Dam is of a homogeneous earth-fill construction with a maximum height of 14 feet and a length of 25,281 feet. The reservoir has a maximum capacity of 11,368 acre feet. Normal storage is 7,360 acre feet with approximately 859 acres of water surface at the elevation of 18.2 feet above mean sea level. Based on the classifications provided in Table 51, the damages to Clear Lake Shores, Kemah, La Marque and Galveston County could result in minor

injuries with possible loss of life (although not expected). Economic losses could be considerable due to the effect a breach may have on the local water supply and the critical facilities located nearby.

Table 51: Dam Size and Hazard Classifications

Size Classification		
Small	Less than 1,000	Less than 40
Intermediate	1,000 to 49,999	40-99
Large	50,000+	100+
Hazard Classification		
Low	None expected	Minimal
Significant	Possible, but not expected	Appreciable
High	Expected	Excessive

Source: http://www.damsafety.org/media/Documents/PDF/TX.pdf

Levee

For levees in the federal system, FEMA relies on the expertise of the USACE and the levee inventory they are developing to determine the appropriate range of flood risk designation to use in re-mapping flood risk on the Flood Insurance Rate Map (FIRM). Information for the inventory is coordinated with the local community and levee owners. For levees not in the federal system, FEMA will coordinate with the impacted community and the levee owner.

While levees reduce the chance of flooding from certain designed events, no levee completely eliminates the risks associated with flooding as levees are designed to provide a specific level of protection and can be overtopped or fail during flood events that exceed the design storm. Table 52 depicts the range of protection that levees provide.

The Texas City levee is considered to be an Accredited Levee, designed to protect to the one percent flood event. Therefore, the levee can protect Texas City against a storm surge range up to 15 feet with waves reaching eight feet high.

Table 52: Levee Classifications/Range of Protection

Classification	Description	Area of Protection/Inundation
Accredited Levees	If a levee meets the criteria and the necessary data and documentation are provided to FEMA, the FIRM will show the area behind the levee as protected from the base flood and it will be mapped as a moderate-risk zone.	Area protected on FIRM/DFIRM – shaded Zone X (area of low to moderate risk)
Provisionally Accredited Levees	If community officials and levee owners reasonably believe a levee system provides protection from the base flood but documentation is not promptly available, this interim designation will allow up to two years for communities to submit documentation and levee certification to FEMA.	Area protected by levee on DFIRM will be mapped as shaded Zone X
Non-accredited	If the levee does not meet the regulatory protection criteria of 44 CFR Section 65.10, then the FIRM will show the area behind the levee as a high-risk zone, or SFHA.	The area of inundation will be shown as a Zone A or AE

15.4 Historical Occurrences

Due to the nature of their construction, both levees and dams are susceptible to decay and deterioration over time and require regular and proper maintenance. However, to date, there has been no historical occurrence of dam or levee failure in the planning area nor any reports of mis-operation of the flood gate located at the water reservoir dam to impact the planning area, including Texas City. In fact, the Texas City/La Marque Hurricane Flood Protection Levee performed as expected and was not damaged during Hurricane Ike in 2008 or Hurricane Harvey in 2017.

15.5 Probability of Future Occurrences

Based on the lack of historical incidents or previous occurrences of dam failure for the Galveston County Water Reservoir Dam (high hazard classification), the probability of a future occurrence of dam failure is unlikely within the next ten years for the planning area, including Texas City.

While Bolivar Peninsula was devastated during Hurricane Ike, the Hurricane and Flood Protection Levee in Galveston County held strong and fared well. Currently, the levee protects Texas City and La Marque from a 15-foot storm surge plus the additional height of waves on top of the surge. This

is equivalent to a strong category 3 or low category 4 storm. The probability of a future occurrence of levee failure is unlikely within the next ten years for the planning area.

15.6 Vulnerability Assessment

Dam and Levee System Failure

The primary purpose of the levee is to protect the local area from a hurricane surge or extreme tidal event. The dam is the western side of the water reservoir, and it also prevents saltwater from entering through Dickinson Bayou on the northwestern side of the dam and levee system.

If the dam and levee system failed to retain the reservoir of fresh water, La Marque and Texas City would be impacted by the freshwater release, and the cascading effect would be the loss of a local water supply for most jurisdictions and local business in the area.

Should the flood gate at the water reservoir fail, Clear Lake Shores, Kemah, and Galveston County could suffer economic loss due to flooding in lower areas of these communities.

If the levee failed independently of the dam, a saltwater intrusion of flood water would occur and inundate La Marque, Texas City, and the industrial complex within the area.

Particularized dollar losses in terms of annualized loss-estimates for dam and levee failures are not available. Therefore, a breakdown is not available for potential dollar losses of critical facilities, infrastructure, and lifelines, or hazardous-materials facilities.

Due to the importance of the area in the overall economy, particularly with regard to supplying our nation with fuel, Galveston County and adjacent communities and partners are reconsidering whether they should be protected by a levee that will withstand a 20-foot storm surge.

A topographic map showing the general area of impact for dam and levee failure in Texas City is provided as Figure 29.

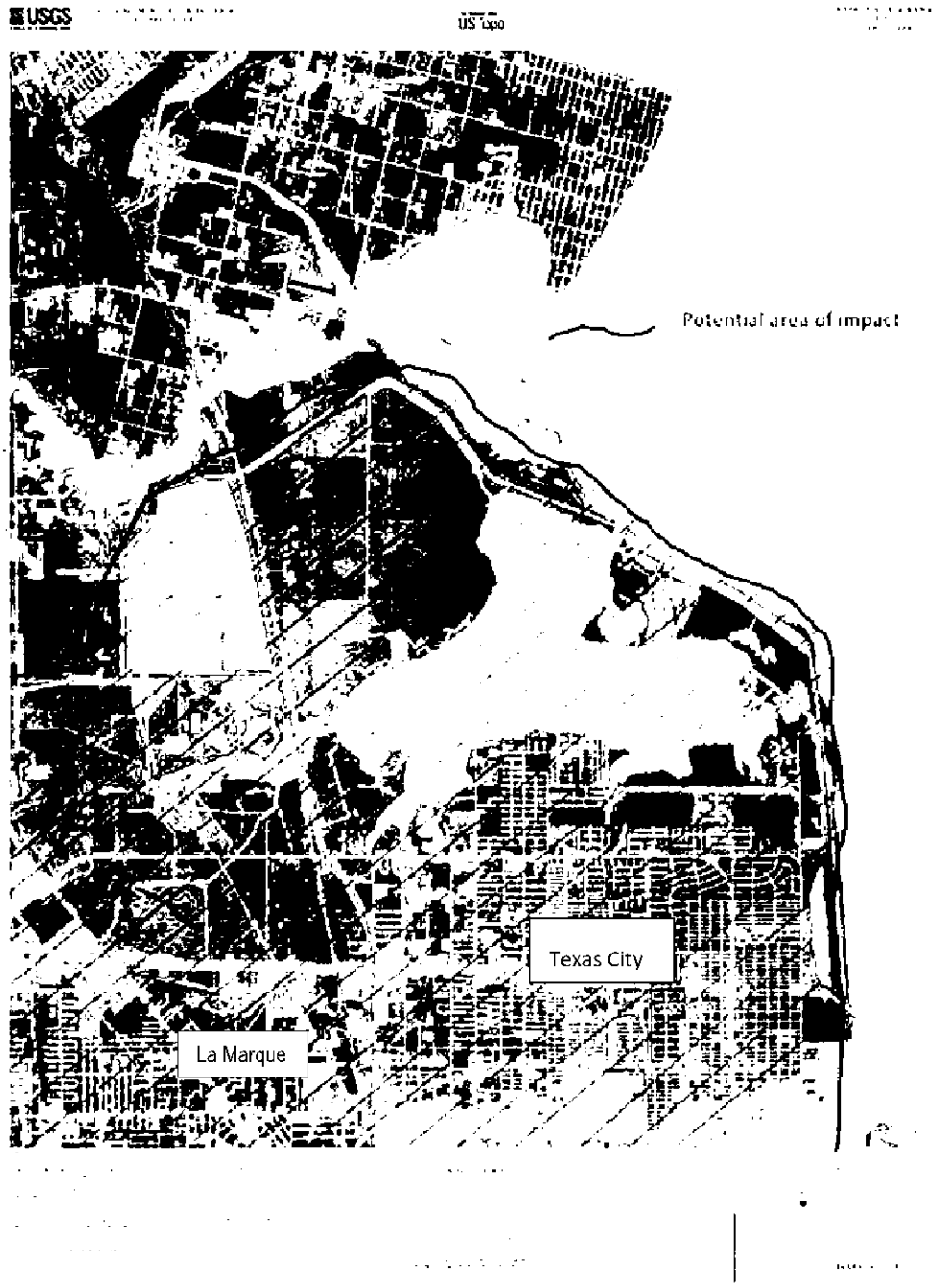


Figure 29: USGS Topographic Map – Area of Impact–Dam/Levee Failure

15.7 Impact

Dam Failure

Failure of the dam and levee system is an unlikely event. However, major industrial, commercial, and residential infrastructure and facilities are in the immediate area and immediately Southeast of the dam and inside of the overall dam and levee system. If a failure occurred at the dam in Texas City, the immediate impact on the planning area would be minor, meaning injuries or illness would not result in permanent disability, critical facilities could be shut down for more than a week, and more than ten percent of property could be destroyed or suffer major damage. However, the impact on the local water supply would be significant considering that only Friendswood and League City utilize water from other sources.

Levee Failure

Although there has not been a previous occurrence of a levee failure in the area, the potential impact would be major. Critical facilities could be shut down for weeks and more than 25 percent of property could be destroyed, including some of the nation's refineries. Area refineries have the capacity to satisfy more than 10 percent of the gasoline demand in the U.S. – enough to fully fuel 21 cars every second. The risk associated with levee failure would also affect other industrial companies behind the levee that produce electricity and steam for the Texas City complex. The Mainland Medical Center serves the industrial complex and remains particularly important when dealing with potential injuries resulting from the work with chemicals and volatile substances. All told, the impact from levee failure would affect over 50,000 residents, almost $7.5 billion in property, and roughly five percent of the nation's oil refining capacity. In addition to these figures, over 5,000 people are employed in the area including more than 2,000 independent contractors at any one time.

16.0 Mitigation Strategy

16.1 Capability Assessment

The planning team reviewed existing regulatory capabilities and opportunities for establishing new capabilities and enhancing existing ones. Texas City can improve its capabilities by: budgeting for mitigation actions and support, passing policies and procedures to implement mitigation actions, adopting and implementing stricter building regulations, approving the hiring and training of staff for mitigation activities, and approving mitigation action updates and additions to existing plans as new needs are recognized.

City of Texas City Administrative, Financial, Regulatory, and Technical Abilities
Floodplain Management
Emergency Management
Subdivision
Zoning
Building Code Enforcement
Nuisance Abatement
Substandard Structures Abatement
Drought Contingency Planning
Comprehensive Planning
Economic Development
Tax Collection
Grant Writing
General Budgeting
Capital Improvement Program Funding
Community Development Block Grant Funding
State and Federal Grant Funding

16.2 Mitigation Goals and Objectives

The hazard mitigation plan must strike a balance between identifying long-term goals and objectives and prioritized mitigation actions that may be addressed sooner, depending on funding availability and local priorities. The result is that certain goals and objectives don't have a corresponding

mitigation action. Instead, by taking the long view, the local planning team has created a framework that can be developed as the plan is updated over time.

Goal 1: Minimize loss of life, injury, damage to property, the economy, and natural systems

- Objective 1.1: Protect the life, health and safety of residents
- Objective 1.2: Protect existing/new critical facilities and infrastructure
- Objective 1.3: Provide protection for future/existing developments
- Objective 1.4: Provide backup power to critical facilities/infrastructure
- Objective 1.5: Minimize impacts from all hazards

Goal 2: Maintain and enhance emergency management/mitigation capabilities

- Objective 2.1: Update/develop plans, studies, and mapping for all hazards
- Objective 2.2: Incorporate/improve hazard mitigation strategies into ordinances, plans and polices
- Objective 2.3: Conduct/develop drills/training for all hazards
- Objective 2.4: Implement and maintain the Texas City Hazard Mitigation Plan
- Objective 2.5: Participate in programs that promote hazard mitigation strategies
- Objective 2.6: Build, obtain, and maintain critical facilities and equipment

Goal 3: Maintain public education and awareness activities

- Objective 3.1: Expand Public Outreach Campaigns for all hazards
- Objective 3.2: Promote disaster preparedness planning for families

Establishing Priorities

When identifying potential mitigation actions, planning team members considered the cost benefit of each to determine if the project makes sense for the overall good of Texas City. The costs and benefits were analyzed on a general level and all projects were considered valuable, viable, and beneficial in consideration of the quantitative and qualitative mitigation benefits versus the cost. Actual and estimated costs are included in the individual mitigation actions listed in Section 16.3. A full Benefit Cost Analysis (BCA) will be conducted as projects become eligible for funding.

Texas City Multi-Hazard Mitigation Plan

The planning team conducted a prioritization process based on FEMA's Mitigation Action Evaluation Worksheet 6.1 provided in the Local Mitigation Planning Handbook (March 2013) for each mitigation action in this plan. The evaluation system utilized the following ranking scale for each of the criteria defined by FEMA.

Ranking Scale:

1 = Highly effective or feasible	0 = Neutral	-1 = Ineffective or not feasible

Evaluation Criteria:

Life Safety – How effective will the action be at protecting lives and preventing injuries?

Property Protection – How significant will the action be at eliminating or reducing damage to structures and infrastructure?

Technical – Is the mitigation action technically feasible? Is it a long-term solution? Eliminate actions that, from a technical standpoint, will not meet the goals.

Political – Is there overall public support for the mitigation action? Is there the political will to support it?

Legal – Does the community have the authority to implement the action?

Environmental – What are the potential environmental impacts of the action? Will it comply with environmental regulations?

Social – Will the proposed action adversely affect one segment of the population? Will the action disrupt established neighborhoods, break up voting districts, or cause the relocation of lower income people?

Administrative – Does the community have the personnel and administrative capabilities to implement the action and maintain it or will outside help be necessary?

Local Champion – Is there a strong advocate for the action or project among local departments and agencies that will support the actions' implementation?

Other Community Objectives – Does the action advance other community objectives, such as capital improvements, economic development, environmental quality, or open space preservation? Does it support the policies of the comprehensive plan?

Scoring:

The total points scored on each mitigation action per the evaluation criteria listed above was then placed into a high, moderate, and low priority as defined below:

High Priority = 10 to 4	Moderate Priority = 3 to -3	Low Priority = -4 to -10

Defining Hazard Type and Mitigation Strategy Group

Each mitigation action was identified for the natural hazard it addresses, using multi-hazard approaches where practical, and determining which mitigation strategy group as defined below.

Prevention: Government, administrative, and regulatory actions or processes influencing the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include planning and zoning, building codes, capital improvement programs, open space preservation, and storm water management regulations.

Property Protection: Actions involving the modification of existing buildings or infrastructure to protect them from a hazard or remove them from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, flood proofing, storm shutters, and shatter-resistant glass.

Public Education and Awareness: Actions that inform and educate citizens, elected officials, and property owners about potential risks from hazards and potential ways to mitigate these risks. Actions include outreach projects, real estate disclosure, hazard information centers, and school-age and adult education programs.

Natural Resource Protection: Actions that not only minimize hazard losses but also preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.

Emergency Services: Actions protecting people before, during, and after a hazard event. Administrative and emergency operations offices that provide critical and vital services, coordinate warnings, responses, and recovery from a disaster are identified. Actions include protection of warning system capabilities, protection or hardening of critical facilities, protection of infrastructure needed for emergency response and training.

Structural Projects: Actions involving the construction of structures to reduce the impact of a hazard include storm water controls (e.g. culverts, floodwalls, seawalls, retaining walls, and safe rooms).

Technical Assistant Projects: Actions that involve required support/education from federal, state and local agencies, data collection for GIS mapping, utilization of technology, and upgrades as products are developed.

Table 53: Hazards Selected by Texas City to Develop Mitigation Actions

Hazard	Texas City
Hurricane/Tropical Storm	X
Flood (Coastal and Inland)	X
Extreme Heat	X
Tornado	X
Windstorm	X
Hailstorm	X
Lightning	X
Severe Winter Weather	X
Drought	X
Tsunami	
Wildfire (Urban and Rural)	X
Coastal Erosion and Retreat	
Land Subsidence	
Expansive Soils	X
Dam/Levee Failure	X

Texas City adopted Galveston County's revised mitigation action numbering system. A multi-hazard approach was utilized to streamline public education/outreach and property protection strategies where appropriate.

16.3 Mitigation Actions

TC 2018 - 1: Moses Lake Floodwater Pump Station	
Mitigation Goal/Objective:	1/1.5
Site and Location	Moses Lake Floodwater Pump Station
Project Description:	Construct a flood water pump station that would be capable of pumping 375,000 gallons per minute out of Moses Lake directly into Galveston Bay. Pump Station would be located on or near the USACE Hurricane levee. The pump station would consist of a battery of six (6) direct-drive diesel-powered axial flow pumps situated inside the Hurricane levee. Each pump would have a dedicated suction and discharge line, taking suction from Moses Lake and discharging over or through the Hurricane levee into Galveston Bay, onto an erosion control structure. The project would include a control building, power to the site, diesel storage tanks, and access driveways.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	$22,000,000.00
Potential Funding Sources:	City Funds, FEMA Mitigation Grant Funds
Lead Agency/Department Responsible:	Public Works, Engineering, Emergency Management
Timeframe for Completion:	Upon funding approval to 2020

TC 2018 - 2: Rainwater Pump Station A Capacity Improvements	
Mitigation Goal/Objective:	1/1.5
Site and Location	Rainwater Pump Station A
Project Description:	To improve flood control by increasing the maximum pumping rate of Rainwater Pump Station A. Presently. All rainwater in the levee-protected areas of the City must pass through either Pump Station A or Pump Station B. Pump Station A has a capacity of 375,000 gallons per minute, while Pump Station B has a capacity of 625,000 gallons per minute. By increasing the capacity of Pump Sat ion A, the City will be able to maintain lower flood water elevations in the City, thereby reducing structural flooding.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	$9,000,000.00
Potential Funding Sources:	City Funds, FEMA Mitigation Grant Funds
Lead Agency/Department Responsible:	Public Works, Engineering, Emergency Management
Timeframe for Completion:	Upon funding approval to 2020

TC 2018 - 3: Southpointe Subdivision Drainage Improvements	
Mitigation Goal/Objective:	1/1.5
Site and Location:	Southpointe Subdivision
Project Description:	Standing water in existing buildings could be reduced or eliminated if adequate drainage provisions are implemented. Improvements may include wider drainage systems and increased size in culverts, etc. Identify drainage areas in need of increased culverts or widening and set priorities for developing funding requests and implementation of construction.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$3,000,000.00
Potential Funding Sources:	Office of Rural Community Affairs, Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program,406 Public Assistance Program(following federal disaster declaration), Us Army Corps of Engineers-Small Flood Control Projects, USDA Natural Resources Conservation Service-Emergency Watershed Protection Agency, Texas Water Development Board(Development Fund II)-Texas Water Development Fund, USDA Natural Resources Conservation Service-Watershed Protection and Flood Prevention Program, EPA-Nonpoint Source Grant Program
Lead Agency/Department Responsible:	Public Works, Emergency Management
Timeframe for Completion:	2018 to 2022

TC 2018 - 4: Amburn Park Drainage Improvements	
Mitigation Goal/Objective:	1/1.5
Site and Location:	Amburn Park
Project Description:	To reduce structural flooding in the Amburn Park area of the City by increasing stormwater conveyance by means of storm sewers, channels, inlets, improving surface drainage flow patterns, and providing stormwater detention. During Hurricane Harvey, a large number of homes in this area experienced structural flooding.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$3,000,000.00
Potential Funding Sources:	Office of Rural Community Affairs, Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program,406 Public Assistance Program(following federal disaster declaration), Us Army Corps of Engineers-Small Flood Control Projects, USDA Natural Resources Conservation Service-Emergency Watershed Protection Agency, Texas Water Development Board(Development Fund II)-Texas Water Development Fund, USDA Natural Resources Conservation Service-Watershed Protection and Flood Prevention Program, EPA-Nonpoint Source Grant Program
Lead Agency/Department Responsible:	Public Works, Emergency Management
Timeframe for Completion:	2018 to 2022

TC 2018 - 5: Delany Lake#2 Stormwater Pump Station	
Mitigation Goal/Objective:	1/1.5
Site and Location	Delany Lake#2 Stormwater Pump Station
Project Description:	To improve flood control by reducing flood water surface in Delaney Lake. Delany Lake is utilized as a stormwater detention basin, but due to the nearly flat terrain of the area has a very limited outfall capacity. The addition of a pump station would allow the City to maintain a lower normal water level in the lake, thereby providing additional detention volume, and would allow an increase in outfall rate out of the pond for the purpose of reducing structural flooding in the area.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	$2,000,000.00
Potential Funding Sources:	City Funds, FEMA Mitigation Grant Funds
Lead Agency/Department Responsible:	Public Works, Engineering, Emergency Management
Timeframe for Completion:	Upon funding approval to 2020

TC 2018 - 6: Storm Sewer Trunk Main Improvements - 7th Ave., Logan Street to Outfall	
Mitigation Goal/Objective:	1/1.5
Site and Location	7th Ave., Logan Street to Outfall
Project Description:	To rehabilitate or replace a deteriorated underground storm sewer trunk main that is heavily deteriorated and undersized. The project would reduce structural flooding and street flooding.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	$13,000,000.00
Potential Funding Sources:	Office of Rural Community Affairs, Local Funds, US Army Corps of Engineers-Small Flood Control Projects, USDA Natural Resources Conservation Service- Emergency Watershed Protection Agency, Texas Water Development Board-Clean Water State Revolving Fund, Texas Water Development Board (Development Fund II)-Texas Eater Development Fund, USDA Natural Resources Conservation Service- Watershed Protection and Flood Prevention Program, EPA-Non-point Source Grant Program, 406 Public Assistance Program (following federal disaster declaration), HMGP, PDM Grant Program (FEMA)
Lead Agency/Department Responsible:	Public Works, Emergency Management
Timeframe for Completion:	2018-2022

TC 2018 - 7: Storm Sewer Improvements - 21st St. Basin, 10th Ave. to Loop 197	
Mitigation Goal/Objective:	1/1.5
Site and Location	21st Basin, 10th Ave to Loop 197
Project Description:	To reduce structural flooding and street flooding in the areas of 21st Street and 23rd Street, between 10th Avenue and Loop 197 North. The area floods frequently due to undersized storm sewers and storm outfall systems.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	$13,500,000.00
Potential Funding Sources:	Office of Rural Community Affairs, Local Funds, US Army Corps of Engineers-Small Flood Control Projects, USDA Natural Resources Conservation Service- Emergency Watershed Protection Agency, Texas Water Development Board-Clean Water State Revolving Fund, Texas Water Development Board (Development Fund II)-Texas Eater Development Fund, USDA Natural Resources Conservation Service- Watershed Protection and Flood Prevention Program, EPA-Non-point Source Grant Program, 406 Public Assistance Program (following federal disaster declaration), HMGP, PDM Grant Program (FEMA)
Lead Agency/Department Responsible:	Public Works, Emergency Management
Timeframe for Completion:	2018-2022

TC 2018 - 8: 34th St. Ditch Conveyance and Erosion Protection Improvements	
Mitigation Goal/Objective:	1/1.5
Site and Location	21st Basin, 10th Ave to Loop 197
Project Description:	To reduce structural flooding in the drainage basin by increasing channel conveyance, and to stabilize the channel banks from further erosion.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	$3,000,000.00
Potential Funding Sources:	Office of Rural Community Affairs, Local Funds, US Army Corps of Engineers-Small Flood Control Projects, USDA Natural Resources Conservation Service- Emergency Watershed Protection Agency, Texas Water Development Board-Clean Water State Revolving Fund, Texas Water Development Board (Development Fund II)-Texas Eater Development Fund, USDA Natural Resources Conservation Service- Watershed Protection and Flood Prevention Program, EPA-Non-point Source Grant Program, 406 Public Assistance Program (following federal disaster declaration), HMGP, PDM Grant Program (FEMA)
Lead Agency/Department Responsible:	Public Works, Emergency Management
Timeframe for Completion:	2018-2022

TC 2018 - 9: Freeway Park and Delaney Lake No. 3 Drainage Improvements	
Mitigation Goal/Objective:	1/1.5
Site and Location:	Freeway Park and Delany Lake
Project Description:	To reduce structural flooding in the Freeway Park area of the City by increasing stormwater conveyance by means of storm sewers, channels, inlets, improving I surface drainage flow patterns, and providing stormwater detention. During Hurricane Harvey, a large number of homes in this area experienced structural flooding.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$2,500,000.00
Potential Funding Sources:	Office of Rural Community Affairs, Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program,406 Public Assistance Program(following federal disaster declaration), Us Army Corps of Engineers-Small Flood Control Projects, USDA Natural Resources Conservation Service-Emergency Watershed Protection Agency, Texas Water Development Board(Development Fund II)-Texas Water Development Fund, USDA Natural Resources Conservation Service-Watershed Protection and Flood Prevention Program, EPA-Nonpoint Source Grant Program
Lead Agency/Department Responsible:	Public Works, Emergency Management
Timeframe for Completion:	2018 to 2022

TC 2018 - 10: Texas City Hurricane Flood Protection Project to improve the current levee system to provide protection from a Category 5 storm-Inner Rainwater Levee Restoration-West of 29th Street	
Mitigation Goal/Objective:	1/1.5
Site and Location:	Texas City area levee restoration-West of 29th Street
Project Description:	The Inner Rainwater Levee separates the developed area of the City of Texas City from Moses Lake. During Hurricane Harvey, an 1,800 foot long segment of the levee was severely eroded by wave action and rising waters. The purpose of this project is to harden the Lake-facing side of the levee to protect against erosion that could threaten the stability of the levee.
Hazard(s) Addressed:	Hurricane / Tropical Storm, Flooding, Dam/Levee Failure
Mitigation Strategy:	Structural
Priority:	Moderate
Estimated Cost:	$2,000,000.00
Potential Funding Sources:	Funding source dependent on project scope
Lead Agency/Department Responsible:	Engineering, Emergency Management
Timeframe for Completion:	Upon approval for funding to 2020

TC 2018 - 11: Storm Sewer Trunk Main Improvements - Westbury and 21st Ave. from 29th St. to 23rd St.	
Mitigation Goal/Objective:	1/1.5
Site and Location	Westbury and 21st Avenue from 29th St. to 23rd St.
Project Description:	To reduce structural flooding and street flooding in the areas of 21st Ave, Westbury and 23rd Street, The area floods frequently due to undersized storm sewers and storm outfall systems.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	$10,000,000.00
Potential Funding Sources:	Office of Rural Community Affairs, Local Funds, US Army Corps of Engineers-Small Flood Control Projects, USDA Natural Resources Conservation Service- Emergency Watershed Protection Agency, Texas Water Development Board-Clean Water State Revolving Fund, Texas Water Development Board (Development Fund II)-Texas Eater Development Fund, USDA Natural Resources Conservation Service- Watershed Protection and Flood Prevention Program, EPA-Non-point Source Grant Program, 406 Public Assistance Program (following federal disaster declaration), HMGP, PDM Grant Program (FEMA)
Lead Agency/Department Responsible:	Emergency Management
Timeframe for Completion:	2018-2022

TC 2018 - 12: Develop and provide public information and awareness for hazards	
Mitigation Goal/Objective:	3/3.1
Site and Location:	All areas of Texas City
Project Description:	The planning area has several outreach initiatives to communicate hazard preparedness information to the general public and visitors to the area. Providing timely information and educational information related to preparedness, mitigation, response, and recovery to the public fosters their ability to become self-sufficient. Information provided includes the following mitigation techniques (elevation, floodproofing, stabilization of soils in construction, electrical grounding devices, generators, insulating water pipes, xeriscaping, open foundations to minimize scour, include potential subsidence in freeboard calculations in flood-prone areas, roof and foundation supports, shutters, shatter-proof and high wind doors and windows, create defensible space around power lines, oil/gas lines, etc.); evacuation routes/procedures; workshop/training programs; alert systems, and the like.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Extreme Heat, Tornado, Windstorm, Hailstorm, Lightning, Severe Winter Storm, Drought, Wildland Fire, Expansive Soils, Dam/Levee Failure
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	$10,000 annually
Potential Funding Sources:	Grants/General Fund
Lead Agency/Department Responsible:	Emergency Management
Timeframe for Completion:	2018-2022

TC 2018 - 13: Install hazard warning systems	
Mitigation Goal/Objective:	1/1.1
Site and Location:	Citywide
Project Description:	Hazard warning systems complement the methods of warning already used by the County Emergency Operation Center and the National Weather Service.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Extreme Heat, Tornado, Windstorm, Hailstorm, Lightning, Severe Winter Storm, Drought, Wildland Fire, Dam/Levee Failure
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$35,000 each
Potential Funding Sources:	HMGP, general fund
Lead Agency/Department Responsible:	Emergency Management
Timeframe for Completion:	Upon approval for funding to 2020

TC 2018 - 14: Stormproof/retrofit critical facilities and infrastructure	
Mitigation Goal/Objective	1/1.2
Site and Location:	City-owned properties
Project Description:	New construction and existing critical facilities and infrastructure should include advanced mitigation techniques. Measures include, roof and foundation supports, shutters, shatter-proof and high wind doors and windows, electrical surge protection, stabilization of soils, addition of thermal insulation, etc.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Extreme Heat, Tornado, Windstorm, Hailstorm, Lightning, Severe Winter Storm, Drought, Wildland Fire, Expansive Soils, Dam/Levee Failure
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	Unknown, dependent upon facility type
Potential Funding Sources:	HMGP, CDBG, General Funds
Lead Agency/Department Responsible:	Emergency Management
Timeframe for Completion:	Upon approval for funding to 2022

TC 2018 - 15: Implement stormwater management plan to improve drainage during flood and other weather events	
Mitigation Goal/Objective:	1/1.5
Site and Location	Citywide
Project Description:	Routinely cleaning and repairing stormwater drains can help avoid unnoticed clogs that may hamper the efficiency of the stormwater system. Insuring that flow paths will have the capacity to convey storm- event flood water volumes will reduce damages.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$25,000
Potential Funding Sources:	Office of Rural Community Affairs, HMGP, PDM Grant Program,406 Public Assistance Program (following federal disaster declaration), USACE-Small Flood Control Projects, USDA Natural Resources Conservation Service-Emergency Watershed Protection Agency, Texas Water Development Board(Development Fund II)-Texas Water Development Fund, USDA Natural Resources Conservation Service-Watershed Protection and Flood Prevention Program, EPA-Nonpoint Source Grant Program
Lead Agency/Department Responsible:	Public Works
Timeframe for Completion:	2018-2022

TC 2018 - 16: Purchase and install generators for existing and new critical facilities and infrastructure	
Mitigation Goal/Objective	1/1.4
Site and Location:	Critical Facilities throughout Texas City
Project Description:	Generators are essential for providing continual operations in the event of a disaster. As funding becomes available, the city will apply for grants to install/upgrade generators to support existing or new facilities/infrastructure.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Extreme Heat, Tornado, Windstorm, Hailstorm, Lightning, Severe Winter Storm, Drought, Wildland Fire, Dam/Levee Failure
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$400,000
Potential Funding Sources:	HMGP, General Funds
Lead Agency/Department Responsible:	City Administration
Timeframe for Completion:	2018-2020

TC 2018 - 17: Mitigate (elevate, reconstruct, acquisition, demolition) Repetitive Flood Claim / Severe Repetitive Loss (RFC/SRL) properties	
Mitigation Goal/Objective	2/2.5
Site and Location:	Citywide – see Section 22 and Appendix E for listing of non-mitigated properties
Project Description:	Grant funding through the HMGP (Flood Mitigation Assistance) may be used to mitigate RFC and SRL properties. Mitigation options (elevate, reconstruct, acquisition, demolition, etc.) will be implemented with property owners as funding becomes available.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP/FMA
Lead Agency/Department Responsible:	City Administration and applicable state and county agencies
Timeframe for Completion:	Upon funding approval to 2020

TC 2018 - 18: Update regulations and permit requirements to address enhanced hazard mitigation strategies	
Mitigation Goal/Objective	2/2.2
Project Description:	Update and/or develop regulations and permits to address hazards prone to the area and include any changes in future development areas. Develop regulation restricting development in areas with soil considered poor or unsuitable for development.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Extreme Heat, Tornado, Windstorm, Hailstorm, Lightning, Severe Winter Storm, Drought, Wildland Fire, Expansive Soils, Dam/Levee Failure
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	2018-2020

TC 2018 - 19: Purchase a portable reader board	
Mitigation Goal/Objective:	2/2.6
Project Description:	· Purchase and maintain a portable reader board mounted on a trailer that could be deployed during emergencies and other events within the City. · The reader board would be accessible to all emergency services as well as Public Works and Parks and Recreation within the City. · This project would convey public information to the public during evacuations and other emergencies.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Extreme Heat, Severe Winter Storm
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	$40,000 (reader board and trailer)
Potential Funding Sources:	Grants and/or city operating funds
Lead Agency/Department Responsible:	· Police Department · Fire Department
Timeframe for Completion:	Upon funding and approval, the equipment could be purchased and implemented within one year.

TC 2018 - 20: Acquire portable lighting devices to be used at major intersections during power outages	
Mitigation Goal/Objective:	2/2.6
Project Description:	Purchase 4 portable light towers on trailers to be utilized at four (4) major intersections during extended power outages to protect residents while driving into and/or outside the city. • Will get intersections
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Severe Winter Storm
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	Per unit cost of $10,000 to $40,000 Minimum costs: $40,000 Maximum costs: $160,000
Potential Funding Sources:	Grant funding, annual city budgeting process
Lead Agency/Department Responsible:	Public Works, Emergency Management
Timeframe for Completion:	2018-2022

TC 2018 - 21: Public information and warning mobile application for Android and Apple applications	
Mitigation Goal/Objective:	1/1.1 and 1.5
Project Description:	· Research and develop a mobile application to be available for citizens to download for IOS and Android operating systems · If cost is too prohibitive, research and promote applications already developed to encourage emergency preparedness · Promote the use of emergency preparedness apps currently available at the Apple Store
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Extreme Heat, Tornado, Windstorm, Hailstorm, Lightning, Severe Winter Storm, Drought, Wildland Fire, Dam/Levee Failure
Mitigation Strategy:	Public Education and Awareness
Priority:	Moderate
Estimated Cost:	· Research has shown that costs associated with the development of an emergency management application – simple, table based app – for IOS systems range $500 to $4,000. All content & clear direction is provided by the organization. If GPS locators, social media integration, and additional add-ins are included, costs will rise accordingly. · If costs are maintained in the range of $5,000 to $10,000, proposals could be made during the budget development process to include this project in the annual operating budget.
Potential Funding Sources:	If this project is rejected by the governing body, research and application for grants could provide an alternative funding source
Lead Agency/Department Responsible:	Emergency Management, IT Department
Timeframe for Completion:	If a funding source is secured, ideally development could be accomplished within 2-3 years.

TC 2018 - 22: Improve Texas City's CRS rating	
Mitigation Goal/Objective:	2/2.1
Project Description:	To attain a lower CRS rating and improve the city's approach for addressing RL/SRL properties, the city will implement the following: · Meet criteria necessary to achieve a lower CRS rating through this initiative. · Initiate and implement additional floodplain requirements that are above the minimum floodplain compliance. · Update the city's current floodplain map to coordinate with the currently proposed FEMA Flood Insurance Rate Map relative to all floodplains as proposed.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$100,000
Potential Funding Sources:	General fund through annual budget process/apply for planning grant funding
Lead Agency/Department Responsible:	Community Development, Floodplain Manager, Emergency Management
Timeframe for Completion:	2018-2022

TC 2018 - 23: Conduct National Weather Service tornado drills along with elementary school in jurisdiction	
Mitigation Goal/Objective:	2/2.3
Site and Location	Citywide
Hazard(s) Addressed:	Flooding, Tornado, Windstorm, Hailstorm, Lightning
Project Description:	Texas City will work with area schools to develop and execute tornado drills.
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	Emergency Management
Timeframe for Completion:	2018-2022

TC 2018 - 24: Construct a storm water detention area	
Mitigation Goal/Objective:	1/1.5
Site and Location	The location of this detention area is located near FM 1765 and SH 146 Lat. 29.378173732237762 Long. -94.9524736404419
Project Description:	Dow Chemical purchased several acres of land east of town for use as a greenbelt. Texas City would like to build a detention pond in this area that will help alleviate flooding on the east side. Phase I will include a feasibility study and a drainage analysis of the new pond row acquisition and associated conveyance improvements on a part of 10 acres of land. Engineering of the pond will be based on results of the study and analysis. Construction of the pond will be the second phase.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Dam/Levee Failure
Mitigation Strategy:	Property Protection
Priority:	Moderate
Estimated Cost:	$4,000,000
Potential Funding Sources:	Grant / Bond / Corporate Sponsor
Lead Agency/Department Responsible:	Public Works
Timeframe for Completion:	2017-2020

TC 2018 - 25: Purchase 100' Aluminum Aerial platform fire apparatus for residential and commercial structure fire rescues.	
Mitigation Goal/Objective:	2/2.6
Site and Location	Citywide
Project Description:	An aerial ladder can be used in many rescue situations, helping the City assist in responding to refinery fires/ explosions, major pipeline breaches, flood water rescues, and residential fires. An aerial apparatus would also aid in swift water and coastal flooding emergencies, as well as assist in plant explosion rescues.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Lightning, Wildfire (Urban and Rural)
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$1,500,000
Potential Funding Sources:	Grant / General Budget
Lead Agency/Department Responsible:	Fire Department
Timeframe for Completion:	2017-2018

TC 2018 - 26: Become a Certified NWS StormReady Community	
Mitigation Goal/Objective	2/2.4
Project Description:	StormReady helps arm America's communities with the communication and safety skills needed to save lives and property-before and during an event. StormReady helps leaders and emergency managers strengthen local safety programs. StormReady communities are better prepared to save lives from the onslaught of severe weather through advanced planning, education, and awareness. Contact NWS before applying, complete application, schedule verification meeting and receive approval.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Drought, Extreme Heat, Severe Winter Storm
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	Undetermined
Potential Funding Sources:	General Funds
Lead Agency/Department Responsible:	Emergency Management
Timeframe for Completion:	2018

TC 2018 - 27: Safe Rooms/Community Shelters	
Mitigation Goal/Objective:	1/1.1
Site and Location	Citywide
Project Description:	The area is prone to tornado and high wind events. Encourage construction and use of safe rooms in existing and new structures. Allow citizens to install safe rooms at a significant discount in preexisting homes. Provide homeowners and developers with funds to assist in installing a safe room in new homes.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	FEMA HMGP
Lead Agency/Department Responsible:	Emergency Management, Planning and Zoning and Building
Timeframe for Completion:	Dependent on funding approval to 2020

TC 2018 - 28: Dam/Levee Failure Inundation Studies	
Mitigation Goal/Objective:	2/2.1
Site and Location	Citywide
Project Description:	This action will determine expected inundation locations and peak discharge rates in the event of a dam/levee failure in Texas City.
Hazard(s) Addressed:	Dam/Levee Failure
Mitigation Strategy:	Prevention
Priority:	Moderate
Estimated Cost:	Unknown
Potential Funding Sources:	FEMA HMGP
Lead Agency/Department Responsible:	Public Works
Timeframe for Completion:	Dependent on funding approval to 2020