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HAZARD MITIGATION ACTION PLAN

FY 2013

Trinity Bay Conservation District was created under the provisions of Section 59 of Article XVI, Constitution of Texas, as a government agency for the purpose of reclamation and drainage of its overflowed lands and other lands needing drainage in part of Chambers County and the west part of Jefferson County and all property and territory situated within this area.

Contents

TBCD made the decision in late 2012 to hire a mitigation planning consultant, Jeffrey S. Ward & Associates, Inc., to assist TBCD in its efforts to develop a better understanding of the vulnerability to risks of natural hazards faced by the jurisdiction and its constituents. The Plan development was assisted by funding from TDEM and TBCD. A one year schedule was developed for completion and adoption of the HMP.

Based on the Guidance provided by FEMA in Local Mitigation Planning Handbook cited above, this document is prepared by the jurisdiction, with the assistance of the Mitigation Planning Committee, to provide documentation of the processes taken, and actions performed by TBCD in development of a standalone Local Hazard Mitigation Plan in 2013. The processes documented in the following pages is based on the 9 Step process outlined in that document and the experience of the Mitigation Planning Consultant in developing plans which meet all of the FEMA requirements for an effective Hazard Mitigation Plan.

Sections of the document cover all of the actions taken in the analysis, development, review and approval of a standalone Hazard Mitigation Plan. The plan is intended to supplement, rather than replace, TBCD's participation in and support for the regional planning effort documented in the H-GAC 2011 Multi-Jurisdictional Plan.

The first several sections provide introductory information about the planning process, the requirements of a Hazard Mitigation Plan and a high level analysis of the jurisdiction's Natural Hazard History. Those sections along with the appendices: General Description of Natural Hazards, Sources, Acronyms, and Terms and Definitions, were prepared and presented at the first Mitigation Planning Committee meeting. This information was used to determine which hazards warranted further analysis of the vulnerabilities and risks the jurisdiction faces. Those analysis and the additional information about how, when and why they were completed were added as an additional section and presented at the following MPC meeting. The document grew logically as the processes and actions were defined and developed by the MPC.

1 SECTION 1 – Introduction

The Hazard Mitigation Plan (HMP) is developed under the authority derived from the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988, P.L. 93-288, as amended by the Disaster Mitigation Act of 2000, P.L. 106-390. The Disaster Mitigation Act of 2000 (The Act) required State and local governments to develop and formally adopt natural Hazard Mitigation Plans by November 2003 in order to be eligible to apply for Federal assistance under the HMGP. The Act was further amended to extend the planning requirement deadline to November 2004.

When the DMA 2000 was signed into law on October 30, 2000, the Robert T. Stafford Disaster Relief and Emergency Assistance Act was amended by adding a new section, 322 – Mitigation Planning. Section 322 places new emphasis on local mitigation planning. It requires local governments to develop and submit mitigation plans as a condition of receiving Hazard Mitigation Grant Program (HMGP) project grants. Afinal rule for implementing Section 322 was published in the Federal Register, 44 CFR Parts 201 and 206, on February 26, 2002. The requirements for local plans, or Local Mitigation Plan Criteria, are found in part 201.6.

In addition to the Plan requirement, the Act also requires communities to utilize a specific planning process developed for an all hazards approach to mitigation planning. This four step planning process is crucial to ensure that the effective planning by a community meets all the Plan content criteria required by the Act. The Act requires adoption by the local governing body and specifies a stringent review process, by which States and FEMA Regional Offices will review, evaluate and approve hazard mitigation plans. Hazard Mitigation Plans and updates are requirements associated with receipt of, or eligibility for, certain federal, and other, mitigation grant program funds. These programs are administered in Texas by the Texas Division of Emergency Management (TDEM) and the Texas Water Development Board (TWDB).

Trinity Bay Conservation District (TBCD) participated in the 2011 update to the Houston-Galveston Area Council Regional Multi-Jurisdictional Hazard Mitigation Plan which was approved by FEMA in October 2011. The development of a Hazard Mitigation Plan was a direct result of an increasing awareness in TBCD that many natural disasters, especially flood hazards, have affected and will continue to affect many of the people and properties within TBCD. It was through this participation TBCD gained a better understanding of the importance of Hazard Mitigation Planning and it was that understanding that triggered this update to the TBCD HMP.

Trinity Bay Conservation District determined that in order to have an effective Hazard Mitigation Plan TBCD needed to better understand the Hazards which directly affect the local planning area. TBCD determined it would be best served by performing additional local planning and analysis. The update process was begun the in early 2013 when TBCD partnered with a Mitigation Planning Consultant. A grant was obtained from the Texas Division of Emergency Management (TDEM) to update its HMP. The additional analysis and support will result in a Local Hazard Mitigation Plan geared specifically to the local jurisdiction, its capabilities, and vulnerabilities. This plan will reflect the local goals and will be used in day to day operations and long range planning efforts.

TBCD undertook this plan update in order to perform a more in-depth analysis of the hazards, both natural and manmade, which have impacted TBCD in the past and what actions TBCD might take to help mitigate vulnerabilities to these hazards in the future. The overall goal of the effort is to focus specifically on those hazards that have the greatest impact on TBCD. Additionally, in the case of hazards such as flood, which TBCD has some authority or ability to mitigate, TBCD would like to perform in-depth risk analysis.

Based on the information provided by the risk analysis specific actions can be identified to address future risks to TBCD. The MPC will attempt, based on the available data, to identify specific mitigation goals and individual actions which support those goals. In the 2011 H-GAC plan update there were 9 mitigation actions that were prepared specifically for TBCD and those will be reviewed as the basis for the plans and actions developed during this planning period.

Once TBCD has determined the risks and vulnerabilities the MPC will work with key stakeholders, including neighboring jurisdictions, local businesses, members of local academia, private and nonprofit interests as well as the general public, to assess hazards and develop local actions which will best support its overall goals and will potentially mitigate against future hazards thereby enhancing the community as well as the communities economic, social, and environmental well-being. The analysis is to include all hazards for which TBCD has authority and is developed in accordance with current FEMA and State planning guidance and requirements.

After discussion it was determined TBCD would use a Mitigation Planning Committee (MPC) comprised at its core of staff representatives from TBCD and a mitigation consultant. TBCD began putting together the remainder of the planning team while the mitigation consultant was assisting with outlining this document and compiling the data which will be needed to be analyzed by the planning team.

Once a basic analysis has been performed and the initial sections including background, introductory, trends and hazard data have been written the planning team will be convened to review and analyze the data. During the first MPC meeting we will discuss the planning process in general. The team will review the goals from other plans as well as those TBCD specified in the 2011 H-GAC plan. Additionally, examples specified in the Local Mitigation Planning Handbook will be reviewed.

The MPC will be asked for recommendations on, and to review a list of, possible stakeholders.

Both the General Description of Natural Hazards and the actual Hazard Profile information will be presented and discussed. The MPC will be asked to rate each Natural Hazard based on that analysis. The analysis will include a description of the type, location, extent, prior occurrences, probability of future occurrences, and the possible impact on the community from each type of Natural Hazard as well as the community's vulnerability to the natural hazards. This analysis will form the basis of the detailed analysis to be performed and presented at the second MPC meeting.

This first MPC meeting will also provide an opportunity for the team members to request any additional information which may be needed or to provide information for consideration. This information includes copies of plans and studies which may impact the planning effort as well as ideas for potential Mitigation Goals and supporting Action Items, ideas for possible outreach opportunities, scheduling and next steps.

Detailed discussion of the process outlined in this document can be found later in this document.

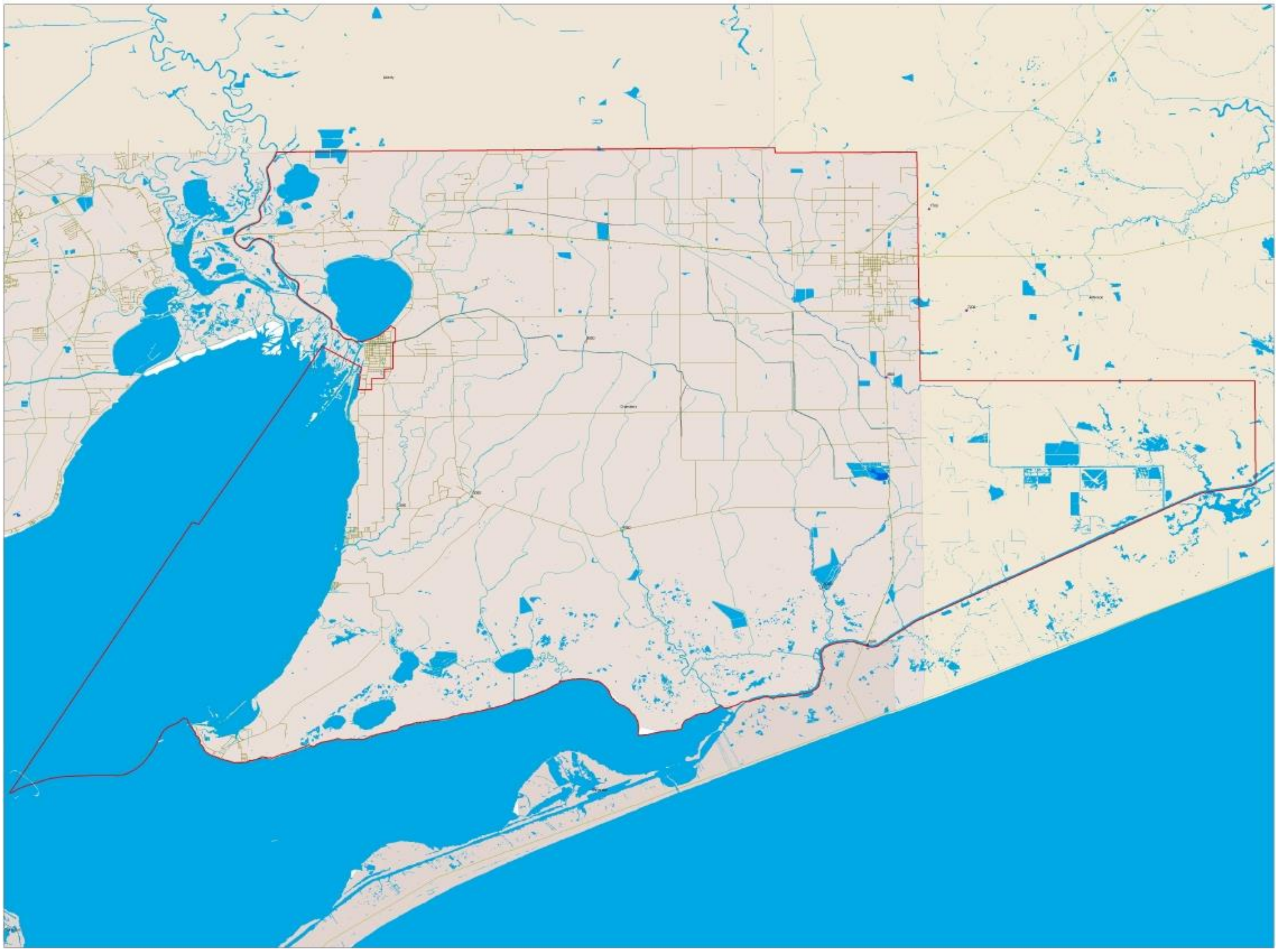
In addition to the MPC, a larger stakeholder group that included staff representatives from the Chambers County, incorporated Cities, local adjacent drainage and/or conservation districts, business organizations, academia, and the general public were asked to review and provide their expertise to the drafting of the Plan.

The 2013 Hazard Mitigation Plan update documented within these pages, sets the stage for long-term disaster resistance through identification of actions that will, over time, reduce the exposure of people and property to all natural hazards. Sections of the Plan provide an overview of each of the hazards that threaten the jurisdiction, characterize the people and property that are exposed to some risk due to those hazards, outline and document the planning process, describe how the hazards are recognized in TBCD's normal processes and functions, and Identify and prioritize mitigation goals and associated mitigation action items.

1.1 GEOGRAPHY, CLIMATE, AND POPULATION

Trinity Bay Conservation District covers an area of 592 square miles within the boundaries of Jefferson and Chambers County, Texas. The majority of TBCD is located within Chambers County with a small portion of Southwestern Coastal Jefferson County also within its jurisdictional boundaries. Ground surface elevations across TBCD vary from sea level to 50 feet above mean sea level. The topography is described as nearly flat prairie and the geologic structure is nearly flat strata. The soils are chiefly coastal clay and sandy loam. The flora includes tall grasses, live oaks, cypress, pine, and cedar trees, as well as hardwoods along rivers and streams.

Figure 1-1 - Boundaries of TBCD



The climate of the region is humid subtropical, with warm summers and moderate winters. Rainfall is abundant and on the average, evenly distributed throughout the year. The heaviest rains usually occur during the hurricane season, which extends from June through October. Average annual precipitation for the area is approximately 54 inches and the average annual temperature is about 68 degrees.

Figure 1-2 - Average Temperature and Precipitation in Anahuac, Texas (Source: www.Claimatedata.com)

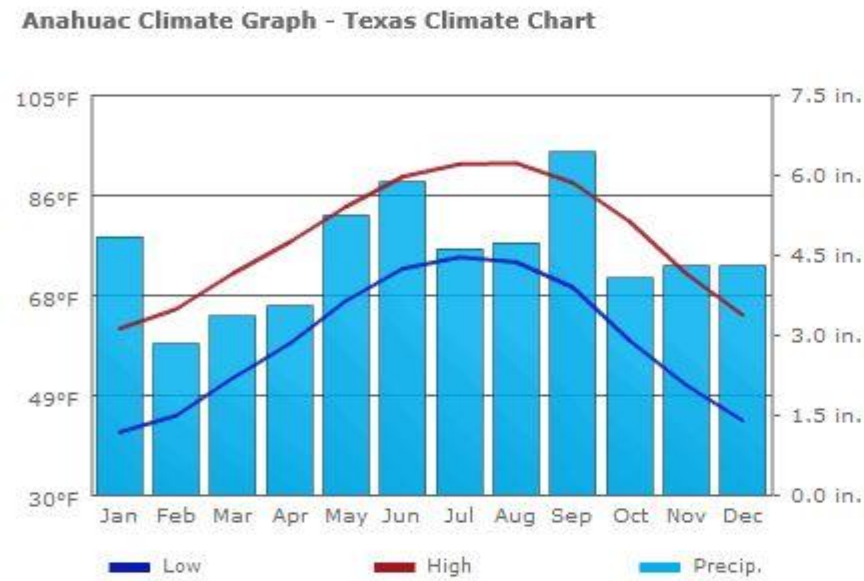
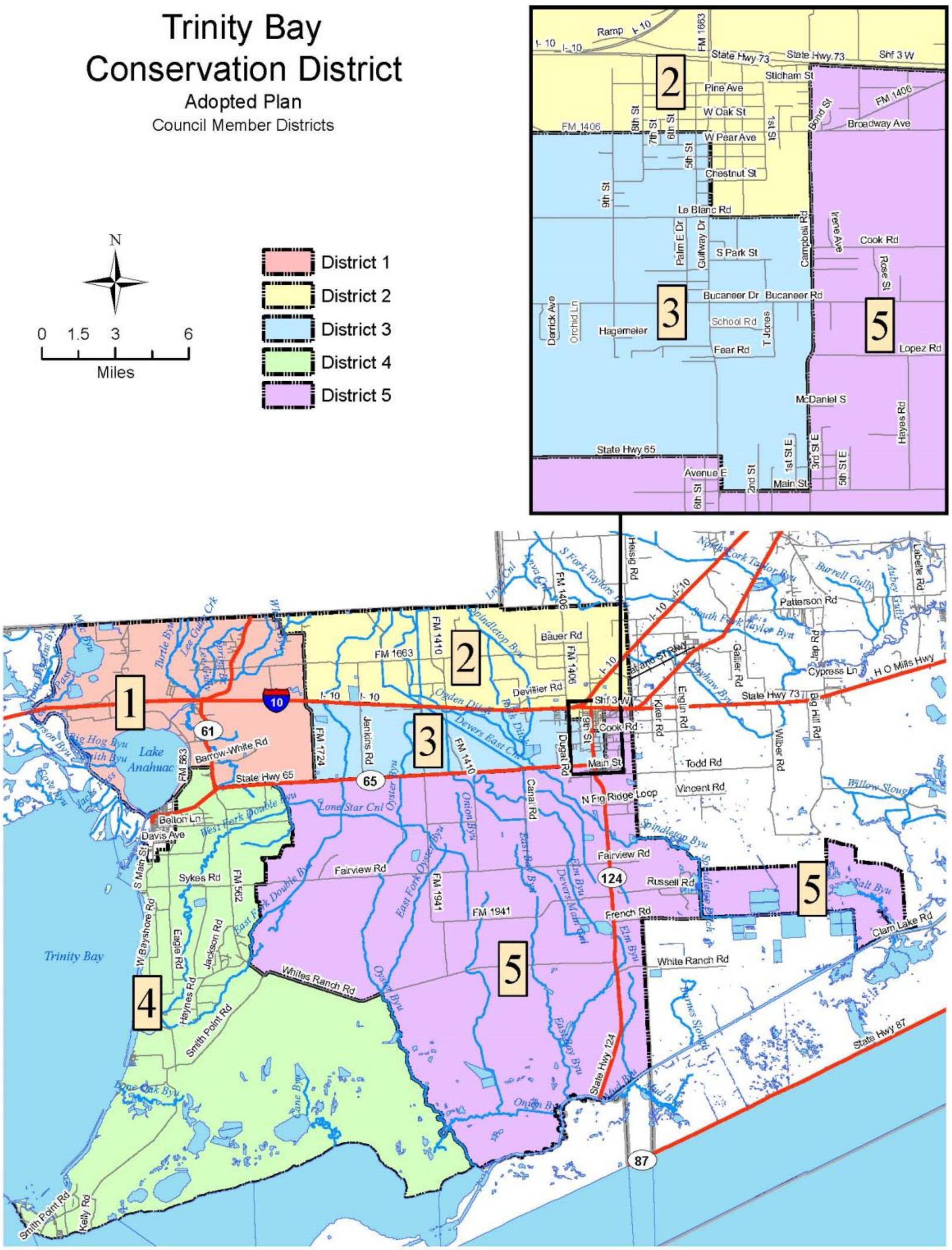


Figure 1-2 above shows Anahuac's coldest month is January when the average temperature overnight is 42°F, in August, the warmest month, the average day time temperature rises to 92°F. The driest month is February with 2.83 inches of precipitation, and with 6.52 inches September is the wettest month.

1.2 PLANNING AREA

Trinity Bay Conservation District covers an area of 592 square miles within the boundaries of Jefferson and Chambers County, Texas. The majority of TBCD is located within Chambers County with a small portion of West Central Jefferson County also within its jurisdictional boundaries. The area is generally located in Southeast Texas.

Figure 1-3 – Trinity Bay Conservation District (Source: TBCD)



1.2.1 Population and Growth

According to the 2010 Census, Chambers County has a total population 35,096 while the population of Jefferson County stood at 252,273. Based on these statistics Trinity Bay Conservation District filed a plan for redistricting in 2011-2012. At this time the population of TBCD was reported to be 10,808 split amongst the five districts.

The population density of Chambers County is approximately 41 people per square mile, while in Jefferson County it is 227 people per square mile. TBCD consists of 592 sq. miles of land populated by 10,808 people making the population density 18 people per square mile. The statewide average is 93.6 persons per square mile.

The population of the major cities within Chambers County are identified in Table 1-1, below

Table 1-1 - Populations of Incorporated areas in the Planning Area (Chambers County) Source (2010 U.S. Census)

Subdivision / Place	Population 2010	Housing Units 2010	Total Area (SqMi)	Land Area (SqMi)	Population Density / SqMi	Housing Unit Density / SqMi
Anahuac CCD	6,777	2,968	585.31	332.2	20.4	8.9
Anahuac City	2,243	869	2.13	2.13	1053.1	408
Oak Island CDP	363	171	1.2	1.2	302.5	142.5
Mont Belvieu CCD	22,045	7,912	134.5	118.71	185.7	66.6
Baytown City (Part)	4,116	1,583	4.06	3.93	1047.3	402.8
Beach City	2,198	922	4.48	4.48	490.6	205.8
Cove City	510	197	1.24	1.19	428.6	165.5
Mont Belvieu City (Part)	3,835	1,426	15.04	14.71	260.7	96.9
Old River-Winfree City (Part)	1,104	408	1.51	1.51	731.1	270.2

	Population	Housing Units	Total Area	Land Area	Population Density	Housing Unit
Stowell CDP	1,756	656	10.24	10.05	174.7	65.3
Winnie CDP	3,254	1,261	3.96	3.96	821.7	318.4
Winnie-Stowell CCD	6,274	2,411	151.38	146.24	42.9	16.5
Chambers County	35,096	13,291	871.18	597.14	58.8	22.3

Note that the planning area refers to Trinity Bay Conservation District. Additional information on incorporated cities within Jefferson and Chambers Counties and in the TBCD jurisdictional area are below. Much of this data is taken directly from the pages of American Fact Finder, the USGS Geographic Names Information System (GNIS) and verified using the public internet based data. The statewide population density figure of 93.6 is figured based on a land area of 268,581 sq. miles and data from the 2010 US Census which shows population figures in the state of 25,145,561.

1.2.1.1 City of Anahuac

The City of **Anahuac** is a city in the U.S. state of Texas within the Houston–Sugar Land–Baytown metropolitan area on the northeast bank of Trinity Bay on the Texas Gulf Coast and has a total area of approximately 2.1 sq miles. According to the USGS (GNIS) the city is located at 29.7730001 north latitude and -94.6826961 west longitude at which point it is approximately nine feet above sea level. The Anahuac National Wildlife Refuge was established in 1963 by the United States Fish and Wildlife Service. The refuge is located 16 miles southeast of Anahuac. In 1990 the population of Anahuac was 1,993. In 2000 the population was 2,210 and the population of the city was 2,243 at the 2010 census. Anahuac is the seat of Chambers County-and is situated in East Texas. The city is known as the "alligator capital" of the state due to the annual alligator festival. The Anahuac Area Chamber of Commerce organized the first annual “Gatorfest” in September 1989, an event that drew 14,000 people to Fort Anahuac Park. The population density per square mile is 1,068 (statewide average is 93.6 persons per square mile). The population of the labor force is 1,568.

1.2.1.2 Winnie, Texas

Winnie, Texas sits at the junction of State Highway 124 and Interstate Highway 10, 25 miles southwest of Beaumont in eastern Chambers County. It has a population of 3,254 persons as of the 2010 census. According to the USGS (GNIS) Winnie is located at 29.8167161 North Latitude and -94.3806728 West Longitude at which point it is approximately seven feet above sea level. Winnie has a total area of four sq. miles making the population density per square mile is 811.2, the statewide average is 93.6 persons per square mile. The population of the labor force is 1,222. Winnie was also the home of the Gulf Coast News and the Winnie Chronicle, and, with neighboring Stowell, has co-hosted the annual Texas Rice Festival which has occurred during the first weekend of October since 1970. In 1990 the population of Winnie was 2,238. The population reached 2,914 in 2000.

Figure 1-4 - Winnie-Stowell VFD (Source: Winnie Wiki Pages)

1.2.1.3 City of Stowell

Stowell sits at the intersection of State Highway 124 and Farm Road 65, 26 miles southwest of Beaumont in eastern Chambers County. It has a population of 1,756 persons as of the 2010 census. According to the USGS (GNIS) Stowell is located at 29.7899436 North Latitude and -94.3832443 West Longitude at which point it is approximately seven feet above sea level. Stowell has a total area of 10.3 sq. miles making the population density per square mile is 170.4, the statewide average is 93.6 persons per square mile. The population of the labor force is 712. By the late 1970s Stowell had a population of 1,500. Along with Winnie, Stowell is the site of the Texas Rice Festival, held annually since 1970. In 1990 Stowell had a population of 1,419. The population was 1,572 in 2000.[1]

1.2.2 Employment and Economy

The top industries in TBCD are Wholesale Trade, Services, Manufacturing, and Retail trade. See the table below for specifics on numbers of people employed by both Major SIC Code and by Occupation. It should be noted that the totals by Occupation and By Major SIC code differ. These numbers were compiled using data from the Labor Force Report on the Community Profile for Chambers County Texas on the Texas Wide Open

[1] *Robert Wooster, "STOWELL, TX," Handbook of Texas Online (http://www.tshaonline.org/handbook/online/articles/hjs28), accessed April 29, 2013. Published by the Texas State Historical Association.*

for Business internet web site. The majority of TBCD is situated with-in Chambers County, Texas. The Texas Wide Open for Business site promotes Texas Economic Development and provides valuable information for companies looking to expand or relocate in the State. Texas Wide Open for Business is the official brand for the Texas Economic Development Division within the Office of the Governor.

Table 1-2 – Number of people employed by Major SIC in Chambers County, Texas as of 2013

Major SIC (2013)	Total Employees
Wholesale Trade (SIC 50-51)	3396
Services (SIC 70-89)	2133
Manufacturing (SIC 20-39)	1985
Retail Trade (SIC 52-59)	1605
Transportation and Communications (SIC 40-49)	772
Public Administration (SIC 90-98)	737
Construction (SIC 15-17)	384
Finance, Insurance And Real Estate (SIC 60-69)	270
Unclassified (SIC 99)	218
Mining (SIC 10-14)	83
Agricultural, Forestry, Fishing (SIC Range 01-09)	69
Total Employment	11,652

Table 1-3 – Number of people employed by Occupation in Chambers County, Texas as of 2013

Occupation	Total Employees
Office and Administrative Support	1722
Sales	1683

Occupation	Total Employees
Production Workers	1127
Executive, Managers, and Administrators	1050
Construction and Extraction	797
Transportation Workers	681
Installation/Maintenance and Repair Workers	519
Food Preparation/Serving	499
Education/Training/Library	440
Material Moving	419
Business and Financial Operations	410
Building and Grounds Maintenance	357
Personal Care and Service	320
Architecture and Engineering	291
Protective Services	228
Health Diagnosing and Treating Practitioners	223
Computer and Mathematical Occupations	140
Healthcare Support	126
Health Technologists/Technicians	99
Life/Physical/Social Science Occupations	78
Community and Social Services	71

Occupation	Total Employees
Legal	41
Farming/Fishing/Forestry	35
Total Employment	11,356

Table 1-4 – Median Hourly and Annual income by occupation in Chambers County, Texas as of 2013

Occupation	Median Hourly	Median Annual
Architecture and Engineering Occupations	$43.59	$90,680
Arts, Design, Entertainment, Sports, and Media Occupations	$18.14	$37,730
Building and Grounds Cleaning and Maintenance Occupations	$9.18	$19,080
Business and Financial Operations Occupations	$32.66	$67,940
Community and Social Service Occupations	$21.63	$44,990
Computer and Mathematical Occupations	$37.19	$77,360
Construction and Extraction Occupations	$16.90	$35,160
Education, Training, and Library Occupations	$23.22	$48,310
Farming, Fishing, and Forestry Occupations	$9.88	$20,550
Food Preparation and Serving Related Occupations	$8.87	$18,440
Healthcare Practitioners and Technical Occupations	$31.30	$65,090
Healthcare Support Occupations	$12.63	$26,280
Installation, Maintenance, and Repair Occupations	$18.78	$39,070
Legal Occupations	$44.99	$93,580

Occupation	Median Hourly	Median Annual
Life, Physical, and Social Science Occupations	$34.19	$71,110
Management Occupations	$49.15	$102,240
Office and Administrative Support Occupations	$15.15	$31,500
Personal Care and Service Occupations	$8.83	$18,360
Production Occupations	$15.51	$32,250
Protective Service Occupations	$16.11	$33,510
Sales and Related Occupations	$12.88	$26,790
Transportation and Material Moving Occupations	$14.21	$29,560
All Occupations	$17.00	$35,350

1.2.3 Special Consideration Communities

For the purpose of this Plan, there are no jurisdictions within the TBCD's area of responsibility that are classified as "special consideration communities." The federal government defines special consideration communities to be those with 3,000 or fewer individuals that is a rural community, and is not a remote area within the corporate boundaries of a larger community. According to the 2010 census data, 2,912 citizens (8.3% of the entire county) were living below the poverty level.[2]

1.3 COMPOSITION OF THE MPC, STAKEHOLDERS AND BOARD OF DIRECTORS

TBCD used the following organizational structure to develop its Hazard Mitigation Plan. The structure has three tiers:

Mitigation Planning Committee (MPC)
Stakeholders Group
TBCD Board of Directors

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[2] ***American Fact Finder – Chambers County TX :*** http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_11_5YR_DP03
Definition of Poverty : http://www.census.gov/acs/www/Downloads/data_documentation/SubjectDefinitions/2010_ACSSubjectDefinitions.pdf

The process used to develop the Plan was guided by a Mitigation Planning Committee (MPC) which carried out most of the planning duties. The MPC was comprised of the following individuals listed in Table 1-5.

Table 1-5 – Trinity Bay Conservation District Hazard Mitigation Plan Mitigation Planning Committee (MPC)

Team Member	Job Title	Organization	MPC Member Responsibility
Jerry Shadden	General Manger	Trinity Bay Conservation District	Data collection, data review, lead on actions, review each section and participate in the approval of information incorporated
David Hoyt	Operations Coordinator	Trinity Bay Conservation District	Data collection, data review, support on actions, review each section and participate in the approval of information incorporated
Jeff Ward	Mitigation Planning Consultant	JSWA	Data collection, data review, support on actions, review each section and participate in the approval of information incorporated
Kristen Thatcher	Mitigation Planning Consultant	JSWA	Data collection, data review, support on actions, review each section and participate in the approval of information incorporated

The MPC determined that in addition to the small committee that would steer the planning process, a larger group of interested individuals called "Stakeholders" would be included in the planning process to review drafts and provide comments at critical points in the plan development. Once the Plan was drafted, the MPC reviewed the contents with the Board for their comment and approval.

At the initial Plan meeting on May 21st, 2013, the MPC determined that the Stakeholders group would be comprised of a group of interested individuals comprised of people from neighboring communities, businesses, academia and other organizations with an interest in the Plan. This Stakeholders Group was provided regular updates on the planning process and given the opportunity to review the Plan at key points in its development. Members of the Stakeholders group were also invited to attend and participate in all public meetings. The Stakeholder Group was identified by the MPC and is listed in Table 1-6.

As drafts of the Plan were prepared, the MPC mailed letters to the Stakeholders, and requested that they provide comments. Stakeholders were requested to provide feedback through email or by telephoning the plan point of contact, Mr. Jerry Shadden or a member of the consultant team. At various points during the process, comments from Stakeholders were periodically emailed to Jerry Shadden or a member of the consultation team. The consultant was responsible for archiving the comments and including them in edited versions of the Plan. The Stakeholders Group was comprised of the following individuals:

Table 1-6 - TBCD Hazard Mitigation Plan Stakeholders Group

Group Member	Title	Organization
Mr. Gilbert Ward	Flood Mitigation - Planning	Texas Water Development Board
Mr. Jack Steele	Executive Director	Houston Galveston Area Council
Mr. Jeff Branick	Judge	Jefferson County
Greg Fountain	Emergency Management Coordinator	Jefferson County, Emergency Management
Michael White	Deputy Emergency Management Coordinator	Jefferson County, Emergency Management
Chuck Wemple	POC	H-GAC Regional Hazard Mitigation Plan

Amy Boyers	POC	H-GAC Regional Hazard Mitigation Plan
Ryan Holzaepfel	Emergency Management Coordinator	Chambers County, Emergency Management
Sidney Lewis	Floodplain Manager	Chambers County, Texas
Doug Canant	District Engineer	JCDD6
Craig McNair	Judge	Liberty County, Texas
Scott Campbell	Superintendent	EC ISD
James Hopper	Superintendent	Anahuac ISD
Scott Wible	City Administrator	Anahuac City
David Popoff	Emergency Management Coordinator	Galveston County, Emergency Management

Table 1-7 - TBCD Board of Directors

Board Member	Title
Jeffrey Jenkins	President
Dorothy Hamilton	Secretary
Gregg Turner	Vice-President
Tommy Gilbert	Board Member - Hankamer
Michael Winzer	Board Member - Winnie
Guy Goodson	Board Attorney

1.4 ACKNOWLEDGMENTS

The Plan development was assisted by funding from TDEM and TBCD and was facilitated by Jeffrey S. Ward & Associates, Inc.

2 SECTION 2 – Introduction to Mitigation Planning

2.1 TABLE OF CONTENTS

2.2 INTRODUCTION

An important step in the lengthy process of improving resistance to hazards is the development of a hazard mitigation plan. The Mitigation Plan for Trinity Bay Conservation District was prepared in accordance with the guidelines provided by FEMA and advice from the TDEM and the TWDB.

The Plan was prepared for several purposes. It sets the stage for long-term disaster resistance through identification of actions that will, over time, reduce the exposure of people and property to hazards. Completion of the Plan, and adoption by the TBCD Board of Directors, is a significant step toward identifying potential hazards that threaten the jurisdiction, assessing the risks, and implementing mitigation actions that will reduce property damages, injuries, and loss from hazards. Approval of the Plan by TDEM and FEMA will also allow for eligibility for certain mitigation grant funds.

Sections of the Plan provide an overview of the planning process, the natural hazards that threaten TBCD, the people and property exposed to those hazards, how hazards are recognized in TBCD's normal processes and functions, and identification of priority mitigation action items. The hazards summary and disaster history help to characterize future hazards. By taking into account the magnitude of past events, the number of people and properties affected, and the severity of damage, TBCD hopes to spotlight the most significant natural hazards to threaten the people and property within TBCD and develop activities to mitigate them. For these reasons it was determined by the MPC that we will concentrate efforts primarily on those hazards which are determined to pose the most significant threat to the people, property and lifestyles of the citizens of TBCD. As part of TBCDs efforts to reduce losses due to natural hazards, TBCD will support the efforts of those jurisdictions within and neighboring TBCD that participate in the NFIP program.

2.3 REQUIREMENTS FOR THE PLANNING PROCESS

In accordance with 44 Code of Federal Regulations (CFR) 201.6(d)(3), local mitigation plans must be "reviewed, revised if appropriate, and resubmitted for approval within five years in order to continue to be eligible for grant project funding." This section of the CFR specifically states:

§201.6(d)(3): A local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and re-submit it for approval within five years in order to continue to be eligible for mitigation project grant funding.

§201.6(c)(1): [The Plan shall document] the planning process used to develop the Plan, including how it was prepared, who was involved in the process, and how the public was involved.

§201.6(c)(4)(ii): [The Plan shall include a] process by which local governments incorporate the requirements of the mitigation Plan into other planning mechanisms such as comprehensive or capital improvement Plans, when appropriate.

§201.6(b): In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:

- An opportunity for the public to comment on the Plan during the drafting stage and prior to Plan approval;
- An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and
- Review and incorporation, if appropriate, of existing Plans, studies, reports, and technical information.

2.4 THE MITIGATION PLANNING PROCESS

The Hazard Mitigation Plan (HMP) is being prepared pursuant to the Flood Mitigation Assistance Program (44 CFR 78.6), the Hazard Mitigation and Pre-Disaster Mitigation Programs (44 CFR Parts 201 and 206), and the process outlined in the FEMA document entitled *Local Mitigation Planning Handbook* (March 2013). The Handbook provides guidance to local governments on developing or updating hazard mitigation plans, interprets and explains the Local Hazard Mitigation Plan regulations from the 44 Code of Federal Regulations (CFR) Part 201, and is FEMA’s official source for defining the requirements local hazard mitigation plans.

For FEMA to approve a Hazard Mitigation Plan it must meet all of the requirements of Title 44 Code of Federal Regulations (CFR) §201.6. FEMA approval of a Hazard Mitigation Plan is a pre-qualification for a jurisdictions eligibility to apply for FEMA hazard mitigation assistance grant programs.

2.5 TASKS AND THEIR ASSOCIATED REQUIREMENTS

A breakdown of the nine recommended tasks in the Local Mitigation Planning Handbook can be found in Appendix A of the Handbook as Worksheet 1.1. It provides a crosswalk of the requirements of Title 44 Code of Federal Regulations (CFR) §201.6 and the Tasks they are associated with.

Task 1: Determine the Planning Area and Resources - **44 CFR 201.6(c)(1)** - (1) Documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

Task 2: Build the Planning Team - 44 **CFR 201.6(c)(1)** - (1) Documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

Task 3: Create an Outreach Strategy - **44 CFR 201.6(b)(1)** - (1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;

Task 4: Review Community Capabilities - **44 CFR 201.6(b)(2) & (3)** - (2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and (3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

Task 5: Conduct a Risk Assessment - **44 CFR 201.6(c)(2)(i)** - (i) A description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

44 CFR 201.6(c)(2)(ii) & (iii) - (ii) A description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. All plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods. The plan should describe vulnerability in terms of: (A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; (B) An estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate; (C) Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions. (iii) For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

Task 6: Develop a Mitigation Strategy - **44 CFR 201.6(c)(3)(i)** - (i) A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

44 CFR 201.6(c)(3)(ii) - (ii) A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008, must also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.

44 CFR 201.6(c)(3)(iii) - (iii) An action plan describing how the actions identified in paragraph (c)(3)(ii) of this section will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

Task 7: Keep the Plan Current - **44 CFR 201.6(c)(4)** - (i) A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle. (ii) A process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate. (iii) Discussion on how the community will continue public participation in the plan maintenance process.

Task 8: Review and Adopt the Plan - **44 CFR 201.6(c)(5)** - (5) Documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commissioner, Tribal Council). For multi-jurisdictional plans, each jurisdiction requesting approval of the plan must document that it has been formally adopted.

Task 9: Create a Safe and Resilient Community - **44 CFR 201.6(c)(4)** - (i) A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle. (ii) A process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate. (iii) Discussion on how the community will continue public participation in the plan maintenance process.

2.6 LOCAL MITIGATION PLANNING TASKS

The Handbook offers many practical approaches, examples and worksheets which can be used to engage in effective planning to reduce long-term risk from natural hazards and disasters. It is available for download on FEMA's website and is a blueprint to the process this document follows.[3]

The *Local Mitigation Planning Handbook* describes Mitigation Planning as follows:

Mitigation is most effective when it is based on a comprehensive, long-term plan that is developed before a disaster occurs. The purpose of mitigation planning is to identify local policies and actions that can be

[3] http://www.fema.gov/library/viewRecord.do?id=7209

implemented over the long term to reduce risk and future losses from hazards. These mitigation policies and actions are identified based on an assessment of hazards, vulnerabilities, and risks and the participation of a wide range of stakeholders and the public in the planning process. Benefits of mitigation planning include:

- Identifying actions for risk reduction that are agreed upon by stakeholders and the public.
- Focusing resources on the greatest risks and vulnerabilities.
- Building partnerships by involving citizens, organizations, and businesses.
- Increasing education and awareness of threats and hazards, as well as their risks.
- Communicating priorities to State and Federal officials.
- Aligning risk reduction with other community objectives.

The process outlined is organized into nine recommended tasks. It is Illustrated in figure 2-1 below. Some of the tasks can be completed concurrently while others depend on completing preceding tasks. Some tasks are very specific while others are more generic.

Figure 2-1 - Local Mitigation Planning Tasks (Source: Local Mitigation Planning Handbook, FEMA, March 2013)

Task One involves defining the Planning area, and determining the available resources. Trinity Bay Conservation District covers a known geographic area and TBCD has a finite set of resources which are also known. TBCD determined that they would lead the planning process assisted by a private consultant who will provide additional resources to assist in the coordination, facilitation, and execution of the mitigation planning process.

Task Two describes the process of identifying and engaging a planning team. The task explains that the planning process is as important as the plan itself, and that the planning team helps shape and guide that process. The task involves putting the planning team together which was completed by the Team Lead for TBCD, Jerry Shadden.

Task Three focuses on engaging the stakeholders and the public in the planning process which promotes discussion. Through this process of discussion among the Stakeholders and community members it is hoped that we will gain knowledge of the activities and programs which are important to the local community. Understanding the things that are important to the community will help identify TBCDs Goals and the specific actions and activities which may be most effective locally to build a safer, more disaster-resilient community. The Local Mitigation Planning Handbook states that"… a plan that accurately reflects the community's values and priorities is likely to have greater legitimacy and 'buy-in' and greater success in implementing mitigation actions and projects to reduce risk".

The task also outlines six points to developing a successful outreach strategy. They include:

1. Brainstorm outreach activities
2. Determine public outreach objectives and schedule
3. Identify appropriate outreach methods
4. Develop clear and consistent messages that align with community values
5. Evaluate and incorporate feedback from outreach activities
6. Provide an opportunity for public review of the final draft plan

The Handbook tells us that certain stakeholders must be given the opportunity to be on the planning team or otherwise involved in the planning process. Stakeholders are defined by FEMA as "… individuals or groups that are affected by a mitigation action or policy". These groups include local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development, neighboring jurisdictions and businesses, academia, and other private and nonprofit interests as well as members of the general public.

Stakeholders need not be involved in all stages of the planning process. They should be selected to inform the planning team on a specific topic or provide input from different points of view in the community.

As part of this task the MPC will document how the plan was prepared and who was involved in the planning process to include the schedule or timeframe and activities that made up the plan's development.

We will also identify all planning team members and stakeholders who were involved or given an opportunity to be involved in the planning process, including the agency/ organization and the person's position or title within the agency.

The public will be given the opportunity to be involved in the planning process during the plan's development period prior to the comment period on the final plan and prior to plan adoption and approval. The MPC will document how their feedback, if any, was incorporated into the plan. The plan describes how TBCD will continue public participation in the plan maintenance process.

Task Four describes the critical step of assessing existing authorities, policies, programs, and resources available to accomplish mitigation. The MPC will collect and review information on community capabilities to describe the existing authorities, policies, programs, and resources available to accomplish hazard mitigation. This begins by reviewing existing plans, reports, and information and interviewing local departments and agencies to gain a better understanding of relevant programs, regulations, resources, and practices.

Capabilities to be identified include:

1. **Planning and regulatory** which includes comprehensive land use plans, capital improvements programs, transportation plans, small area development plans, disaster recovery and reconstruction plans, and emergency preparedness and response plans. Additional examples include the enforcement of zoning ordinances, subdivision regulations, and building codes that regulate how and where land is developed and structures are built.
2. **Administrative and technical** capabilities include local engineers, planners, emergency managers, GIS analysts, building inspectors, grant writers, floodplain managers, county planners, engineers, or a regional planning agency.
3. **Financial** capabilities are resources that a jurisdiction has access to or is eligible to use to fund mitigation actions.
4. **Education and outreach** capabilities are programs like fire safety programs that fire departments deliver to students at local schools; participation in community programs, such as Firewise or StormReady. Additional examples include activities conducted as part of hazard awareness campaigns, such as Tornado or Flood Awareness Month.

TBCDs floodplain management program will be described and we must address how continued compliance with the NFIP requirements. The local floodplain administrator is often the primary source for this information and should likely be part of the Stakeholders Group. Where FEMA has issued a floodplain map but the jurisdiction is currently not participating in the NFIP this requirement may meet by describing the reasons why the community does not participate. We describe the community's adoption and enforcement of floodplain management regulations.

In **Task Five** we will determine the potential impacts of hazards to the people, economy, and built and natural environments of the planning area. The risk assessment will provide the foundation for the rest of the mitigation planning process, which will be focused on identifying and prioritizing actions to reduce risk to hazards.

The Handbook provides definitions of relevant Risk Assessment Terminology which it notes were derived from FEMA *Local Mitigation Plan Review Guide*, October, 2011, *Threat and Hazard Identification and Risk Assessment Guide: Comprehensive Preparedness Guide* (CPG) 201, First Edition, April 2012, and adapted from the Department of Homeland Security Risk Lexicon, 2008.

It defines the following seven terms as they relate to Hazard Mitigation Planning.

- **Natural hazard** – source of harm or difficulty created by a meteorological, environmental, or geological event
- **Community assets** – the people, structures, facilities, and systems that have value to the community
- **Vulnerability** – characteristics of community assets that make them susceptible to damage from a given hazard
- **Impact** – the consequences or effects of a hazard on the community and its assets. The type and severity of impacts are based on the extent of the hazard and the vulnerability of the asset, as well as the community's capabilities to mitigate, prepare for, respond to, and recover from events.
- **Risk** – the potential for damage, loss, or other impacts created by the interaction of natural hazards with community assets
- **Risk assessment** – product or process that collects information and assigns values to risks for the purpose of informing priorities, developing or comparing courses of action, and informing decision making.
- **Threat or human-caused incident** – intentional actions of an adversary, such as a threatened or actual chemical or biological attack or cyber event.

The concept of risk as the relationship between hazards and community assets is illustrated with the following figure.

Figure 2-2 - Overlap between risk and community assets. (Source: FEMA Local Mitigation Planning Handbook March 2013)

The process defines four recommended steps for conducting the risk assessment. The steps include: **Describing the Hazard, Identifying Community Assets, Analyzing Risk, and Summarizing vulnerability**. Through this evaluation we will develop an understanding of each hazard's potential impact on the people, economy and the environments both built and Natural within the planning area.

Step One, Describing the Hazard, indicates the assessment will include a description of the location, extent, previous occurrences, and probability of future events for each hazard. This understanding of the community's overall vulnerability and the knowledge of which are the most significant risks to impact TBCD will assist in the development of problem statements and to identify mitigation actions which will reduce TBCDs risk.

The Local Mitigation Planning Handbook March 2013 defines Location, Extent, Previous Occurrences and Probability of Future Occurrences as follows:

- **Location.** Location is the geographic areas within the planning area that are affected by the hazard, such as a floodplain.
- **Extent.** Extent is the strength or magnitude of the hazard.
- **Previous occurrences.** The history of previous hazard events.
- **Probability of future events.** Probability is the likelihood of the hazard occurring in the future.

A mitigation plan update typically focuses on how risk has changed since the previous plan was completed however in this case the MPC has determined that it will be best served by completing a full risk assessment. The 2011 H-GAC Regional Mitigation Action Plan covered eight Counties in Southeastern Texas. There were 4,854,454 people residing 2,426,098 in Residential Buildings having a value of $747,730,480. The region covers an area of 6,541 square miles. The plan also identified 3,504 Critical Facilities and 20,580 Commercial Buildings with a value of $90,609,145.

The **second step** is to identify specific vulnerable assets in the planning area. These are the people, economy, and built and natural environments we are attempting to protect in this plan. People are your most important asset. After a disaster, economic resiliency drives recovery. The built environment includes existing structures, infrastructure systems, critical facilities, and cultural resources. Areas of future growth and development are also an important component when assessing the building environment. All structures are exposed to risk, but certain buildings or concentrations of buildings may be more vulnerable because of their location, age, construction type, condition, or use. Infrastructure systems are critical for life safety and economic viability and include transportation, power, communication, and water and wastewater systems. Many critical facilities depend on infrastructure to function. Critical facilities are structures and institutions necessary for a community's response to and recovery from emergencies. Critical facilities must continue to operate during and following a disaster to reduce the severity of impacts and accelerate recovery. Environmental assets and natural resources are important to community identity and quality of life and support the economy through agriculture, tourism and recreation, and a variety of other ecosystem services, such as clean air and water. The natural environment also provides protective functions that reduce hazard impacts and increase resiliency.

The **third step** is the actual risk analysis which involves evaluating vulnerable assets, describing potential impacts, and estimating losses for each hazard. The purpose of this analysis is to help the community understand the greatest risks facing the planning area. This step occurs after hazards and assets have been identified.

Step four of task five summarizes the information regarding hazards, vulnerable assets, and potential impacts and losses the previous three steps in the risk assessment process generated. These summaries allow us to understand the most significant risks and vulnerabilities. These summaries inform the mitigation strategy, elected officials and other stakeholders to support present and future decision making.

Task Six provides suggestions for developing a mitigation strategy which will serve as a long-term blueprint for reducing the potential losses identified by the risk assessment. It will describe how the community will accomplish the overall purpose of the planning process through an Action Plan which describes how the specific projects and activities, which support TBCDs stated Mitigation Goals, are prioritized, administered, and incorporated into the community's existing planning mechanisms.

The stated goals should represent what TBCD seeks to achieve through mitigation plan implementation. Clear goals provide the basis for prioritizing mitigation actions and must be consistent with the hazards identified in the risk assessment. In determining TBCDs Goals we should look the Goals from the State

Plan, Goals stated in the Current H-GAC Plan, findings of the risk assessment, themes that stood out during planning team meetings and outreach activities, and the goals of other community plans.

The Handbook describes a mitigation action as "…a specific action, project, activity, or process taken to reduce or eliminate long-term risk to people and property from hazards and their impacts". Mitigation actions are implemented in support of the plan's mission and goals. Actions to reduce vulnerability to threats and hazards form the core of the plan and are key to the outcome of the planning process.

Mitigation actions which include government authorities, policies, or codes that influence the way land and buildings are developed and built are part of local plans and regulations. Structure and infrastructure projects involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area or projects to construct manmade structures to reduce the impact of hazards. Actions related to Natural systems protection minimize damage and losses and also preserve or restore the functions of natural systems. Finally, Education and Awareness Programs inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them.

Action plans lays the groundwork for implementation by describing how the mitigation plan will be incorporated into existing planning mechanisms and how the mitigation actions will be prioritized, implemented, and administered to succeed in reducing risks in the long term. The information and recommendations of the mitigation plan can be integrated throughout TBCDs operations. Through this planning process, we can form partnerships where needed. The action plan identifies how specific mitigation actions will be implemented, including who is responsible for which actions, what funding mechanisms and other resources are available or will be pursued, when the actions will be completed, and how they are prioritized which can increase the community's resilience to disasters. The action plan is the primary tool to obtain funding, assign priorities, guide the decision making process, and track progress in future plan updates.

Task Seven involves developing procedures to monitor, evaluate, and update the mitigation plan over time. Describing the method and schedule for monitoring, evaluating, and updating the plan within a five-year cycle helps to ensure that the mitigation strategy is implemented according to the plan. The Plan provides the foundation for an ongoing mitigation programs and activities within TBCD which will standardize long-term monitoring of hazard-related activities. Integration of mitigation principles into the responsibilities and roles of District officials will help to maintain momentum through continued engagement and accountability in the plan's progress. Future updates provide the opportunity to consider how well the procedures established in the plan are working and to revise them as necessary. Continuing to provide opportunities for public involvement in the plan and its implementation is an important part of the plan maintenance process.

Task Eight describes the final review and adoption of the plan document by TBCD and the process for FEMA plan approval. Prior to submittal to the State and FEMA for approval the public must be given the opportunity to review and comment on the mitigation. After the public has reviewed the final draft it will be submitted to the State and FEMA for review prior to formal adoption. Figure 2-3 below illustrates the Plan Approval Process.

Figure 2-3 - Plan Approval Process (Source: FEMA Local Mitigation Planning Handbook March 2013)

Task Nine is mostly informational. It identifies some common challenges TBCD may face in implementing its mitigation strategy as well as providing suggestions for how to overcome mitigation barriers. It also contains some available funding sources and other resources available to help.

Some of the more common challenges TBCD may encounter in implementing its mitigation strategy are the loss of interest or meeting fatigue on the part of the planning team, stakeholders, and the public after the mitigation planning and adoption process ends. Lack of funding and other resources and capabilities to accomplish the mitigation actions is a challenge often faced. Address the more complicated problems and controversial solutions may require political will. " When time passes without a significant hazard event apathy such as "disaster amnesia" or the perception that "nothing ever happens here" can be created. Challenges will also occur when the policies and objectives of other local plans and programs cause disconnect between the mitigation strategy and the day-to-day operations, staff work plans and procedures of the jurisdiction.

2.7 PUBLIC MEETINGS

<<Details of the Public Meetings held, attendance, and comments will be placed here>>

2.8 INCORPORATING MITIGATION PLAN REQUIREMENTS INTO OTHER LOCAL PLANNING MECHANISMS

As required by the FEMA **44 CFR 201.6(c)(4)(ii),** governing mitigation planning, the project requirements from the Hazard Mitigation Plan are incorporated into other planning mechanisms, as applicable, during the routine development of local Plans. As part of the HMP development, TBCD integrated components of the Plan into other planning mechanisms. The MPC is currently reviewing the plans listed later in this section and looking for opportunities to incorporate components of these other plans and studies.

TBCD joins local planning organizations and Stakeholder groups to have an opportunity to review and provide input into other plans. This process keeps TBCD involved continually in Mitigation Planning and helps integrate mitigation goals of the local community into other local planning mechanisms. TBCD also participates in the COG for the Southeast region to find out what other local planning mechanisms are in progress. If TBCD determines it has a stake in these plans, the General Manager reaches out to the planners to find effective ways to incorporate issues that impact TBCD and its Goals into these other planning devices.

The NFIP's Community Rating System (CRS) is another method that communities can benefit from the mitigation planning requirements addressed in the Plan. These requirements and mitigation actions can work to improve a community's CRS rating. Since TBCD is a Drainage and Conservation District and not a community, it is not eligible to participate in the CRS, a voluntary program for NFIP participating communities. The goals of the CRS are to reduce flood losses, to facilitate accurate insurance rating, and to promote the awareness of flood insurance. The CRS rewards communities that undertake activities beyond the requirements of the NFIP. The CRS is a point system program that reduces flood insurance premiums for the citizens of participating communities.[4] All communities start with a Class 10 rating and activities are offered to earn credit points that reduce their classification. The lower a community's Class rating, the greater the premium discounts offered by the NFIP. Any future CRS activities such as flood damage reduction or flood preparedness as a result of this should be considered by these jurisdictions if they determine to participate in the CRS program.

[4] *Emergency Management Institute (EMI) web site, CRS Resource Center*

2.9 REVIEW AND INCORPORATION OF PLANS, STUDIES, REPORTS AND OTHER INFORMATION

Other planning documents can be used as a valuable resource for integrating information related to hazard mitigation into TBCD's HMP. As part of the development, other plans, studies, and reports that are applicable to the hazards discussed in the Plan were reviewed and incorporated where applicable.

The following Plans were reviewed along with a discussion on how they were incorporated into the Plan.

2010 State of Texas Mitigation Plan Update. The State HMP update was reviewed and summarized in Section 2.7 of this Plan. The mitigation strategies from the State Plan are also summarized in Section 2.7 for the flood, wildfire, tornado, hurricane and tropical storm, and drought hazards. The goals from the State Plan update were also reviewed and included in Section 4.3 of TBCD's Plan.

Chambers and Jefferson County Flood Insurance Rate Map (FIRM). The Flood Insurance Rate Maps (FIRMs) prepared by FEMA offer the best overview of flood risks. FIRMs are used to regulate new development and to control the substantial improvement and repair of substantially damaged buildings. Chambers and Jefferson County FIRMs were reviewed and included in the Plan to develop a floodplain map identifying the 100-year floodplain.

Chambers and Jefferson County Study (FIS). The most recent FIS's for Chambers County is dated June 15, 1983. Information describing the flood hazard was added to Section 6.

H-GAC Hazard Mitigation Plan Update, 2011. The updated Chambers and Jefferson County plans provided useful data and historical support for the Trinity Bay Conservation Districts plan update and is referenced throughout the plan.

The following are a list of plans and studies that have been completed for the planning area. These plans were reviewed and referenced during the plan development process. Action items in this plan include recommendations from several of these studies. As work is proposed from these studies and plans, TBCDs' team refers back to this plan for consistency in prioritization and implementation and to determine if there is a potential for federal mitigation funds to support the mitigation efforts.

Table 2-1 - TBCD List of Plans and Documents Reviewed and Incorporated

#	Plan NAME
1	2010 State of Texas Mitigation Plan Update
2	Chambers and Jefferson County Flood Insurance Rate Maps
3	Chambers and Jefferson County Study (FIS)

4	H-GAC Hazard Mitigation Plan Update, 2011

Step by Step process for incorporating the mitigation strategy and other information contained in the plan into other planning mechanisms.

Step 1 -When an update to an existing local plan, TBCD Assistant General Manager will provide a copy of the most recent HMP to the team responsible for the local plan update, specifically highlighting the action items

Step 2 -The planning process for the plan updates will include a review of the most current HMP and the actions to ascertain if any of the plan data (strategy and actions) are relevant for inclusion in the specific plan update. Particular attention will be given to incorporating action items that would enable the potential reduction in future damages from an identified hazard

Step 3 -Incorporate the relevant HMP data or actions into the draft plan update

Step 4 -Get feedback on the recommended incorporation from Management, Board Members and Stakeholders

Step 5 - Incorporate the relevant HMP data or actions in the final plan update

2.10 THE STATE MITIGATION PLAN

The State of Texas has long been aware that it is exposed to a variety of natural hazards. Of particular concern are flood hazards associated with thunderstorms, hurricanes, and tropical storms. The 2010 State of Texas Hazard Mitigation Plan Update is summarized below.

Originally prepared by TDEM to fulfill the requirements set forth by Congress in the Stafford Act (Section 409), the State's Hazard Mitigation Plan was completed in 2004 and was updated in 2007 and again in 2010 to satisfy new planning requirements prompted by the Disaster Mitigation Act of 2000.

The State's Plan acknowledges that people and property in Texas are at risk from a variety of hazards that have the potential to cause widespread loss of life and damage to property, infrastructure, and the environment. The Plan "establishes hazard mitigation goals, strategies, and specific measures designed to reduce the occurrence or severity of the consequences of hazards." It also documents procedures for implementation and administration of certain mitigation grant programs.

The State Hazard Mitigation Team is designated to coordinate and influence mitigation and is composed of several agencies that participate on the Emergency Management Board. Primary agencies are the Texas Division of Emergency Management; Texas Water Development Board Texas Department of Housing and Community Affairs; Texas Parks and Wildlife Department; Texas Department of Environmental Quality (formerly the Texas Natural Resource Conservation Commission); Texas

Department of Transportation, General Land Office; Railroad Commission of Texas; Texas Department of Insurance; Texas Forest Service; and Texas Engineering Extension Service;. Brief summaries of each of these primary agencies are provided in the State Plan, noting key natural hazard mitigation measures associated with each agency. For the most part, existing measures are ongoing agency functions and responsibilities.

As currently structured, the State's Hazard Mitigation Plan contains attachments outlining specific strategies for dealing with hazards related to floods, tornadoes, hurricanes and tropical storms, wildfires, and drought. Strategies particularly pertinent to local jurisdictions are described below:

2.10.1 Flood Mitigation

Historically, floods are and continue to be one of the most frequent, destructive, and costly natural hazards facing the State of Texas, constituting over 90% of the disaster damage in the State. Texas, on average, suffers approximately 400 floods annually, double the number of the second highest State.

State Strategies include:

- Mitigating severe repetitive loss properties (SRL) either by elevation or acquisition. According the 2010 State Hazard Mitigation Plan, there were 3,162 properties on the SRL list (Statewide);
- Redirecting $6.1 million in taxes and license fees collected biannually and given to TWDB so they can fund floodplain management training compliance functions and other mitigation activities; and
- Adopt a No Adverse Impact Policy to ensure that future development activity both in and out of the floodplain be part of mitigation planning.

2.10.2 Tornado Mitigation

Tornadoes occur annually and most frequently in the northern two-thirds of the State caused by cool frontal systems that enter from the north and west, and in the remainder of the State primarily caused as a cascading hazard from tropical storms.

State Strategies include:

- Adopt and enforce building codes and/or design criteria for construction of storm shelters and the construction of safe rooms,
- Promote and provide for expanded coverage options for standard peril and windstorm insurance coverage for public and private property;
- Promote and provide enhanced statewide awareness concerning the risks and consequences of tornadoes; and
- Promote and provide enhanced warning capabilities.

2.10.3 Hurricane/Tropical Storm Mitigation

Texas has experienced 23 Federal disaster declarations due to hurricane/ tropical storm events, the most recent events being Hurricane Rita (DR-1607) that was declare on September 24, 2005, Hurricane Dolly (DR-1780) that was declared on July 24, 2008, Hurricane Ike (DR-1791) that was declared on September 13, 2008, and Hurricane Alex (DR-1931) that was declared on September 16, 2010.

State Strategies include:

- Continue to fund Coastal Erosion and Response Act Projects, and
- Continue to promote the Hurricane Local Grant Programs.

2.10.4 Wildfire Mitigation

With the semi-arid climate of the western, southern and panhandle counties of the State, wildland fires are most common in the spring and summer months, but can occur at any time during the year. These wildland fires can have significant economic impact to local and regional economies. Threats to improved structures are a growing problem.

State Strategies include:

- Provide Urban Forestry Grants to improve community forestry programs,
- Establish and implement burning standards,
- Continue Urban Wildfire Interface, a traveling exhibit maintained by the Texas Forest Service (TFS) and
- Continued maintenance of the TFS website that contains fire safe mitigation initiatives.

2.10.5 Drought Mitigation

Given the expanse of the land mass within Texas and the geographic location of 2/3rds of the counties of the State are located either in an arid or semi-arid climate, roughly those west of a North-South line formed by Interstate Highway 35, are almost always in varying stages of drought. During the past 15 years, the worst droughts in Texas occurred in 1996, 2000, 2002, 2006, and 2009.

State Strategies include:

- Provide training and education programs for EMCs.

The Texas Department of State Health Services maintains a web site that provides tips and actions for citizens, governments and medical facilities.

2.11 FEDERAL MITIGATION PLANNING REQUIREMENTS

As mentioned elsewhere in the Plan, the Disaster Mitigation Act of 2000 requires State and local governments to develop and adopt natural hazard mitigation plans in order to be eligible for some types of federal assistance, including mitigation grants. The Act authorizes up to seven percent of Hazard Mitigation Grant Program (HMGP) funds available to a State after a disaster to be used for the development of State, tribal, and local mitigation Plans.

In addition to the Disaster Mitigation Act of 2000, mitigation planning requirements are set forth in various FEMA policies and guidance documents, including the Interim Final Rule of February 26, 2002, and the “386” series of mitigation planning how-to guides. The following series of bullets briefly describes the FEMA’s six hazard mitigation programs, all of which require some form of mitigation plan in order for communities to be eligible for grants. Although the programs differ in their eligibility requirements, funding amounts, etc., requirements related to mitigation planning are substantially similar. In 2008-2009, requirements for all the mitigation grant programs except for the Hazard Mitigation Grant Program were unified under the Hazard Mitigation Assistance (HMA) program guidance.

Flood Mitigation Assistance Program (FMA). To qualify to receive grant funds to implement projects such as acquisition or elevation of flood-prone homes, local jurisdictions must prepare a mitigation plan.

Pre-Disaster Mitigation Grant Program (PDM). By November 2003, to qualify for pre-disaster mitigation funds, local jurisdictions must adopt a mitigation plan that is approved by FEMA.

Hazard Mitigation Grant Program (HMGP). By November 2004, to qualify for post-disaster mitigation funds, local jurisdictions must adopt a mitigation plan that is approved by FEMA.

NFIP Community Rating System (CRS). The CRS offers recognition to communities that exceed minimum requirements of the National Flood Insurance Program. Recognition comes in the form of discounts on flood insurance policies purchased by citizens. The CRS offers credit for mitigation plans that are prepared according to a multi-step process.

FEMA/NFIP Severe Repetitive Loss Program (SRL). The SRL program was authorized by the Flood Insurance Reform Act of 2004 to provide funding to reduce or eliminate the long-term risk of flood damage to residential structures under the NFIP which have suffered repetitive losses. SRL properties have at least four NFIP claim payments over $5,000, with at least two of the claims within a 10 year period. SRL properties are also residential structures that have at least two separate claim payments made within a 10 year period with the cumulative amount of the building portion of the claims exceeding the value of the property. States are required to have SRL mitigation plans in order for local communities to be eligible for grant funds through this program.

FEMA/NFIP Repetitive Flood Claim Program (RFC). The SRL program was authorized by the Flood Insurance Reform Act of 2004 to assist States and communities reduce flood damages to properties that have at least one NFIP claim payment. Various hazard mitigation activities are eligible including acquisition, elevation, and dry flood proofing of residential structures.

3 SECTION 3 - Approval and Adoption

3.1 REQUIREMENT FOR APPROVAL AND ADOPTION

§201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., Board of Commissioners, County Commissioner, Tribal Board).

3.2 AUTHORITY

Authority for the preparation of the Hazard Mitigation Plan (HMP) is derived from the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988, P.L. 93-288, as amended by the Disaster Mitigation Act of 2000, P.L. 106-390. The Disaster Mitigation Act of 2000 (The Act) required State and local governments to develop and formally adopt natural Hazard Mitigation Plans by November 2003 in order to be eligible to apply for Federal assistance under the HMGP. The Act was further amended to extend the planning requirement deadline to November 2004.

When the DMA 2000 was signed into law on October 30, 2000, the Robert T. Stafford Disaster Relief and Emergency Assistance Act was amended by adding a new section, 322 – Mitigation Planning. Section 322 places new emphasis on local mitigation planning. It requires local governments to develop and submit mitigation plans as a condition of receiving Hazard Mitigation Grant Program (HMGP) project grants. A rule for implementing Section 322 was published in the Federal Register, 44 CFR Parts 201 and 206, on February 26, 2002. The requirements for local plans, or Local Mitigation Plan Criteria, are found in part 201.6.

In addition to the Plan requirement, the Act also requires communities to utilize a specific planning process developed for an all hazards approach to mitigation planning. This planning process is crucial to ensure that the effective planning by a community meets all the Plan content criteria required by the Act. The Act requires adoption by the local governing body and specifies a stringent review process, by which States and FEMA Regional Offices will review, evaluate and approve hazard mitigation plans.

3.3 APPROVAL AND ADOPTION PROCEDURE

Throughout the 2013 HMP process, the MPC and Stakeholders Group had opportunities to provide comments and feedback. In <<Insert Month>> 2014, Trinity Bay Conservation District submitted the initial draft of the Plan to TDEM for review and comment. After addressing TDEM's comments in the document, the HMP was resubmitted for final consideration and approval by TDEM and FEMA. FEMA provided a letter of approvability on [insert date], and the Plan was forwarded to the Trinity Bay Conservation Districts Board of Directors for adoption, which occurred on [insert date]. The adoption resolution is provided as Appendix G. Following adoption, the plan was resubmitted to FEMA for final approval, which occurred on [insert date]. The FEMA approval letter is included as Appendix H.

3.3.1 Adoption Resolution

Trinity Bay Conservation Districts' Board of Directors formally adopted the HMP on [insert date].

4 SECTION 4 - Mitigation Goal Statements

4.1 INTRODUCTION

State and federal guidance and regulations pertaining to mitigation planning require the development of mitigation goals to reduce or avoid long-term vulnerabilities to identified hazards. Mitigation goals have been established by the Federal Emergency Management Agency, the Texas Division of Emergency Management, and TBCD.

4.2 TRINITY BAY CONSERVATION DISTRICT'S MITIGATION GOALS

State and federal guidance and regulations pertaining to mitigation planning require the development of a mitigation goal statement that is consistent with other goals, mission statements and vision statements. To do so, the MPC reviewed FEMA's national mitigation goals, several examples of goal statements from other states and communities, and the State of Texas' Mitigation Goal. The committee also considered information about natural hazards that may occur in the area and their potential consequences and losses.

As part of the Plan, TBCD's mitigation goal statement was reviewed by the MPC during the initial meeting held on May 21st, 2013 and reads as follows:

Trinity Bay Conservation Districts Mitigation Goal Statement

The mitigation goals of TBCD are:

- To protect public health, safety, and welfare
- To reduce losses due to hazards by identifying hazards, minimizing exposure of citizens and property to hazards, and increasing public awareness and involvement
- To facilitate the development review and approval process to accommodate growth in a practical way that recognizes existing storm water and floodplain problems while avoiding creating new problems or worsening existing problems
- In cooperation with other local organizations to develop and initiate hazard mitigation actions and projects which will serve to protect the lives and property of citizens in the planning area.
- To seek solutions to existing problems

4.3 STATE OF TEXAS MITIGATION GOALS

The Texas' Division of Emergency Management (TDEM) is designated by the Governor as the state's coordinating agency for disaster preparedness, emergency response, and disaster recovery assistance. TDEM also is tasked to coordinate the state's natural disaster mitigation initiatives and administer grant funding provided by FEMA. A key element in that task is the preparation of the State of Texas Hazard Mitigation Plan. The State's 2010 plan includes a series of mitigation goals, as follows:

Texas State Mitigation Goals

- Reduce or eliminate hazardous conditions that cause loss of life;
- Reduce or eliminate hazardous conditions which inflict injuries;
- Reduce or eliminate hazardous conditions which cause property damage; and
- Reduce or eliminate hazardous conditions which degrade important natural resources.

Texas Hazard Mitigation Plan (2010)

4.4 FEMA'S MITIGATION GOAL

FEMA's mitigation strategy is set forth in a document originally prepared in the late 1990s. This strategy is the basis on which FEMA implements mitigation programs authorized and funded by the U.S. Congress. The national mitigation goal statement is as follows

- To engender fundamental changes in perception so that the public demands safer environments in which to live and work; and
- To reduce, by at least half, the loss of life, injuries, economic costs, and destruction of natural and cultural resources that result from natural disasters.

5 SECTION 5 – Hazards

5.1 INTRODUCTION

As part of its efforts to support and encourage hazard mitigation initiatives, the TDEM prepared an assessment of hazards that have caused or have the potential to cause disaster situations in communities throughout the State of Texas. Results of the study are found in the State of Texas Hazard Assessment (2010). Other public sources of information provide some information about natural hazards and past events. Of the 86 Presidential Disaster Declarations that Texas received between 1953 and 2011, 35 were for floods, 15 for tornadoes, 14 for hurricane/tropical storms, 16 for severe storms, three for extreme wildfire, and the remaining were a combination of events, or designated as "other."

The following subsections provide an overview of past hazard events and associated losses. Natural hazards that are deemed pertinent to Trinity Bay Conservation District are described, along with summary statements about exposure to risks associated with those hazards. Because flooding and wind poses the most significant risk in the TBCD planning area, Section 6 provides a detailed vulnerability assessment and loss estimation for flood and wind hazards.

Although TBCD is subject to a range of hazards typical of the northern Gulf Coast, for the reasons outlined below, Trinity Bay Conservation District has determined that the most appropriate and useful approach to developing its mitigation plan is to eliminate certain hazards from detailed consideration in its HMP. There are three reasons for this:

- the hazards are not significant enough to warrant detailed vulnerability assessment and loss estimation;
- TBCD's mission and jurisdictional authority is explicitly limited to activities related to controlling floods (although the organization does have the authority to complete actions to protect and mitigate damage to its own facilities), and;
- All other assets and populations that are potentially exposed to hazards are part of another mitigation plan, and hence including them in the present document would be redundant and serve no meaningful purpose. Trinity Bay Conservation District and the incorporated areas within the District have both the authority and the responsibility to sponsor mitigation activities for their constituent populations and communities. TBCD will continue to coordinate with the local jurisdictions to ensure that mitigation actions are developed and implemented in a rational manner, reducing or eliminating conflict and overlap between the jurisdictions.

Based on this reasoning, the MPC has determined that flood and wind (hurricane wind and tornado) hazards will be described and assessed in detail in this HMP, and that the other hazards will be profiled, but not included as part of more detailed vulnerability and risk assessments. Although State and FEMA guidance permits jurisdictions to simply eliminate hazards from consideration, the District believes that it is important to profile these hazards to ensure general consistency with mitigation plans in surrounding (and overlapping) jurisdictions, but that they are addressed sufficiently in other plans and processes. It is also worth noting that as part of carrying out its flood control mission, TBCD has assessed potential damages to its own facilities from flood and wind hazards, and has developed specific mitigation measures to address these, where appropriate.

5.2 REQUIREMENT FOR HAZARD IDENTIFICATION, PROFILING, AND RISK ASSESSMENTS

§201.6(c)(2)(i): [The risk assessment shall include a] description of the location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

§201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

§201.6(c)(2)(ii): [The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.

5.3 OVERVIEW OF RISKS

Damages and losses (including physical damage, indirect and economic losses, and injuries and deaths) that are associated with hazards result when an event affects areas where people and improved property are located. After hazards are identified, estimates of how exposed people and property are, "at-risk" can be prepared, especially if the hazards can be characterized by areas on a map.

When the full range of possible natural hazards are reviewed, it becomes apparent that some events occur frequently and some are extremely rare. Some hazards impact large numbers of people to a limited degree, while others may cause much localized but very significant damage. As described in Section 5.1, floods have historically caused the most property damage in the planning area.

The National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) collects and maintains certain hazard data in summary format, indicating injuries, deaths, and estimated damages. According to the NCDC database, between 1950 and 2012, Chambers County (data was unavailable for TBCD specifically) has experienced 125 severe thunderstorms (seven of which had greater than 60 knot winds), 36 tornadoes, and 35 floods/flash floods. A number of these events caused property damage and loss of life. The NCDC database indicates that as of spring 2012, these hazard events caused a combined total of over 56 million in property damage. The database also indicates that there have been 214 injuries and 125 deaths as a result of these events.

5.3.1 Weather-Related Deaths

The National Weather Service maintains data on weather-related deaths. The following summary is taken directly from the NOAA website and summarizes natural hazard statistics for the entire U.S. in the year 2010.

5.3.1.1 Summary of 2010 Natural Hazard Statistics for the entire United States

Weather-related deaths were up in 2010 to 490 deaths, from 373 fatalities in 2009. This number is well below the 10-year average (2001-2010) of 578. Heat was the most deadly hazard, claiming 138 lives in 2010, up significantly from 45 in 2009. Flooding was the next most deadly weather category, with 103 victims, up from 56 in 2009, followed by rip currents with 64, up from 55 victims in 2009.

Weather related injuries were up significantly in 2010. There were 2,369 reported weather-related injuries/illnesses, up from 1,829 in 2009 but down from 2008 with tallied 2,903. Tornadoes caused the most injuries, with 699 victims up 351 in 2009, followed by heat with 592, up from 204 in 2009, and thunderstorm and other high winds, with 388 injuries, up from 257 the previous year.

Extreme weather caused approximately $9.9 billion in combined property and crop damages in 2010, up substantially from $7.5 billion in 2009. Property damages were estimated at $7 billion, up slightly from $6.8 billion in 2009 but well below 2008, which came in at $27.1 billion. In contrast to 2009, when hail and thunderstorm damage caused the heaviest property losses, in 2010 flooding was the leading hazard, responsible for $3.9 billion in losses, followed by tornado damages with $1.1 billion in losses. Crop damage was most affected by flooding as well, which accounted for $1.2 billion in damages to farmers, followed by drought and cold which each accounted for about $750 million in crop losses.

Figure 5-1 - Summary of U.S. Fatalities by Age (Source: NOAA)

2010 Summary of Fatalities for All Hazards by Age and Gender

	Female	Male	Unknown	Total	Percent
0 to 9	17	16	1	34	6.94
10 to 19	14	23	0	37	7.55
20 to 29	11	28	0	39	7.96
30 to 39	10	30	0	40	8.16
40 to 49	15	47	0	62	12.65
50 to 59	19	57	0	76	15.51
60 to 69	26	46	0	72	14.69
70 to 79	16	29	1	46	9.39
80 to 89	15	21	0	36	7.35
90 to --	10	2	0	12	2.45
Unknown	8	20	8	36	7.35
Total	161	319	10	490	
Percent	32.86	65.10	2.04		

5.3.1.2 Summary of 2010 Natural Hazard Statistics for the State of Texas and TBCD

Summary statistics for the year 2010 in the State of Texas based on storm data from NOAA/NCDC.

The NOAA/NCDC database has 2,537 Hazardous Weather events for the State of Texas in 2010. Of those, only one was reported to have effected Chambers County, which represents the major portion of the planning area for Trinity Bay Conservation District. Weather-related deaths in the State of Texas account for 26, or 5%, of the 490 total fatalities in the United States for 2010. There was one fatality reported associated with this storm. Flood/Flash Flood was the most deadly hazard, claiming 14 of the 26 lives in 2010. Rip Currents were the next most deadly weather category, with 6 victims followed by excessive heat with 4 victims. The cost in property damage for 2010 exceeds $222.4 million with an additional $88 million in crop damages being reported. There was no property or crop damages reported in the TBCD planning area for 2010 however there was one injury and one death reported to be associated with this storm.

There were 2,369 reported weather-related injuries/illnesses in the United States for 2010. Of those 2,369 injuries reported the State of Texas reports 32 injuries and only one of those were reported to have occurred in the planning area in 2010. Thunderstorm Winds caused the most injuries in the State of Texas with 21 followed by Tornados with 8 injuries reported.

5.4 NATURAL HAZARD STATISTICS FOR THE STATE OF TEXAS AND TBCD

The NOAA/NCDC database was analyzed to determine the Natural Hazards which affect the State of Texas and the planning area of Chambers County. Table 5-1 shows a summary of all weather related events in Texas between 1950 and 2011. Approximately $33.9 Billion in recorded damages, 1,366 fatalities and 17,667 injuries have been attributed to weather. Analysis of this data shows Thunderstorms/High Winds is the most frequent type of event in Texas. The most costly weather related event is Hurricane/Tropical Storm with 84 incidents accounting for 32 fatalities, 20 injuries and over $9.6 Billion in damages reported. The next most costly and frequent category is Floods/Flooding which is reported to account for 9,564 events costing 267 lives and 6,928 injuries. Floods/Flooding is reported to account for $6.6 Billion in damages over the 60+ years for which data is available.

Table 5-1 - Summary of Natural Hazards for State of Texas (Source: NOAA /NCDC)

Event Type	# of Events	Fatalities	Injuries	Property Damage	Crop Damage
Drought	433	0	0	$349,027,000	$6,373,438,000
Extreme Heat	158	298	787	$200,000	$50,000
Floods/Flooding	9,564	267	6,928	$6,665,721,150	$113,670,000
Hurricane/Tropical Storm	84	32	20	$9,634,738,000	$4,190,000
Landslide	2	0	0	$0	$0
Other	107	21	13	$6,503,000	$3,000,000
Thunderstorms/High Winds	62,884	129	1,351	$5,298,424,580	$546,881,000
Tornados	8,762	538	8,207	$3,720,856,040	$81,889,100
Wildland Fires	777	24	146	$606,012,700	$161,796,400
Winter storms	941	57	215	$360,235,200	$15,963,000
Grand Total	83,712	1,366	17,667	$26,641,717,670	$7,300,877,500

5.5 PUBLIC AWARENESS OF HAZARDS & RISK

The public becomes aware of local hazards in a number of ways. For example, public awareness of flood hazards is enhanced during the following activities:

Buying property in a floodplain triggers the federal requirement to obtain flood insurance when obtaining a federally insured and regulated mortgage. Federally insured and regulated mortgage lenders are required to make homebuyers purchase flood insurance if the building is located in a mapped flood hazard area. Buyers are supposed to be notified well in advance of closing.

Applying for permits leads to a determination that the property or construction site is within a mapped floodplain and therefore subject to floodplain management requirements.

When flooding occurs the news media frequently carries stories about travel hampered by flooded roads and homes damaged by floodwaters. Research has shown that many flood victims themselves tend to discount the likelihood that flooding will occur again. This tendency is attributed to a general lack of understanding of probability (see Comparing Risks, below). All too often, people interpret the phrase "100-year storm" to mean that it only occurs once every 100 years, rather than that such an event has a 1-in-100 chance of happening each year. FEMA reports that, based on insurance statistics, a building in the floodplain is five times more likely to be damaged by flood than to sustain major damage by fire.

Flood warnings reach the public as regional warnings from the National Weather Service.

5.6 OVERVIEW OF TRINITY BAY CONSERVATION DISTRICT'S NATURAL HAZARDS HISTORY

Numerous federal agencies maintain a variety of records regarding losses associated with natural hazards. Unfortunately, no single source is considered to offer a definitive accounting of all losses. FEMA maintains records on federal expenditures associated with declared major disasters. The U.S. Army Corps of Engineers (USACE) and the Natural Resources Conservation Service (NRCS) collect data on losses during the course of some of their ongoing projects and studies. As mentioned earlier in this Section, NOAA's NCDC database is another source where data statistics such as injuries, deaths, and damage estimates are maintained for a variety of natural hazards. The data is maintained throughout the District, with more recent entries listing the specific location within the district. Although not always specific to Trinity Bay Conservation District, this hazard data from the NCDC is often the best available resource for documenting historical events. For many of the hazards profiled, the query results from the NCDC database are provided in the hazard specific subsections later in Section 5.

In the absence of definitive data on some of the natural hazards that may occur in TBCD, illustrative examples are useful. The section below provides a brief description of several particularly significant natural hazard events occurring in Trinity Bay Conservation District in recent history. This list is not meant to capture every event that has affected the area; rather it lists one or two examples of the types of events than have affected the area in the past.

Data on Presidential Disaster Declarations characterize some natural disasters that have affected the area. In 1965, the federal government began to maintain records of events determined to be significant enough to warrant declaration of a major disaster by the President of the United States. Presidential Disaster Declarations are made at the county level and are not specific to any one city or sub-area. As the boundaries of the Trinity Bay Conservation District and Chambers County coincide for the most part it should be noted that all disaster declarations for Chambers County affected the Trinity Bay Conservation District. However, as of 2012, 16 such disasters had been declared in Chambers County and some are identified as part of the summary below.

5.7 SUMMARY OF MAJOR WEATHER EVENTS FOR TRINITY BAY CONSERVATION DISTRICT

Based on data from the NCDC database there have been 264 storms which have effected Chambers County[5] which caused 122 deaths and 215 injuries. The storms overall did a reported $5,614,453,780 in property damages and an additional $235,303,000 in crop damages.[6] It should be noted that figures for damages to both crops and property are a total over a large number of years and were not corrected for inflation. Actual numbers would be much higher if inflated to present values.

Table 5-2 - Summary of Natural Hazards for Trinity Bay Conservation District (Source: NOAA /NCDC)

Disaster Type	Count	FATALITIES	INJURIES	PROPDMG	CROPDMG
Drought	29	0	0	$0	$235,200,000
Extreme Heat	8	87	200	$0	$0
Flood	34	1	0	$1,193,000	$50,000
Hail	50	0	0	$243,500	$0
Hurricanes and Tropical Storms	11	28	5	$5,610,598,000	$50,000
Thunderstorm/High Winds	71	2	1	$900,000	$3,000

[5] *While Chambers County and the Trinity Bay Conservation District boundaries do not exactly match this data was deemed to be the best available for the overview of Hazards which this section attempts to provide.*

[6] *Data collected from the NCDC data source provides the total for all counties the storm effect and therefore are not considered reliable indicators of local damages but are intended to provide scale and intensity data for a storm.*

Disaster Type	Count	FATALITIES	INJURIES	PROPDMG	CROPDMG
Tornado	37	4	8	$1,505,280	$0
Wildfire	6	0	1	$0	$0
Winter Storm	19	0	0	$14,000	$0
Grand Total	264	122	215	$5,614,453,780	$235,303,000

5.8 LOSSES DUE TO MAJOR DISASTERS

No definitive record exists of all losses – public and private – due to disasters for TBCD. For the United States as a whole, estimates of the total public and private costs of natural hazards range from $2 billion to over $6 billion per year. Most of those costs can only be estimated. In most declared major disasters, the federal government reimburses 75% of the costs of cleanup and recovery, with the remaining 25% covered by the state and affected local jurisdictions.

FEMA's estimate of its expenditures in the State of Texas for flood disasters alone for the period from 1991 through 2009 exceeds $8 billion. This period includes Tropical Storm Allison, and Hurricanes Rita and Ike. These costs, which do not include costs incurred by other federal agencies or by state and local agencies, include those associated with:

- Public assistance for debris removal, emergency services, roads and bridges, flood control facilities, public buildings and equipment, public utilities, and parks and recreational facilities.
- Assistance paid out for individual and family grants, emergency food and shelter, and other assistance to individuals.

TBCD received Public Assistance (PA) funds after several of the events described above. Pa funds were set aside to support hazard mitigation grants. These include debris cleanup, destroyed bridges, saltwater weirs, saltwater gates and other small PW's. In addition to PA funds outlined in Table 5-3. A detailed description of planned mitigation projects can be found in Section 7.7, Ongoing Mitigation Initiatives.

Table 5-3 - Public Assistance Summary Trinity Bay Conservation District (Sources: PA PWs)

Category	Count	Project Amt	Fed Share	Approved
A	4	$ 12,655,270.28	$ 12,655,270.28	$ 12,655,270.28
B	10	$ 959,730.74	$ 781,871.49	$ 781,871.49
C	17	$ 5,065,532.00	$ 4,558,986.50	$ 4,558,986.50
D	16	$ 3,563,602.11	$ 2,709,594.55	$ 2,709,594.55

E	7	$ 72,625.70	$ 42,006.11	$ 42,006.11
F	15	$ 539,767.78	$ 260,015.60	$ 260,015.60
Total	69	$ 22,856,528.61	$ 21,007,744.53	$ 21,007,744.53

5.9 HAZARDS OTHER THAN FLOOD

Natural hazards other than flood hazards that are deemed pertinent to Trinity Bay Conservation District are described, along with summary statements about exposure to risks associated with those hazards. Because flooding and wind pose the most significant risks in TBCD, Section 6 provides a more detailed risk assessment for these two hazards. The following subsections provide an overview of past hazard events and associated losses:

- Dams/Dam Failure
- Drought
- Earthquake/Seismic
- Extreme Heat
- Hurricanes and Tropical Storms
- Landslide
- Thunderstorms/High Winds
- Tornadoes
- Wildland Fire
- Winter Storm
- Flood

Table 5-4 identifies the total number and estimated value of buildings/infrastructure within the TBCD planning area. The table indicates there are 15,449 residential buildings, 1,495 mobile homes, 10,078 other and 6,265 commercial buildings. The total population of Chambers County is estimated to be 252,051. The data in Table 5-4 is used periodically throughout Section 5 to identify the overall District-wide exposure for certain hazards that equally impact the entire planning area such as hurricanes/tropical storms and drought.

Table 5-4 - Buildings/Infrastructure in TBCD Planning Area (Sources: US Census Bureau, Central Appraisal District)

Type	Number of Structures/Estimated Improvement Value		Total Acreage
Residential Buildings	15,449	$ 1,359,633,770*	40,905.16
Commercial Buildings	6,265	$ 112,923,600*	13,970.27

Type	Number of Structures/Estimated Improvement Value		Total Acreage
Mobile Homes	1,495	$25,191,840	1,442.15
Other	10,078	$244,808,280	357,948.41
Vacant Land	5,281	$0	143,814.01
District owned Buildings	1	$169,722	
Total	38,569	$ 1,743,707,490	558,080

** – Value based on insured value of District owned structures

Table 5 5 - Buildings/Infrastructure in the SFHA in TBCD Planning Area (Sources: US Census Bureau, Central Appraisal District)

Type	Number of Structures/Estimated Improvement Value		Total Acreage
Residential Buildings	8,033	$ 707,009,560	21,271.00
Commercial Buildings	3,258	$ 58,720,272	7,265.00
Mobile Homes	777	$ 13,099,757	750.00
Other	5,241	$ 127,300,306	186,133.00
Vacant Land	2,746	$ -	74,783.00
District owned Buildings	0	$ -	0
Total	20,056	$ 906,129,895	290,202

Table 5-6 - Buildings/Infrastructure out of the SFHA in TBCD Planning Area (Sources: US Census Bureau, Central Appraisal District)

Type	Number of Structures/Estimated Improvement Value		Total Acreage
Residential Buildings	7,416	$ 652,624,210	19,634.48
Commercial Buildings	3,007	$ 54,203,328	6,705.73
Mobile Homes	718	$ 12,092,083	692.23
Other	4,837	$ 117,507,974	171,815.24
Vacant Land	2,535	$ -	69,030.72
District owned Buildings	1	$169,722	0
Total	18,513	$ 836,979,595	267,878

5.10 GENERAL ASSESSMENT OF PROBABILITY

For each hazard profiled in the present section, the planning team assigned a high, medium, or low probability of future occurrences. The hazard probability was assigned by dividing the period of record by the numbers of previous events, then scaling the probabilities as low, medium, and high, as shown in Table 5-7 Note that the percent ranges in the table below are not intended as exact probabilities; they are estimates made by the planning team, intended to be used as a general guide for future planning purposes. Also note that future probability is only one component of the risk calculation (the others being severity, vulnerability and value). Some hazards, such as major hurricanes and earthquakes have a low probability but potentially very high impact on life and property in the planning area.

Table 5-7 - Annual Percent Probability Ranges

Probability	Annual Percent Probability Range (%)
Low	1-9
Medium	10-24
High	25-100

5.11 DAMS/DAM FAILURE

Research into the geographic location of dams within the planning area, previous occurrences of dam failure, the probability of an occurrence of dam failure in the future, the potential magnitude/severity/extent of an occurrence of dam failure, and the overall vulnerability of the district and its facilities to this hazard was conducted. The research included data available on the FEMA website, USACE National Inventory of Dams, The State of Texas Commission on Environmental Quality (TCEQ), The State of Texas Division of Emergency Management (TDEM), the current State of Texas Hazard Mitigation Plan, and The Harris-Galveston Area Council Hazard Mitigation Plan dated 2011. Much of the following hazard description was taken from the 2011 H-GAC Hazard Mitigation Plan.

5.11.1 Hazard Description

Dams are described as water storage or diversion barriers that impound water upstream in reservoirs. Dam failure can be a collapse, breach or overtopping of this structure. While most dams have storage volumes small enough that failures have relatively minor repercussions, dams with large storage volumes can cause significant flooding at lower relative elevations.

Dam failures are not themselves natural hazards, but are often caused by natural hazards such as floods and earthquakes, and their failure can then result in floods. Dam failures can result from a variety of causes including lack of maintenance, seismic activity, improper design or construction, or the effects of large storms. Significant rainfall can quickly inundate an area and cause floodwater to overwhelm a reservoir. If the spillway of the dam cannot safely pass the resulting flows, water will begin flowing in areas not designed for such flows and failure may occur. See Appendix L for a more detailed description of the dam failure hazard. For additional information about dam failure visit FEMA's Dam Failure page located at http://www.fema.gov/hazard/damfailure/index.shtm.

The failure of dams can result in injuries, loss of life, and damage to property and environment. While levees are built solely for flood protection, dams often serve multiple purposes such as hydroelectric generation, flood control, and recreation. Dams are usually engineered to withstand a flood with a calculated risk of occurrence. Simultaneous occurrence of causal factors can exponentially increase the potential of dam failure. Failed dams can create floods that are catastrophic to life and property, in part because of the tremendous energy of the released water.

The hazard potential for dam failure is classified according to the following definitions accepted by the Interagency Team on Dam Safety:

- *Low Hazard Potential*—Failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

- *Significant Hazard Potential*—Failure or mis-operation results in possible loss of human life but can also include or cause economic loss, environmental damage, disruption of lifeline facilities, or other impacts. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
- *High Hazard Potential*—Failure or mis-operation will probably cause loss of human life.

Dam failure can be caused by simple structural failure, or any combination of the following factors:

- earthquake
- flood conditions leading to overtopping
- internal erosion
- inadequate spillway capacity
- improper operation or maintenance
- arson
- failure of upstream dams

Warning time for dam failure varies widely and depends on the causal factors. Dam failure can occur in as little as a few minutes or slowly over the course of months. Catastrophic failure of a large dam would result in short evacuation times for locations directly downstream. Topography and floodplain characteristics determine warning time for locations further downstream.

FEMA indicates that there are over 80,000 dams in the United States and that according to the National Inventory of Dams one third, or nearly 27,000, of these pose a "high" or "significant" hazard to life and property if failure occurs.

The State plan indicates that Texas as a whole has experienced 136 documented dam failures. In 1900, 25 people were killed when the Lake Austin dam failed and in 1989 one man dies when the Nix Lake Dam in Rusk County failed.

The Harris – Galveston Area Council plan refers to the State plan and provides no additional information with regard to past occurrences.

5.11.2 Geographic Location

There are nine dams included in the USACE National Inventory of Dams (NID) database which lay within the boundaries of Chambers County. A dam is included in the NID database if it meets one of the following criteria:

- It has High Hazard classification – loss of one human life is likely if the dam fails,
- It has Significant hazard classification – possible loss of human life and likely significant property or environmental destruction,

- Equal or exceed 25 feet in height and exceed 15 acre-feet in storage,
- Equal or exceed 50 acre-feet storage and exceed 6 feet in height.

Table 5-8 below outlines the dams listed by the NID for Chambers County. Classification is not publicly available, although TCEQ reports that no EAP is required for the nine dams and therefore the MPC surmised that the dams are not considered significant or high by the aforementioned definitions. The general location of the nine dams is indicated on the map labeled figure 5-2 below.

Figure 5-2 Dams of Chambers County Texas (Source: USACE NID Database, JSW GIS)

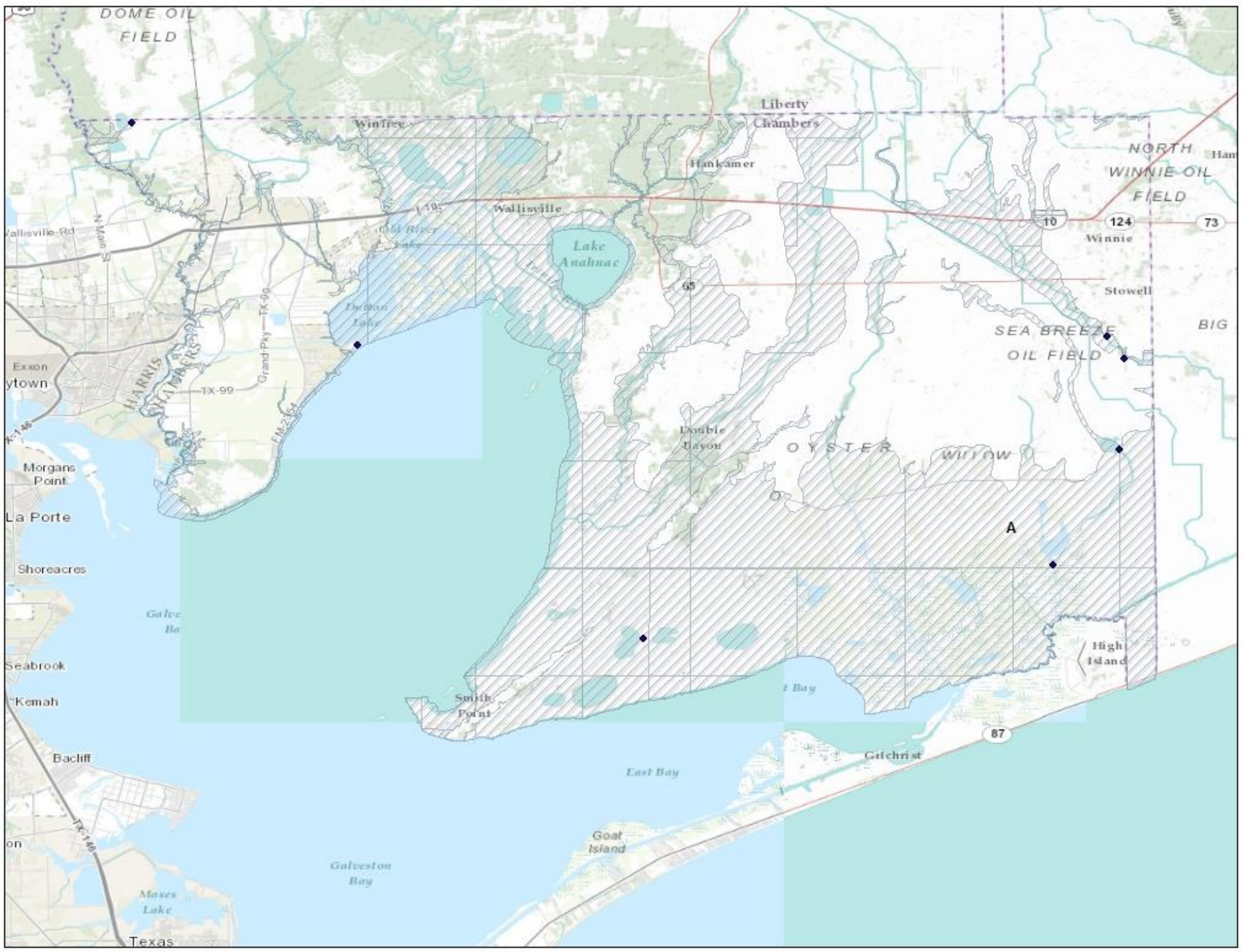

Table 5-8 - Dams of Chambers County Texas (Source: USACE NID Database)

Dam Name	USGS Topo Map	Elevation	Lat	Long
Cedar Bayou Generating Pond Levee	Cove	Unknown	29.755ºN	94.819ºW
E W Monteith Number 1 Levee	Lake Stephenson	3 feet	29.584ºN	94.652ºW
E W Monteith Number 2 Levee	Lake Stephenson	3 feet	29.584ºN	94.652ºW
E W Monteith Number 3 Levee	Lake Stephenson	3 feet	29.584ºN	94.652ºW
Marshall Estate Dam Number 1	Stowell	13 feet	29.760ºN	94.382ºW
Marshall Estate Dam Number 2	Whites Ranch	10 feet	29.747ºN	94.372ºW
Martrac Farms Dam	Stanolind Reservoir	3 feet	29.627ºN	94.414ºW
W Scott Frost Reservoir Number 1 Levee	Sheeks	33 feet	29.884ºN	94.950ºW
William S Edwards Dam	Stanolind Reservoir	7 feet	29.694ºN	94.375ºW

5.11.3 Previous Occurrences

The State of Texas Plan and the H-GAC Plan list no dam failure occurrences in the planning area. In addition, a review of the Association of Dam Safety Officials database on dam failure, does not include any failures in the planning area.

5.11.4 Probability of Future Occurrence

Due to no reports of any previous occurrences in the planning area in the last 50 years, the probability of future occurrence is zero (number of occurrences divided by number of years)

5.11.5 Magnitude/Severity/Extent

The severity of a dam failure event depends on several factors, including the size of the dam, the extent of the failure (i.e., catastrophic structural failure versus a small breech), the velocity of the floodwater released, and the density of built environment and populations downstream. There is the potential for total collapse of a dam, but less significant failures are more likely as a result of overtopping (inadequate spillway design, debris blockage), foundation defects, or seepage. Overtopping of a dam during a flood event due to clogged debris has the potential to be catastrophic. Unlike the Richter scale for earthquakes or the Torro scale for hail, there is no defined scale to determine the magnitude for dam failure. Inundation maps would show the area around the dam that would be inundated by flooding from a dam failure, but that is not publicly available. While TBCD has identified the physical dam locations, some inundation maps are not yet developed for the dams within Chambers County and where they are, they are not readily available due to security reasons. TBCD has been working with Dam owners and with TCEQ to obtain as much data as possible to address this requirement but have not been successful in obtaining any further data other than storage capacity for many of the dams. TBCD is identifying this requirement as a data deficiency in this plan and has added an action item associated with attempting to obtain this data for our next plan update.

5.11.6 Impact

The Dam or Levee Failure hazard profile in the State plan concludes the potential severity of impact, state-wide, to be limited with the frequency of occurrence unlikely and minimal to no warning time prior to an event. The cascading potential of dam or levee failure in the State can lead to flooding of crops, homes and cities with injury, including loss of life possible. Events can cause structural damage to homes, businesses, and infrastructure. The Trinity Bay Conservation District planning area could face flooding of residential and commercial structures from a dam failure. It could also see injury or death of residents as dam failure may have little warning for residents and motorists in that inundation area. Dam failure could cause downed utilities and flooded roads which makes it difficult for emergency personnel as well as residents. Dam failure can also cause debris build up or be disbursed which can impede rescue and cleanup efforts. It could damage or destroy crops and cause disruption of business if businesses are located in the inundation area.

5.11.7 Overall Vulnerability

Critical Facilities – If located in a floodplain or in an inundation area, critical facilities (including hospitals, police, fire stations, and government facilities) could be damaged or destroyed by flooding.

Critical Infrastructure – If located in a floodplain or in an inundation area, critical infrastructures (including roads, bridges and overpasses) could be blocked by flood waters and debris, and/or damaged or destroyed from the flooding.

Structures – If located in a floodplain or in an inundation area, residential and commercial structures (including houses, mobile homes, barns and other buildings, commercial and industrial business buildings) could be damaged or destroyed by flooding.

Population – If located in a floodplain or in an inundation area, persons in the direct inundation path of the failure would be at risk of serious injury and possible death.

Economic – if located in a floodplain or in an inundation area, crops could be destroyed, and business forced to close until cleanup of area and building (if damaged) is completed.

Future Development – if not properly identified, developers could build in areas that are within an inundation area which would cause more damage and threaten more residents and businesses.

5.12 DROUGHT

5.12.1 Hazard Description

Drought is generally defined as a condition of climatic dryness severe enough to reduce soil moisture and water supplies below the requirements necessary to sustain normal plant, animal, and human life. In Texas, drought is often defined in terms of agricultural and hydrologic drought:

- Agricultural drought is considered a dry period of sufficient duration and intensity that crop and animal agriculture are markedly affected.
- Hydrologic drought is considered a long-term condition of abnormally dry weather that ultimately leads to the depletion of surface and ground water supplies. During hydrologic drought, a significant reduction in flow of rivers, streams, and springs is notable.

5.12.2 Geographic Location

Texas is divided into ten climatic divisions that range from substantially heavy precipitation through semi-arid to arid climates. Most of Texas is prone to periodic droughts of differing degrees of severity. One reason is the state's proximity to the Great American Desert of the southwestern United States. In every decade of this century, Texas has fallen victim to one or more serious droughts. The severe-to-extreme drought that affected every region of the state in the early to mid-1950s was the most serious in recorded U.S. history. Drought is a normal part of almost all climatic regimes, including areas with high and low average rainfall. Texas and Chambers County, specifically, are not immune from the occurrence or effects of drought and are county wide. See Appendix A for a more detailed description of the drought hazard.

5.12.3 Previous Occurrences

In Trinity Bay Conservation District, extended drought periods were experienced in 1996, 1998, 2000, 2006, 2007, 2009, 2010, 2011 and 2012. The drought hazard affects the entire planning area. The 1996 drought affected the entire state. Its impacts were greatest on major population centers, prompting water conservation and reduction measures over an extended period. The Texas Agricultural Extension Service projected a $4 billion statewide economic loss as a result of the 1996 drought. In the Southeast Texas area, damage from the extended drought reached record proportions as many crops were completely lost and large numbers of animals were sold because of lack of grass. In the Southeast Texas region, property damage was estimated at $10 million and agricultural losses were estimated at $100 million. Specific numbers for TBCD planning area were not available.

The NCDC database indicated that between 1950 and 2013, there were 29 drought events that affected the planning area. The database provides no indication as to why there are no events prior to 1996, although presumably occurrences follow the same pattern and frequency as shown in the NCDC list. The events are summarized below in Table 5-9. The events in the table are listed by month. For example, if a drought lasts several continuous months, it is listed in the database as a separate event. If the continuous months are combined into single events, the number of events is reduced from 29 to 13.

Table 5-9- Drought Events in Chambers County, 1950 – 2011 (Source: NOAA/NCDC)

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
5/1/1996			$ -	$ -
6/1/1998			$ -	$ -
8/1/1998			$ -	$ 150,200,000
4/1/2000			$ -	$ 85,000,000
8/1/2000			$ -	$ -
11/1/2006			$ -	$ -
12/1/2006			$ -	$ -
1/1/2007			$ -	$ -
2/1/2007			$ -	$ -
3/1/2007			$ -	$ -
2/1/2009			$ -	$ -
3/1/2009			$ -	$ -
4/1/2009			$ -	$ -
12/1/2010			$ -	$ -
1/1/2011			$ -	$ -
2/1/2011			$ -	$ -
3/1/2011			$ -	$ -
4/1/2011			$ -	$ -
6/1/2011			$ -	$ -
7/1/2011			$ -	$ -
8/1/2011			$ -	$ -
9/1/2011			$ -	$ -
10/1/2011			$ -	$ -
11/1/2011			$ -	$ -
12/1/2011			$ -	$ -
1/1/2012			$ -	$ -
3/1/2012			$ -	$ -
4/1/2012			$ -	$ -
7/1/2012			$ -	$ -
Totals			$ -	$ 235,200,000

*While the NCDC reports the event, it is unknown the effects on the TBCD jurisdictional area.

Within Trinity Bay Conservation District, All people and assets are considered to have the same degree of exposure (See Table 5-4 for District-wide total number of buildings/infrastructure and estimate values).

The drought hazard affects all residential and commercial building types about equally within the planning area. Data related to the number of structures by building type and past damages for specific building types was unavailable at the time of the Plan and therefore the loss estimates for the drought hazard are based on total property damage as reported by the NCDC.

5.12.4 Probability of Future Occurrence

The 13 events caused an estimated $235,200,000 in damage across the entire County. This number divided by the span of years (17 years) it is estimated that TBCD will incur $1,383,529 dollars in damage annually due to drought. Based on the medium to high probability indicated above, droughts will most likely continue in TBCD as the dollar amount would place the future occurrence as **high**.

5.12.5 Magnitude/Severity/Extent

A drought's severity depends on numerous factors, including duration, intensity, and geographic extent as well as regional water supply demands by humans and vegetation. The severity of drought can be aggravated by other climatic factors, such as prolonged high winds and low relative humidity[7]. Due to its multi-dimensional nature, drought is difficult to define in exact terms, and also poses difficulties in terms of comprehensive risk assessments.

One method used by scientists to calculate the severity and duration of a drought is the Palmer Drought Severity Index (PDSI). The PDSI indicates the prolonged and abnormal moisture deficiency or excess and indicates general conditions, not local variations caused by isolated rain. The PDSI is an important climatological tool for evaluating the scope, severity, and frequency of prolonged periods of abnormally dry or wet weather.[8]

The equation for the PDSI was empirically derived from the monthly temperature and precipitation scenarios of 13 instances of extreme drought in western Kansas and central Iowa and by assigning an index value of -4 for these cases. Conversely, a +4 represents extremely wet conditions. From these values, seven categories of wet and dry conditions can be defined. Table 5-10 identifies the values used to define the PDSI.[9] Trinity Bay Conservation District Planning area could see drought severity from -4.0 to 3.9 based on the PDSI table.

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[7] FEMA, 1997

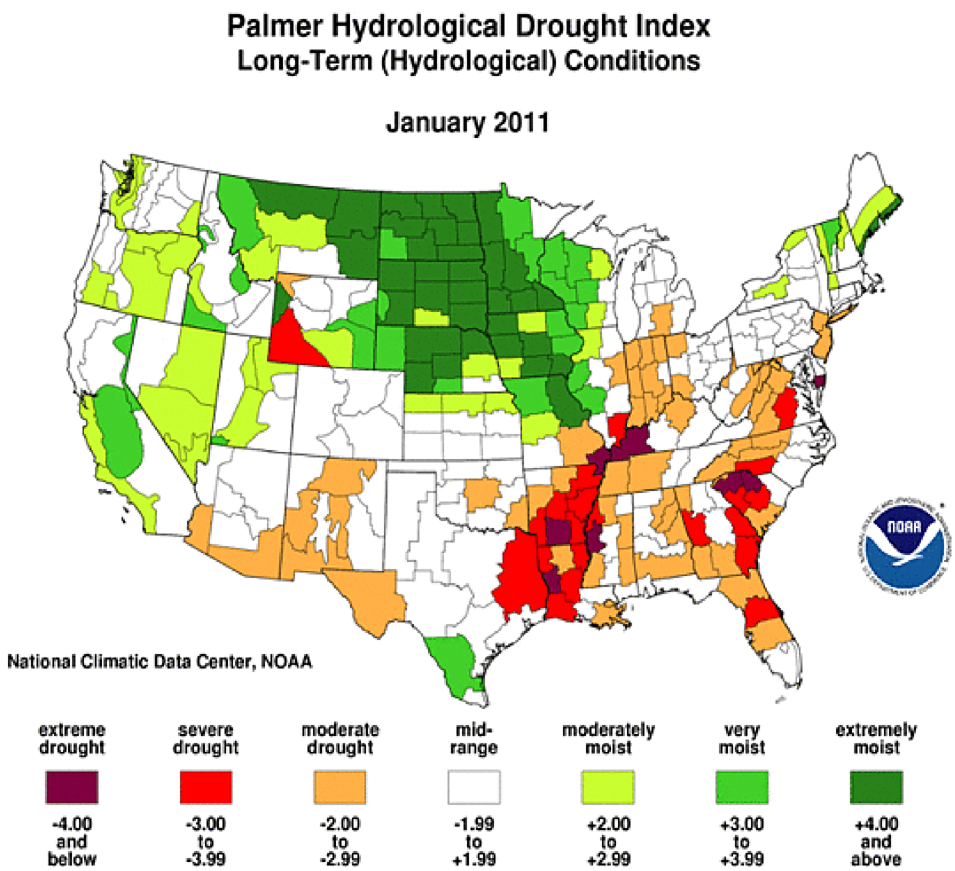
[8] *NOAA. NWS. Climate Prediction Center. Drought Indices – Explanation.*

[9] *NOAA. NWS. Climate Prediction Center. Drought Indices – Explanation.*

Table 5-10 - Palmer Drought Severity Index (Source: NOAA, National Weather Service - Climate Prediction Center)

Palmer Drought Severity Index
-4.0 or less (Extreme Drought)
-3.0 or -3.9 (Severe Drought)
-2.0 or -2.9 (Moderate Drought)
-1.9 to +1.9 (Near Normal)
+2.0 or +2.9 (Unusual Moist Spell)
+3.0 or +3.9 (Very Moist Spell)
+4.0 or above (Extremely Moist)

Figure 5-3 - Long Term Conditions



5.12.6 Impact

Drought can cause crops to be damaged or destroyed which has an impact on the local economy. Drought can cause illness and death in farm animals which also has a health and monetary impact on the local economy. Drought can cause jurisdictions to place mandatory water restrictions on the community which can cause hardship to businesses that rely on water (e.g. car washes). Drought conditions can be a hardship on the environment as lack of water causes degradation to the soil and can cause trees and other wildlife plants to die. In turn, that dead brush is susceptible to fire which is another indirect risk. Droughts have the ability impact many sectors of the economy, and reaches well beyond the area experiencing physical drought. Drought impacts are commonly referred to as direct or indirect. Reduced crop productivity, increased fire hazard, reduced water levels, and damage to wildlife and fish habitat are a few examples of direct impacts. Drought can cause extensive damage to commercial and residential structure foundations, framing and walls, levees, roads, bridges, pipelines and other integral infrastructure. Indirect impacts of drought include increased prices for food, unemployment, and reduced tax revenues because of reduced supplies of agriculture products dependent upon on rainfall.

5.12.7 Overall Vulnerability

While all residents of Chambers County could be adversely affected by drought conditions, which could limit water supplies and present health threats, during summer drought, or hot and dry, conditions, Chambers County elderly persons, small children, infants and the chronically ill who do not have adequate cooling units in their homes may be more vulnerable to injury and/or death. The NCDC database includes no known deaths or injuries from droughts in the planning area.

The NCDC indicates that droughts have caused an estimated $235,200.000 in damage. The drought hazard affects all residential and commercial building types about equally within the planning area. The State of Texas 2010-2013 Hazard Mitigation Plan hazard profile worksheet, on page 61 of the plan, indicates that overall for the State, drought is considered to have minor potential impact severity. Drought is considered to be an occasional frequency event which occurs mostly in the summer months but could occur anytime. It is expected that there would be in excess of 12 hours' notice prior to an event and the likely duration of a drought event is anywhere from a few weeks to several years.[10]

TBCD had no jurisdictional authority to mitigate against drought and there is not potential impact from drought on TBCD owned facilities. It has been determined that the planning area, based on jurisdictional authority and owned facilities, will not be negatively impacted from drought. For this reason, drought has been eliminated from further consideration and there are no mitigation action items associated with

[10] *State of Texas 2010-2013 Hazard Mitigation Plan*

drought. TBCD will work with other local and regional jurisdictions where needed to mitigate against Drought.

5.13 EARTHQUAKES/ SEISMIC

5.13.1 Hazard Description

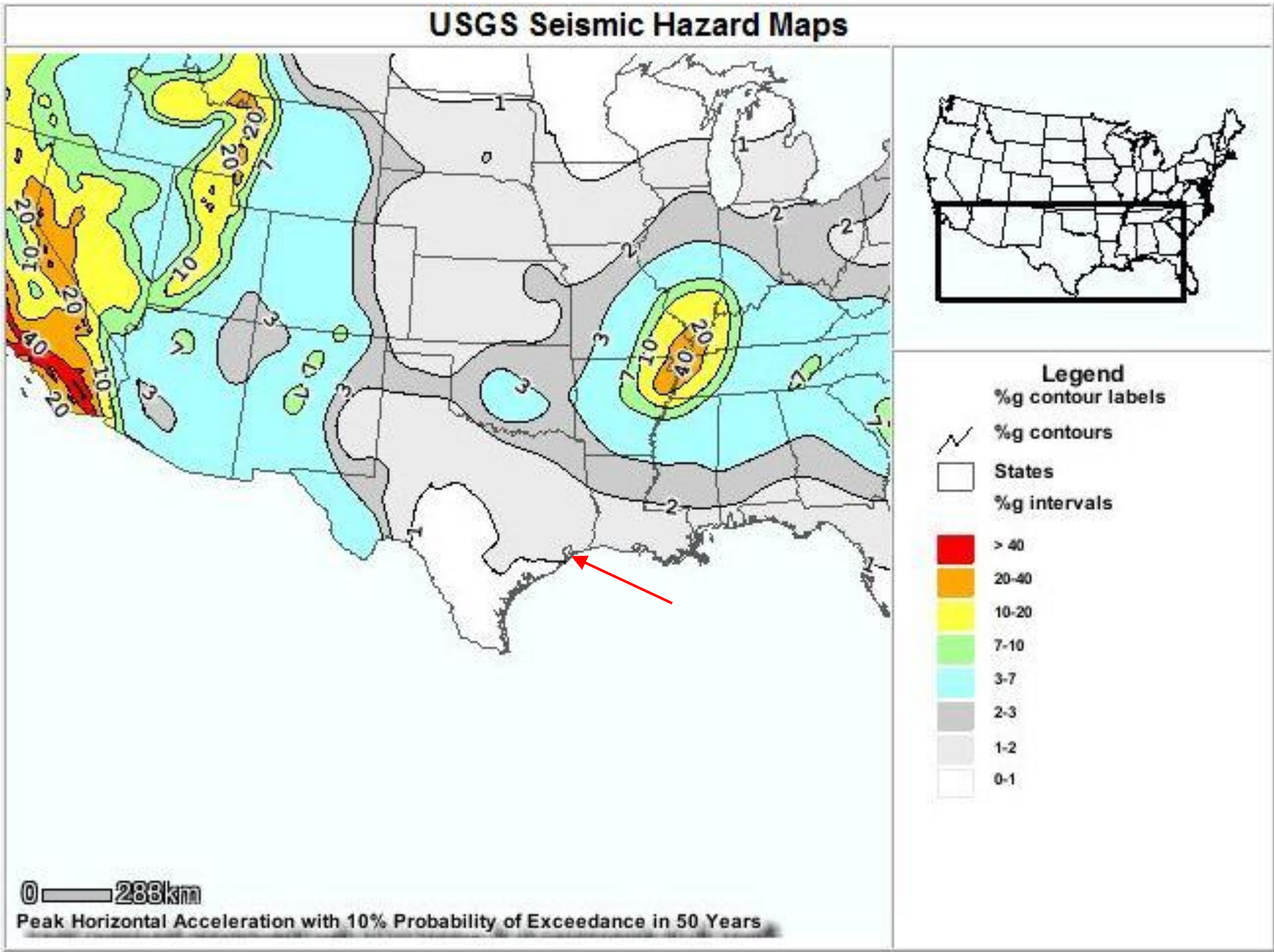
An earthquake is a sudden motion or trembling caused by an abrupt release of accumulated strain on the tectonic plates that comprise the Earth's crust. Tectonic plates become stuck, putting a strain on the ground. When the strain becomes so great that rocks give way, fault lines occur. At the earth's surface, earthquakes may manifest themselves by a shaking or displacement of the ground, which may lead to loss of life and destruction of property. The size of an earthquake is expressed quantitatively as magnitude and local strength of shaking as intensity. The inherent size of an earthquake is commonly expressed using a magnitude. See Appendix A for a more detailed description of the earthquake hazard.

5.13.2 Geographic Location

Figure 5-4 displays the United States Geological Survey (USGS) earthquake hazard map produced in May of 2012. The map shows peak ground acceleration (pga) with a 10% chance of being exceeded over 50 years. In Texas, the majority of the State falls in the low seismic risk range. The FEMA How-To guidance, Understanding Your Risks, suggests the earthquake hazard should be profiled when the pga is greater than 3%g.[11] The map shows that southeastern Texas, including Chambers County, is located in the 1%g range, a relatively low risk area. The earthquake hazard affects the entire planning area.

[11] *FEMA. How-To guidance, Understanding Your Risks (386-2), page 1-7*

Figure 5-4 - United States Seismic Hazard Map, Showing Peak Ground Acceleration In Percent Of g, With 10% Exceeded In 50 Years. (Source: USGS, May 2012)



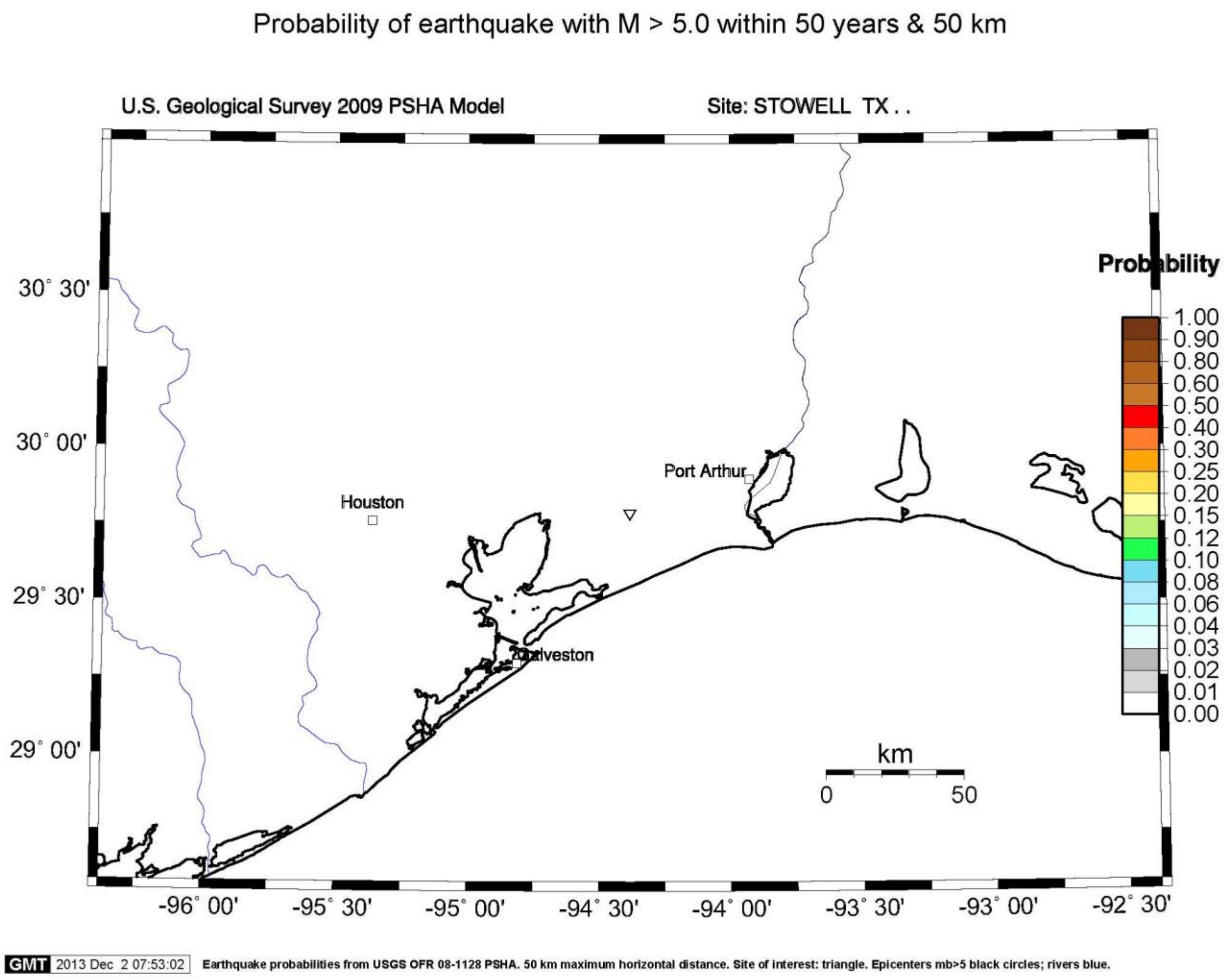
5.13.3 Previous Occurrences

The 2011 H-GAC HMP notes that there have been are no recorded earthquakes in Chambers County. The NCDC database does not have any record of an earthquake in Chambers County. TBCD is roughly 250 miles from the region of recent seismic activity in Northeast Texas. Although the State of Texas is generally considered an area of low seismic risk, the University Of Texas Institute Of Geophysics has recorded 100 3+ magnitude earthquakes during the twentieth century.

5.13.4 Probability of Future Occurrence

In TBCD, seismic risks to people and property cannot be distinguished by area; the hazard is reasonably predicted to have uniform probability of occurrence across the entire planning area. All people and assets are considered to have the same degree of exposure. The earthquake hazard affects all residential and commercial building types about equally within the planning area.

Figure 5-5 - Probability of Earthquake > Mag 5 in 50yrs within 50km of Zip code 77665



The above figure shows less than .01% chance of a Magnitude 5 or greater earthquake within 50 km of Zip code 77665.[12] Due to the extremely low probability of an earthquake within TBCD and the fact that there is no record of any historical building damage as a result of seismic activity in the Planning Area, the future probability of an event is low.

5.13.5 Magnitude/Severity/Extent

Earthquakes with epicenters in southeast Texas are rare and small, according to the Hazards Analysis for the State of Texas. Most past earthquakes in Texas have been of low magnitude and have mainly occurred in west Texas, or the Panhandle area. It is possible, however, for earthquakes to occur in this region of the State. Chambers County is located in the southeastern section of the State. The hazard level,

[12] *http://earthquake.usgs.gov/hazards/apps/*

according to the UTIG-Online Handbook, is not zero anywhere in Texas. Small earthquakes are possible almost anywhere, and all regions face possible ill effects from very large, distant earthquakes.

These event provide little to no warning time with a probable duration from a few minutes to several hours. The magnitude of an earthquake is measured in the amplitude of the seismic wave and is expressed in the Richter scale. Figure 5-5 maps the chance of a Magnitude 5 or greater earthquake within 50 km of Zip code 77665 in 50 years. The map shows a chance near zero across the planning area. As shown in Figure 5-5 above, the probability of any severe earthquake in the area is low. However, Chambers County could be affected by “very large and distant quakes which might occur in Missouri, Tennessee or Oklahoma; the earthquakes that pose such a hazard are rare, probably occurring only once every 500 years or less,” states the Hazard Analysis for the State of Texas.

Although there have been no known earthquakes that have impacted the planning area, an earthquake in the Richter magnitude 5 - 6 range (based on past events in Texas) is possible in Chambers County. The severity of earthquakes is influenced by several factors, including the depth of the quake, the geology in the area, and the soils. Earthquakes are measured in peak ground acceleration (PGA) measured in g. Southeastern Texas including Chambers County falls within the 0.01 g zone. This would correspond to an earthquake approximately 1-3 on the Richter scale which is minor and not felt by many (See the figure of the Richter scale below).

Figure 5-6 – Understanding the Richter Scale

Understanding the Richter Scale

Richter Magnitude	Feels like KG of TNT	Extra Information
0-1	0.6 -20 kilograms of dynamite	We can not feel these.
2	600 kilograms of dynamite	Smallest quake people can normally feel.
3	20,000 kilograms of dynamite	People near the epicenter feel this quake.
4	60,000 kilograms of dynamite	This will cause damage around the epicenter. It is the same as a small fission bomb.
5	20,000,000 kilograms of dynamite	Damage done to weak buildings in the area of the epicenter.
6	60,000,000 kilograms of dynamite	Can cause great damage around the epicenter.
7	20 billion kilograms of dynamite	Creates enough energy to heat New York City for one year. Can be detected all over the world. Causes serious damage.
8	20 billion kilograms of dynamite	Causes death and major destruction. Destroyed San Francisco in 1906.
9	20 trillion kilograms of dynamite	Rare, but would causes unbelievable damage!

5.13.6 Impact

An earthquake in Chambers County could cause commercial and residential structure damage or destruction. An earthquake could also damage or destroy infrastructure like roads and bridges as well as cause injury or death to residents. Earthquakes can bring utilities down and cause economic hardship on the economy until damages to infrastructure and property are fixed. Chambers County has not had any deaths or injuries due to earthquakes as reported by the NCDC database as well as no damages. There is a low probability of future occurrence; however, the potential to cause damage to buildings and infrastructure as well as cause disruption of services is possible.

5.13.7 Overall Vulnerability

Any resident who lives or works on or near the epicenter of an earthquake is most vulnerable. In additional any residential and commercial structure or infrastructure like schools, critical facilities, roads and bridges on or near the epicenter are most vulnerable. Economically, any business on or near the epicenter would suffer loss of business until power, damage to building, and ability to safely return to its operations are allowed. While an earthquake has a potential of causing tremendous damage, geography, history and probability indicate that this area is not susceptible to damaging earthquakes. It has been determined that the planning area, based on jurisdictional authority, and owned facilities will not be negatively impacted from earthquakes. For this reason, earthquakes have been eliminated from further consideration and there are no mitigation action items associated with earthquakes. Trinity Bay Conservation District will work with other local and regional jurisdictions where needed to mitigate against Earthquakes.

5.14 EXTREME HEAT

5.14.1 Hazard Description

According to Ready.gov, heat kills by pushing the human body beyond its limits. In extreme heat and high humidity, evaporation is slowed and the body must work extra hard to maintain a normal temperature.

Most heat disorders occur because the victim has been overexposed to heat or has over-exercised for his or her age and physical condition. Older adults, young children and those who are sick or overweight are more likely to succumb to extreme heat.

Conditions that can induce heat-related illnesses include stagnant atmospheric conditions and poor air quality. Consequently, people living in urban areas may be at greater risk from the effects of a prolonged heat wave than those living in rural areas. Also, asphalt and concrete store heat longer and gradually release heat at night, which can produce higher nighttime temperatures known as the "urban heat island effect."

A heat wave is an extended period of extreme heat, and is often accompanied by high humidity. These conditions can be dangerous and even life-threatening for humans who don't take the proper precautions.

Extreme heat is a persistent period of high temperatures (significantly above normal) which is often accompanied by high humidity. Extreme heat can cause the heat induced illness hyperthermia, better known as “heat stroke.” Heat stroke affects the ability to maintain proper body temperatures and in severe cases may result in death. Children, elderly people, persons without air conditioning, the sick, disabled and the overweight are at greatest risk of heat stroke though anyone may be affected. In addition to human health impacts, extreme heat can stress agricultural crops and livestock thus reducing yields and may cause widespread power outages as a result of increased demand for electricity to power air-conditioning systems.

The "Heat Index" is a measure of the effect of the combined elements of heat and humidity on the human body. The Heat Index (HI) or the "Apparent Temperature" is an accurate measure of how hot it really feels when the Relative Humidity (RH) is added to the actual air temperature.

An Excessive Heat Warning is issued within 12 hours of the onset of a heat index of at least 105°F for more than three hours per day for two consecutive days, or heat index more than 115°F for any period of time. An Excessive Heat Watch is issued by the National Weather Service when heat indices in excess of 105ºF (41ºC) during the day combined with nighttime low temperatures of 80ºF (27ºC) or higher are forecast to occur for two consecutive days.

The Heat Index Chart shown below (Figure 5-7) was provided by the National Weather Service and indicates the relationship of ambient air temperature and relative humidity to the likelihood of heat disorder and health risk.

Figure 5-7 - Heat Index Chart (Source: National Weather Service)

Temperature (°F)

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

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution · Extreme Caution · Danger · Extreme Danger

Extreme heat can cause heat stroke or heat exhaustion. Heat stroke is the more serious of the two heat-related illnesses. It occurs when the body becomes unable to control its temperature: the body's temperature rises rapidly, the body loses its ability to sweat, and it is unable to cool down. Body temperatures can rise to 106(°F) or higher within 10 to 15 minutes. Heat stroke can cause death or permanent disability if emergency treatment is not provided. Heat exhaustion is a milder form of heat-related illness that can develop after several days of exposure to high temperatures and inadequate or unbalanced replacement of fluids.

According to data provided by the National Weather Service, for the period 1979 to 1999, extreme heat exposure caused 8,015 deaths in the United States (annual mean: approximately 400 deaths). During this period, more people in this country died from extreme heat than from hurricanes, lightning, tornados, floods, and earthquakes combined.

From 1999 to 2003, a total of 3,442 deaths resulting from exposure to extreme heat were reported to the Center for Disease Control (annual mean: 688). For 2,239 (65 percent) of these deaths, the underlying cause of death was recorded as exposure to extreme heat; for the remaining 1,203 (35 percent), hyperthermia was recorded as a contributing factor. Deaths among males accounted for 66 percent of deaths and outnumbered deaths among females in all age groups. Of the 3,401 decedents for whom age information was available, 228 (7 percent) were aged under 15 years, 1,810 (53 percent) were aged 15--64 years, and 1,363 (40 percent) were aged 65 years or older.

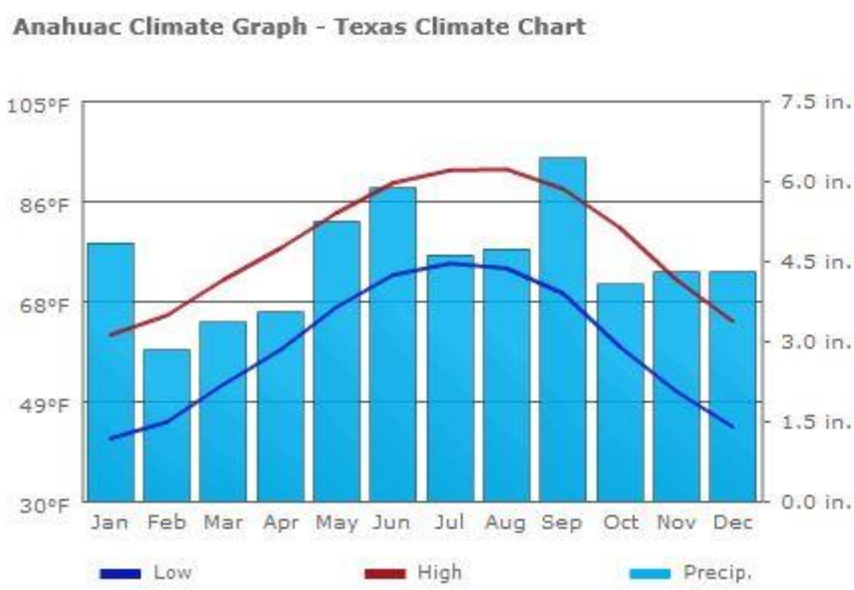
The Texas Department of State Health Services analyzed death certificates for cause of death due to extreme temperatures from 1999-2004. Over the 5-year reporting period there were 258 deaths due to exposure to heat as the underlying cause. During this reporting period there was one reported death due to heat in Chambers County. For geographical context, there was one heat related death in each of the following adjacent counties (Hardin, Liberty and Jefferson).

The elderly, children, and people with certain medical conditions, such as heart disease are at greater risk to extreme heat impacts. However, even young and healthy individuals can succumb to heat if they participate in strenuous physical activities during hot weather. Factors that increase risk of impact include drinking alcohol, strenuous outdoor physical activity, and medications that impair the body's ability to regulate its temperature or inhibit perspiration. Air-conditioning is the number one protective factor against heat-related illness and death. If a home is not air-conditioned, people can reduce their risk for heat-related illness by spending time in public facilities or private facilities that are air-conditioned. Suggestions for preventing a heat-related illness include frequently drinking water or non-alcoholic fluids; wearing lightweight, light-colored, loose-fitting clothing; reducing or eliminating strenuous activities or doing them during cooler parts of the day. Periodically checking on neighbors who do not have air conditioning is also recommended.

5.14.2 Geographic Location

The eastern third of the State of Texas is classified climatologically as subtropical humid, and is noted for warm summers. Southeast Texas and specifically Chambers County, the Trinity Bay Conservation District planning area, is hotter in the summer and cooler in the winter. The relatively mild and wet climate is largely due to the influence of the Gulf of Mexico. The following figure shows average July temperatures for the city of Anahuac in the planning area.

Figure 5-8 - Average temperatures Anahuac, Texas



The figure above shows Anahuac has an average temperature for July ranging from 74° to 92° Fahrenheit. The entire planning area is affected by extreme heat.

5.14.3 Previous Occurrences

In figure 5-8 above the Minimum, Maximum and Average temperatures for each month and annually are reported for the weather station at Anahuac, Texas in Chambers County. The average monthly high temperatures for the summer months since from 1961-1990 are as follows: June 90° (F), July 92° (F) and August 92° (F). The following table illustrates the dates the maximum temperature was at or exceeded 102° (F) in Beaumont, Texas during the traditional summer months. The temperatures are reported from Southeast Texas Regional Airport located in Beaumont; however, the airport is located closer to Nederland, TX rather than Beaumont, TX proper. It is assumed that the temperatures felt in Beaumont would be within one to two degrees throughout the Chambers County area.

Table 5-11 - Temperatures at or above 102° (F) in Beaumont, Texas Since 1902 (Source: National Weather Service)

Temperature	Year (number) of occurrence(s)
102° (F)	1933, 1935, 1939 (x2), 1944(x2), 1962, 2000, 2007, 2009
103° (F)	1902 (x2), 1913 (x2), 1917 (x2),1924 (x2), 1925, 1944 (x3), 1962(x3), 1970, 1980, 2000 (x2)
104° (F)	1902 (x7), 1924, 1930 (x2),2000 (x2), 2011

Temperature	Year (number) of occurrence(s)
105° (F)	1902 (x2), 1962, 2000, 2011
106° (F)	1962
107° (F)	
108° (F)	1902, 2000

*While the NCDC reports the event, it is unknown the effects on the TBCD jurisdictional area.

Southeast Texas and the planning area specifically are known for high relative humidity which can increase the heat index to dangerous levels. Table 5-12 illustrates the average relative humidity percentages through the summer months in Port Arthur; the closest community to the planning area from which relative humidity records were available.

Table 5-12 - Average Monthly Relative Humidity for Port Arthur, Texas (Source; NOAA)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Morning	88	88	88	90	92	93	95	94	92	91	89	89	91
Afternoon	68	63	62	63	64	64	65	65	64	58	62	67	64

The following two extreme heat events were recorded by the NCDC for southeast Texas.

- ***August 29-31, 2000*** – Southeast Texas: Record heat occurred in late August across southeast Texas. At the southeast Texas Regional Airport, (Jefferson County) the all-time record high of 108 was tied on August 31st. Previously it has been achieved on July 14, 1902.
- ***September 1-5, 2000*** – Southeast Texas: Record heat which began in last August continued into the beginning of September across southeast Texas. The all-time record high temperature for the month of September was set on September 4th at Beaumont/Port Arthur, Texas with a high of 105° (F).

Source: National Climatic Data Center

5.14.4 Probability of Future Occurrence

As stated above, there is a National Weather Service station in Port Arthur, which was used to illustrate the high temperature records. In general, the summer months are consistently warm, with maximum temperatures at or above 90 degrees 83 days a year (Port Arthur, Texas). The high heat coupled with the high summer time humidity associated with subtropical climates make for annual oppressive heat events resulting in a **High** probability of future occurrence. This assessment agrees with that of the 2011 H-GAC Plan while the state of Texas plan on page 101 has a Hazard Planning Worksheet which indicates a Highly Likely probability of future occurrence.

5.14.5 Magnitude/Severity Extent

The heat index (sometimes called the apparent temperature) is a measure of the contribution that high temperature and high humidity (expressed either as relative humidity (RH) or dew point temperature) make in reducing the body's ability to cool itself. The table below may be used to estimate the heat index. For example, with a dew point of 79° F and RH of 70% the heat index is 106° F. The heat index (HI) is an accurate measure of how hot it really feels when the effects of humidity are added to high temperature.

When the heat index is between 90° F and 104° F sunstroke, heat cramps or heat exhaustion are possible with prolonged exposure and physical activity. When the index is between 105° F and 129° F sunstroke, heat cramps, or heat exhaustion is likely and heatstroke is possible. Heat indices of 130° or higher will result in heatstroke or sunstroke quickly. Based on the Heat index Chart, TBCD can expect to see a heat index up to 117 at the most extreme, in which cases sunstroke, heat cramps or heat exhaustion is likely and heatstroke is possible.

Table 5-13 – Heat Index Chart

Heat Index Chart (Temperature & Dewpoint)																
Dewpoint (° F)	Temperature (° F)															
	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105
65	94	95	96	97	98	100	101	102	103	104	106	107	108	109	110	112
66	94	95	97	98	99	100	101	103	104	105	106	108	109	110	111	112
67	95	96	97	98	100	101	102	103	105	106	107	108	110	111	112	113
68	95	97	98	99	100	102	103	104	105	107	108	109	110	112	113	114
69	96	97	99	100	101	103	104	105	106	108	109	110	111	113	114	115
70	97	98	99	101	102	103	105	106	107	109	110	111	112	114	115	116

71	98	99	100	102	103	104	106	107	108	109	111	112	113	115	116	117
72	98	100	101	103	104	105	107	108	109	111	112	113	114	116	117	118
73	99	101	102	103	105	106	108	109	110	112	113	114	116	117	118	119
74	100	102	103	104	106	107	109	110	111	113	114	115	117	118	119	121
75	101	103	104	106	107	108	110	111	113	114	115	117	118	119	121	122
76	102	104	105	107	108	110	111	112	114	115	117	118	119	121	122	123
77	103	105	106	108	109	111	112	114	115	117	118	119	121	122	124	125
78	105	106	108	109	111	112	114	115	117	118	119	121	122	124	125	126
79	106	107	109	111	112	114	115	117	118	120	121	122	124	125	127	128
80	107	109	110	112	114	115	117	118	120	121	123	124	126	127	128	130
81	109	110	112	114	115	117	118	120	121	123	124	126	127	129	130	132
82	110	112	114	115	117	118	120	122	123	125	126	128	129	131	132	133
Note: Exposure to full sunshine can increase HI values by up to 15° F																

5.14.6 Impact

As an area known for high summer temperatures and humidity, significant health related impacts and/or economic impacts from extreme heat likely have been underreported. Extreme heat can be combated through the use of air conditioning. However, persistent heat also increases demand on energy infrastructure. Extreme heat also increases the risk of wildfire and typically compounds the effects of drought.

5.14.7 Overall Vulnerability

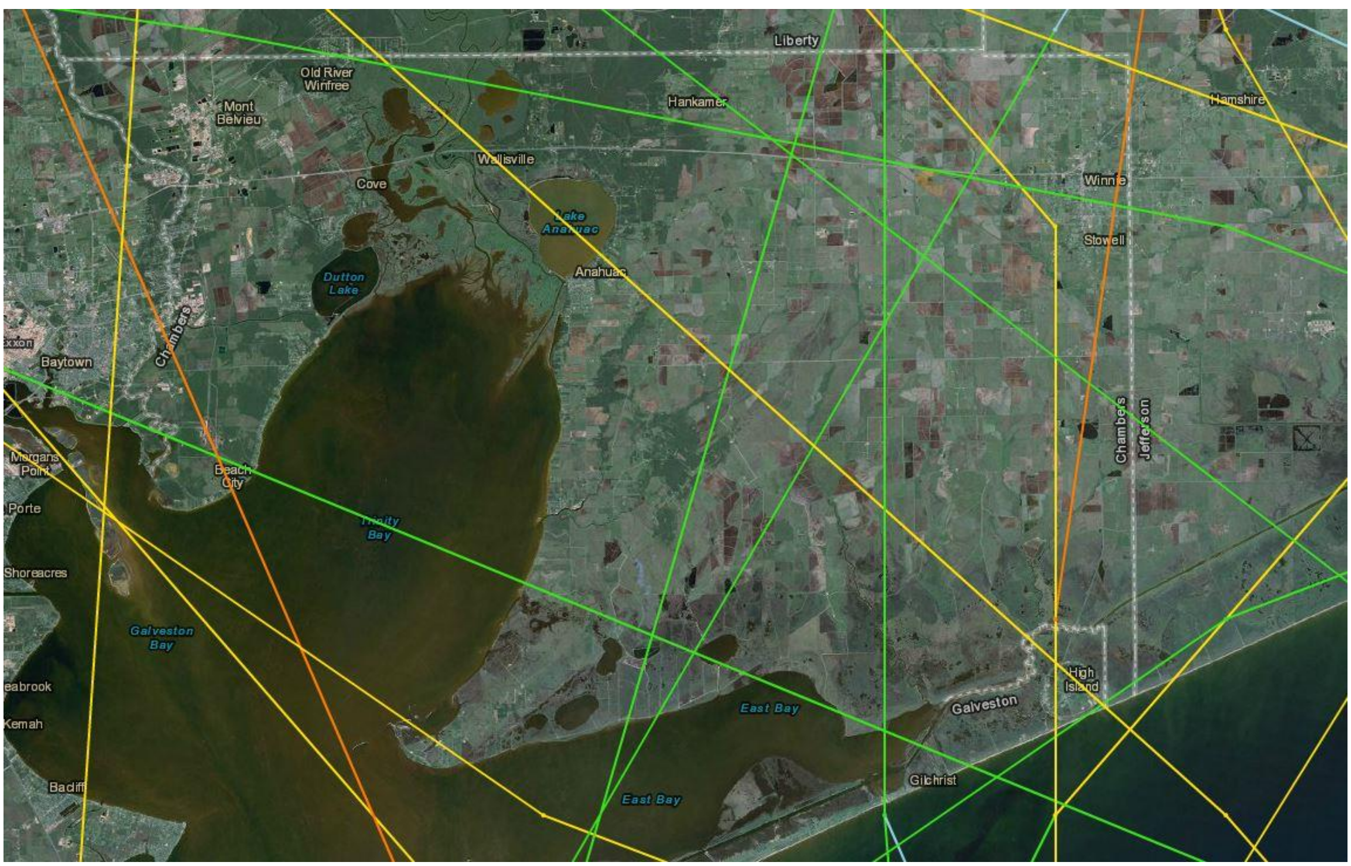
While the planning area has a history of extreme heat, it has been determined that the planning area, based on jurisdictional authority, and owned facilities for TBCD will not be negatively impacted from extreme heat. For this reason, extreme heat has been eliminated from further consideration and there are no mitigation action items associated with extreme heat.

5.15 HURRICANES AND TROPICAL STORMS

5.15.1 Hazard Description

A hurricane is a tropical storm with winds that have reached a constant speed of 74 miles per hour or more. Hurricane winds blow in a large spiral around a relative calm center known as the "eye." The "eye" is generally 20 to 30 miles wide, and the storm may extend outward 400 miles. As a hurricane approaches, the skies will begin to darken and winds will grow in strength. As a hurricane nears land, it can bring torrential rains, high winds, and storm surges. A single hurricane can last for more than two weeks over open waters and can run a path across the entire length of the eastern seaboard. August and September are peak months during the hurricane season that lasts from June 1 through November 30. Figure 5-9 below shows the path of the Tropical cyclones which made landfall in and around the Trinity Bay Conservation District planning area (Chambers County) Texas from 1851 to date. They are color coded by Hurricane Category. Dark Red/Black is Category 4, Green is Category 3, Red is Category 1 and 2 and Yellow is Tropical Storm. See Appendix A for a more detailed description of the hurricane and tropical storm hazard.

Figure 5-9 - Chambers Co. Tropical Cyclone Paths sine 1851 (Source: NOAA)



5.15.2 Geographic Location

In Trinity Bay Conservation District, located within close proximity to the Gulf of Mexico, the entire planning area is exposed to risk from hurricanes and tropical storms and therefore, the hurricane and tropical storm hazard affects the entire planning area.

5.15.3 Previous Occurrences

The NCDC database indicates that between 1950 and 20012 there were 11 hurricanes or tropical storms that impacted Chambers County. The events occurred between 1995 and 2008. There are most likely additional events prior to 1995 that were not reported in the database. It is unclear why the database does not include any events prior to 1995. In addition, Hurricane Ike in September of 2008 was reported twice, once as a Hurricane and once as a Tropical Storm. For the events listed, the NCDC database reported 28 deaths, 5 injuries and a total of $5.6 billion in property damages. Table 5-14 summarizes the 11 hurricanes and tropical storms that have impacted the planning area.

Table 5-14 – Tropical Cyclones - 1995 and 2012 (Source: NCDC data)

Date	FATALITIES	INJURIES	PROPERTY DAMAGE	CROP DAMAGE
7/30/1995	0	0	$400,000	$50,000
8/21/1998	0	0	$25,000	$0
9/7/1998	3	0	$287,180,000	$0
6/5/2001	22	0	$5,150,000,000	$0
7/14/2003	0	2	$10,880,000	$0
8/30/2003	0	0	$50,000	$0
9/1/2003	0	0	$63,000	$0
9/23/2005	3	3	$159,500,000	$0
9/12/2007	0	0	$2,500,000	$0
8/5/2008	0	0	$0	$0
08/16/2008	0	0	$0	$0
Totals	28	5	$5,610,598,000	$50,000

*While the NCDC reports the event, it is unknown the effects on the TBCD jurisdictional area.

In addition to the NCDC database, the Historical Hurricane Tracks database from NOAA was also queried to identify past hurricane events. According to the NOAA, from 1863 to 2008, there were 51 Tropical Storms which passed within 65 nautical miles of Anahuac, Texas. The data shows thirty nine tropical storms, sixteen Cat-1 Hurricanes, five Cat-2 Hurricanes, four Cat-3 Hurricanes, and five Cat-4 Hurricanes. Based on nearly 150 years of historical data from NOOA, the probability of future hurricanes impacting coastal area of eastern Texas is **high**, averaging one event approximately every three years.[13]

Data from the NOAA database indicates there were many additional major hurricanes between 1863 and 2008 that were not included in the NCDC database.

Perhaps the most significant tropical storm to impact the region was Tropical Storm Allison, which descended on southeast Texas in June of 2001. Tropical Storm Allison produced flooding throughout Southeast Texas, Louisiana, and across the eastern United States. Total damages were estimated at $5 billion and prompted a Presidential Disaster Declaration for 30 counties in Texas. The event claimed a total of 23 lives in Texas. There was no property damage related directly to the Chambers County entry for this storm. The storm damaged approximately 73,000 residential homes and impacted over two million people.[14]

5.15.4 Probability of Future Occurrence

According to the NOAA, from 1863 to 2008, the planning area experienced nine direct hits from major hurricanes (Categories 3 and 4). During the same time period, the planning area experienced 21 direct hits from other hurricanes (Category 1 and 2) and an additional thirty nine direct hits from tropical storms and tropical depressions. Based on approximately 150 years of historical data from the Tropical Prediction Center, the probability of future hurricanes impacting the planning area is considered **high**, averaging approximately one event every three years.

Hurricane probability in the planning area can also be assessed based on data from the 1999 study Hurricanes of the North Atlantic, Climate and Society. The study includes a series of maps showing the return periods and wait times for the Counties along the Texas coastline over the time period 1900 - 1996. The maps are shown in Figures 5-10 and 5-11 and include the following:

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[13] *National Hurricane Center (NHC), Historical Hurricane Tracks*

[14] *2007 State of Texas Mitigation Plan Update*

Figure 5-10 - Southeast Texas Hurricane Return Periods (a) and Wait Times (b) (Source: Hurricanes of the North Atlantic, Climate and Society, 1999)

All Hurricanes (Categories 1-5)

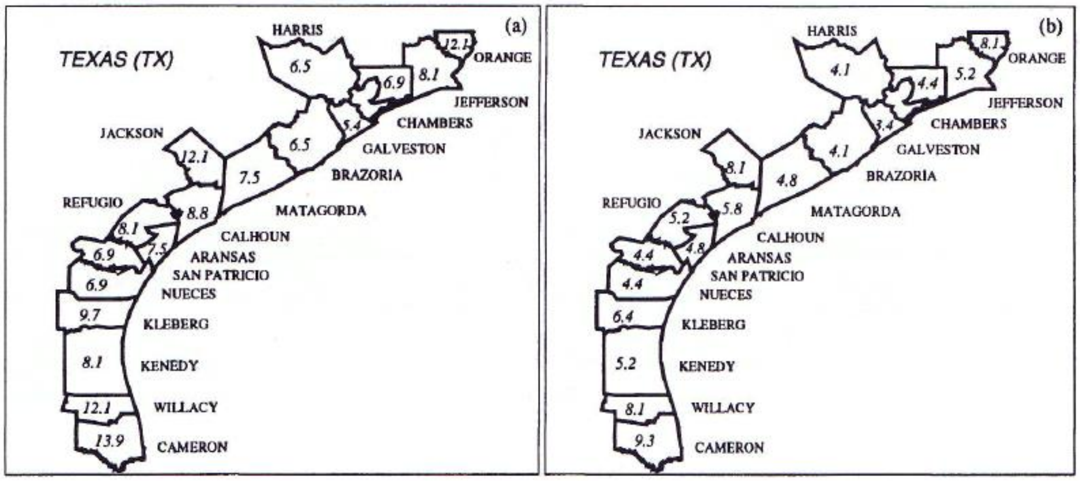
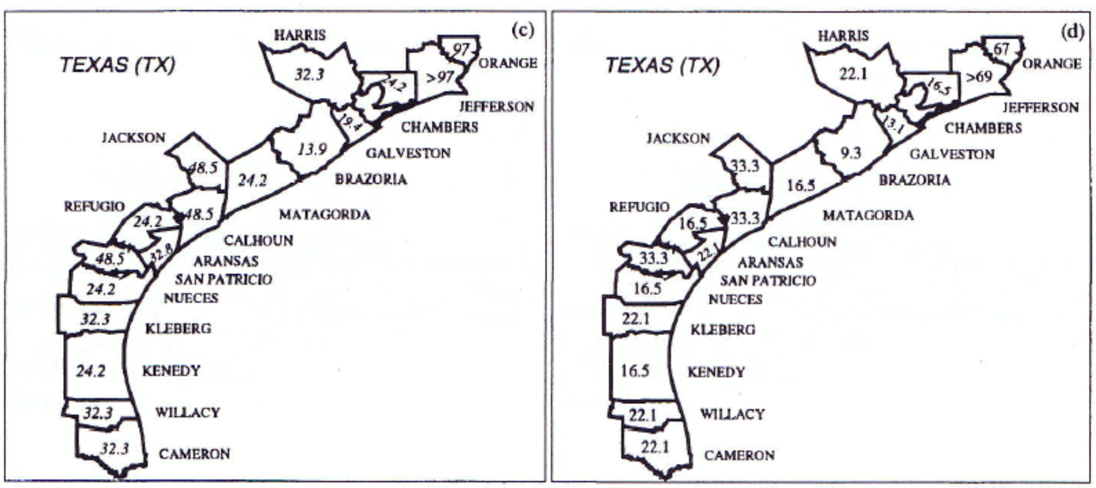


Figure 5-11 Major Hurricanes (Categories 3-5) Return Periods(c) and Wait Times(d) (Source: Hurricanes of the North Atlantic, Climate and Society, 1999)



The number in each County is the return period or wait time in years. The wait time is the average time in years between hurricanes.

The upper left hand map in the figure above (map a) shows the return period for all hurricanes (categories 1-5) in the planning area (Chambers County) is 6.9 years, which equates to an approximate 14.5% annual probability of future occurrences. Major hurricanes have occurred once every 24.2 years, which translates to an approximate 4% annual probability[15].

5.15.5 Magnitude/Severity/Extent

The severity of tropical storms is measured primarily by wind velocity, flooding, central pressure, and storm surge. As hurricanes or tropical storms move towards land, areas can experience moderate to severe flooding due to intense and prolonged rainfall as well as high wind hazard associated. The severity of a tropical cyclone can be measured by flooding (see flood), storm surge (see flood) and wind speed. Chambers County has seen wind speeds of up to hurricane strength as defined in the NOAA Hurricane and Tropical Cyclone Wind Speed Categories, storm surge of a 4 as shown in the Table below, the Saffir / Simpson Hurricane Scale is used to classify storms by numbered categories. Hurricanes are classified as Categories 1 through 5 based on central pressure, wind speed, storm surge height, and damage potential. Based on the Saffir-Simpson Scale, Trinity Bay Conservation District can expect to be vulnerable from a tropical storm to a Category 5 hurricane.

Table 5-15 - Saffir/Simpson Hurricane Scale

Storm Category	Central Pressure	Sustained Winds	Storm Surge	Potential Damage
1	> 980 mbar	74 - 95 mph	4 – 5 ft.	Minimal
2	965 – 979 mbar	96 - 110 mph	6 – 8 ft.	Moderate
3	945 – 964 mbar	111 – 130 mph	9 – 12 ft.	Extensive
4	920 – 944 mbar	131 – 155 mph	13 – 18 ft.	Extreme

Table 5-16 Hurricane and Tropical Cyclone - Wind Speed Categories(Source: NOAA)

Category	Wind Speed	Definition
Tropical Depression	> 38 mph	A tropical cyclone in which the maximum sustained surface wind speed is 38 mph or less.

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[15] *Hurricanes of the North Atlantic, Climate and Society,* James Elsner and A. Birol Kara, New York, Oxford University Press, 1999

Tropical Storm	39 -73 mph	A tropical cyclone in which the maximum sustained surface wind speeds range from 39 to 73 mph.
Hurricane	74+ mph	A tropical cyclone in which the maximum sustained surface wind is74 mph or more. The term hurricane is used for Northern Hemisphere tropical cyclones east of the International Dateline to the Greenwich Meridian.

5.15.6 Impact

Chambers County and the planning area of Trinity Bay Conservation District can be impacted by hurricanes and tropical storms. Hurricanes and Tropical storms can cause flooding of residential and commercial structures as well as roads making it difficult for emergency personnel and residents. It can cause storm surge, which causes damages to homes, business and infrastructure as well as property and crops as well as death or injury. The winds from a tropical storm can cause utilities to be taken down and flying debris can be used to cause further damage. Once the storm passes, debris is left that needs to be removed. It can have an impact on the economy if the storm shuts parts of government and businesses down due to no power, damage to structures or impassable roads.

5.15.7 Overall Vulnerability

As mentioned earlier, future probability is only one component of the risk calculation, potential impact is another. As mentioned above in the NCDC data, there have been 11 hurricane/tropical storms between 1995 and 2012; causing approximately $5.6 billion in damages. Dividing this prior loss total for hurricanes/tropical storms by the span of years in which this loss was incurred (15 years) is $148.48 million in damages for the planning area annually. Dividing the 11 events in 17 year period gives us one event every 1.5 years. The entire planning area is at risk from rain, storm surge and wind associated with hurricanes and tropical storms/cyclones. The entire County has been affected by rain, storm surge and wind associated with hurricanes and tropical storms. Therefore, all residents, residential and commercial property and infrastructure like roads and bridges, schools and critical facilities are vulnerable to wind associated with tropical storms hazard.

The most vulnerable population, property and infrastructure from flooding due to Tropical Storm rains in Chambers County are residents, residential and commercial structures, and infrastructure, like roads, bridges, critical facilities and schools located in the floodplain. From an economic vulnerability perspective, those businesses located in the floodplain are also at risk for losing business due to temporary closure of roads and their place of business if the building was flooded. This hazard will be mitigated in section 8.

5.16 LANDSLIDE

5.16.1 Hazard Description

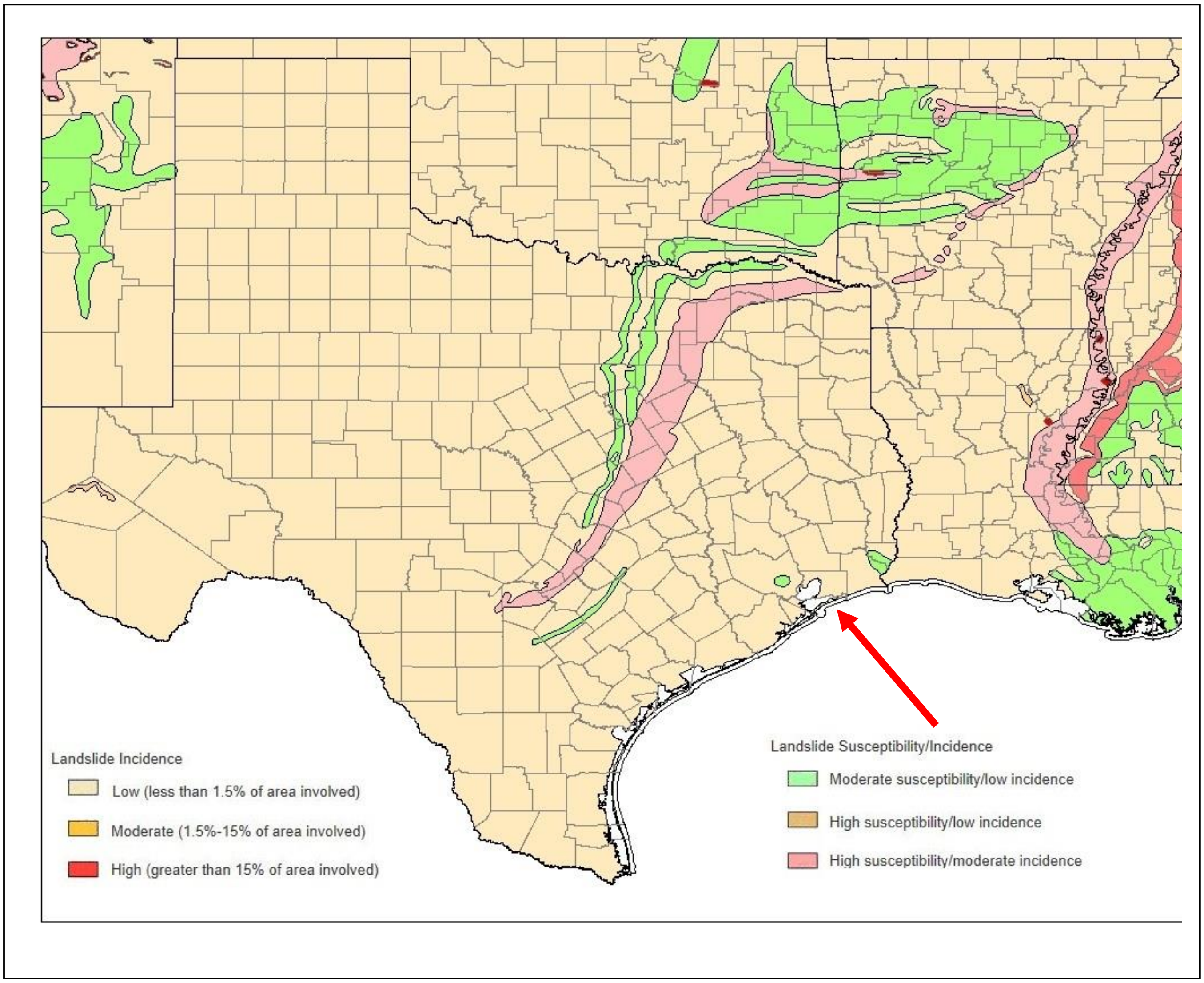
The term landslide is used to describe the downward and outward movement of soils and rocks moving down a slope under the force of gravity. Landslides include mudflows, mudslides, debris flows, rock falls, rock slides, debris avalanches, debris slides, and earth flows. Most landslides are associated with heavy, prolonged rains which saturate soils. The landslide hazard affects the entire planning area approximately equally. See Appendix A for a more detailed description of the landslide hazard.

Riverine erosion is defined as downstream flow, shifting, or removal of sediment from a watershed. Caving river and stream banks are common associations with the migration of river channel alignment, and can threaten structures, undermine bridge foundations, and pose public safety risks.

5.16.2 Geographic Location

In 1997, USGS published a national map to illustrate landslide risk areas. Since then the data has been made available as GIS shapefiles for public access. Figure 5-12 is a map of Texas made from these GIS shapefiles. The map combines past incidents with a measure of “susceptibility”, defined as the “probable degree of response of rocks and soils to natural or artificial cutting or loading of slopes, or to anomalously high precipitation.” Figure 5-12 displays the USGS landslide map for the State of Texas. The map indicates the entire Texas coastal plain, including the planning area of Chambers County, is shown as having had less than 1.5% of its land area affected by movement of soils on slopes (no planning period is identified). The map also shows that the planning area is outside of any moderate or high “susceptibility/incidence” area. Chambers County is illustrated by the red arrow pointing to the jurisdictional area.

Figure 5-12 - Landslide Incidence / Susceptibility Map (Source: USGS)



According to the 2011 H-GAC plan, the greater Houston area began seeing the effects of land subsidence in the early 1900's. Studies in the 40's identified problems due to groundwater extraction. The 50's and 60's had communities beginning to link frequency and severity of flooding to subsidence.

The Texas State legislature created the Harris-Galveston Subsidence District (HGSD) in 1975. This resulted in a series of regulatory plans to reduce ground water pumpage. HGSD mandated in their 1999 plan, a reduction to only twenty-percent groundwater pumpage by 2030.

5.16.3 Previous Occurrences

Information from the Texas Water Development Board (TWDB) provides a report from Karl W. Ratzlaff of the U.S. Geological Survey dated November 1982. In the abstract of this report Mr. Ratzlaff states "In

Jefferson County which neighbors to the east the planning area, "the Spindletop Dome area subsided approximately 5 feet (1.5 meters) during 1925-77, and the Port Acres area subsided about 3 feet (0.9 meter) during 1959-77, mainly from the withdrawal of oil or gas and associated ground water. Local subsidence caused by sulfur mining in the Spindletop Dome area has been estimated to exceed 10 feet (3.0 meters)."

A review of the State of Texas assessment of the Landslide Risk indicates the location of riverine erosion in the planning area is along waterways and bayous.

Landslides in the planning area are centered primarily on bridge footings for highway overpasses and isolated steep banks adjacent to stream/bayou channels. The State of Texas Hazard Mitigation Plan identifies Chambers County as one of roughly eight counties in the south east Texas region with a propensity for land subsidence, typically attributed to subsurface extraction such as groundwater withdrawal.

5.16.4 Probability of Future Occurrence

Due to the extremely low probability of a landslide within TBCD and the fact that there is no record of any historical building damage as a result of landslides in the planning area, landslide events occurring in TBCD, the probability of future events is considered **low**.

5.16.5 Impact

Landslides can cause damage to residential and commercial buildings if in the way of a landslide as well as cause disrupted roadways, bridges, underpasses and railways that can endanger motorists and disrupt transport and access to emergency care. Landslides can also cause broken electrical, water, gas and sewer lines and if in the path of the landslide, could cause injury or death.

5.16.6 Magnitude/Severity/Extent

Unlike the Richter scale for earthquakes or the PDSI for droughts, there is no one defined measurement for landslides. Using Figure 5-12 - Landslide Incidence / Susceptibility Map (Source: USGS), Chambers County is low for landslide incidence. The planning area landslides most likely occur due to heavy rain events, saturation from rainfall could be one measurement to determine the extent or severity of the landslide; another measurement could be soil composition.

5.16.7 Overall Vulnerability

Vulnerable populations in Chambers County include any resident who lives near an area that has a history with landslides. In addition to population, any residential or commercial structures as well as any infrastructure (schools, critical facilities, roads and bridges) located in an area that has a history with landslides. However, Trinity Bay Conservation District had no jurisdictional authority to mitigate against landslides, therefore, It has been determined that the planning area, based on jurisdictional authority, and owned facilities will not be negatively impacted from landslides. For this reason, landslides have been eliminated from further consideration and there are no mitigation action items associated with landslides.

5.17 THUNDERSTORMS/HIGH WINDS

5.17.1 Hazard Description

Several meteorological conditions can result in winds severe enough to cause property damage. High winds have been associated with extreme hurricanes traveling inland, tornadoes, and locally strong thunderstorms. Thunderstorms are the by-products of atmospheric instability, which promotes vigorous rising of air particles. A typical thunderstorm may cover an area three miles wide. The National Weather Service considers a thunderstorm “severe” if it produces tornadoes, hail of 0.75 inches or more in diameter, or winds of 58 miles per hour or more. Structural wind damage may imply the occurrence of a severe thunderstorm. See Appendix A for a more detailed description of the high wind hazard.

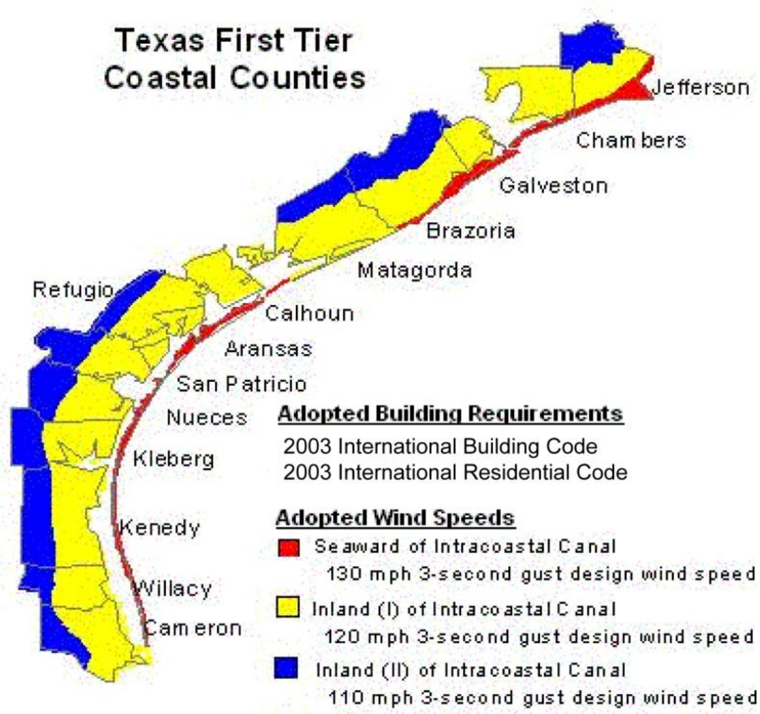
Figure 5-13 shows the “basic wind speed” map from the International Building Code. This map is used as the basis for structural design of buildings, such that they can withstand reasonably anticipated winds in order to minimize property damage [16] Trinity Bay Conservation District falls within the area where the “design wind” speed is 110 miles per hour. The building code administered within the incorporated areas of Chambers County require all new construction to be designed and constructed for 110 mile per hour wind loads. This design wind speed contemplates the potential effects of hurricanes, thunderstorms and tornadoes, and is based on three-second peak gusts at a height of 33 feet above the ground. Since this design wind speed is based on three kinds of events, it is not possible to state definitively that the potential high wind speed for thunderstorms is 110 mph, but it is safe to assume that the maximum potential straight line wind is perhaps in the 90 mph range.

5.17.2 Geographic Location

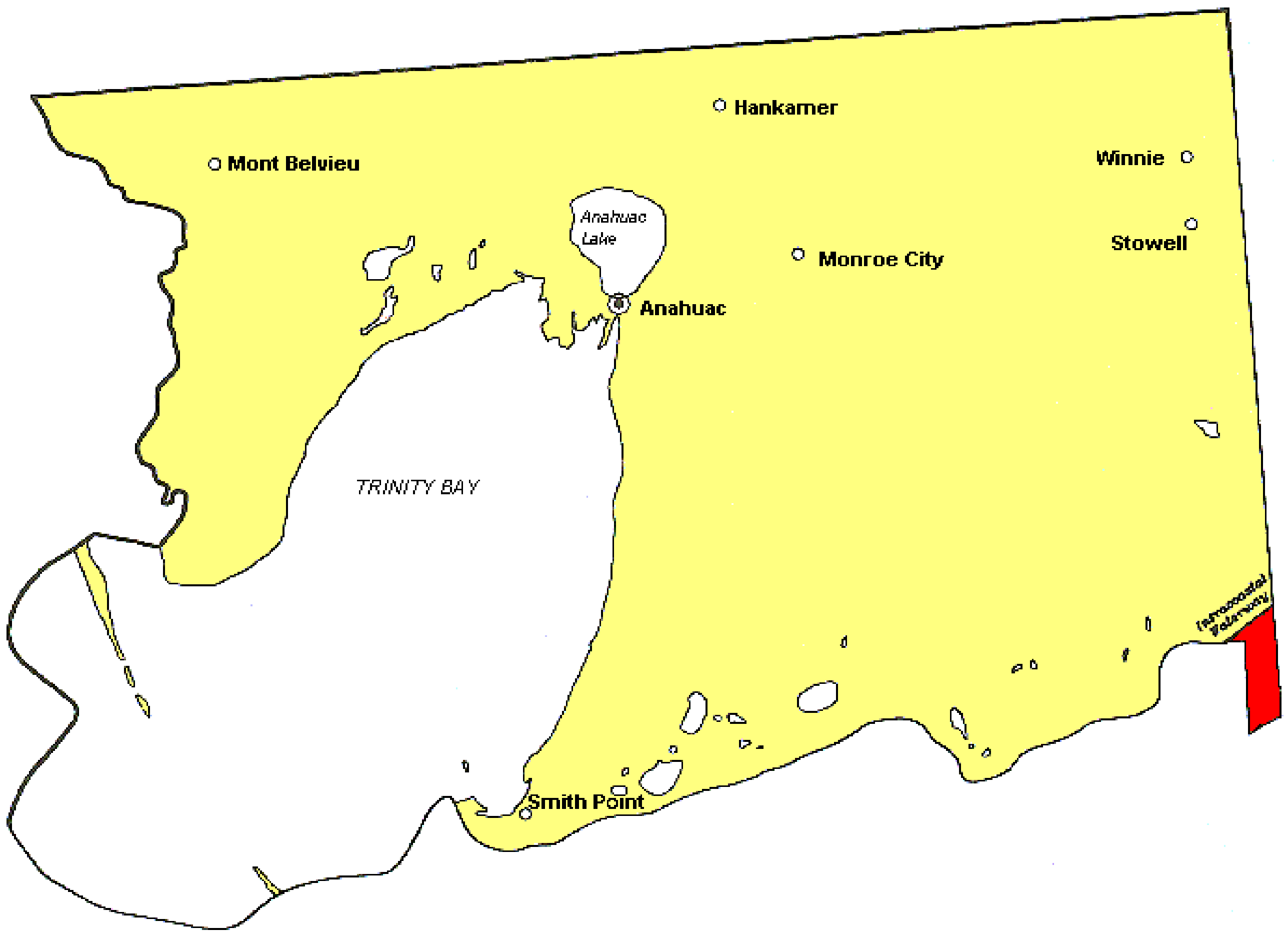
The Texas Windstorm Insurance Association provides the following maps of the Coastal Counties, the planning area (Chambers County) and a list of the communities within each delineated wind area.

[16] *American Society of Civil Engineers, 2002*

Figure 5-13 - Basic Wind Speed: Texas First Tier Coastal Counties (Source: Texas Windstorm Insurance Association)



The 70th Texas Legislature passed House Bill 2012, (codified as Article 21.49 Section 6A, Texas) Insurance Code), which implements certain inspection requirements for structures to be considered insurable property for windstorm and hail insurance through the Texas Windstorm Insurance Association (T.W.l.A.), formerly known as the Texas Catastrophe Property Insurance Association (T.C.P.I.A.). All new construction, repairs, or additions which commenced on or after January 1, 1988, shall be inspected or approved by the Texas Department of Insurance for compliance with the building specifications in the T.WI.A. Plan of Operation, if the property is to be certified as insurable by the T.W.I.A. Participation in this program is not mandatory. However, property which has not been inspected and certified in accordance with the requirements of this inspection program will not be eligible for. Windstorm insurance through the T.W.I.A. The inspection program applies only to structures located in areas designated as a “catastrophe area” by the Commissioner of the Texas Department of Insurance. The current areas designated as a “catastrophe area” are as follows: Of which Chamber and Jefferson are included.



List of Communities

The following is a list of communities located in Chambers County. The communities have been categorized according to the zone they fall under. If a structure is located in a community or area not shown below, then refer to the county map to determine which zone the structure falls under.

Table 5-17 INLAND I- 2006 IBC/IRC with the Texas Revisions, 120 mph 3-second gust design wind speed

Anahuac	Beach City
Cove	Double Bayou
Eminence	Figridge
Four Corners	Hankamer

Monroe City	Mont Belvieu
Oak Island	Sea Breeze
Smith Point	Stowell
Turtle Bayou	Wallisville
Winfree	Winnie

Written Description of Dividing Line between Inland I and Inland II Zones: Chambers County:

Continuing from the intersection of the Galveston/Chambers/Harris County lines north along the Harris/Chambers County line to the intersection of the Harris/Chambers/Liberty County line; continuing east along the Chambers/Liberty County line to the intersection of the Jefferson County line and continuing east and south along the Chambers/Jefferson County line to the intersection of Interstate Highway 10.

5.17.3 Previous Occurrences

In Trinity Bay Conservation District, most wind damage has been limited to downed trees, blocked roads, and disabled power lines. Since 1989, only 2% were associated with lightning and severe thunderstorms combined. The NCDC database indicates that between 1950 and 2011, the planning area of Chambers County experienced 325 severe thunderstorms and high wind events (seventeen of which had greater than 60 knot winds). Note that the thunderstorm and high winds category of the NCDC database excludes hurricane wind events. High winds associated with hurricanes are captured under the Hurricanes and tropical storms category of the database. Therefore, events such as Hurricane Ike in September of 2008 are not included as part of the query results for high winds. Table 5-18 summarizes the seventeen high wind events with greater than 60 knot winds.

Table 5-18 - Chambers County: Thunderstorm/High Wind Events over 35 Knots, 1950 – 2011 (Source: NOAA/NCDC)

DATE	WIND SPEED	PROPERTY DAMAGE	REMARKS
06/20/63	85	$0	
06/03/88	52	$0	
08/31/90	52	$0	
05/28/92	56	$0	
06/30/92	52	$0	
12/17/95	50	$10,000	Cars blown off the road at Interstate 10 and Winnie. Spotter estimated Winds of 60 mph.
10/03/97	80	$50,000	90 mph wind recorded at Chambers County Airport. One aircraft destroyed. Damage to high school roof, mobile home roof lifted, garage destroyed, power lines down, and minor damage to a miniature golf course.
12/03/97	80	$75,000	90 mph wind recorded at Chambers Co Airport. One aircraft destroyed. Damage to a high school roof, mobile home roof lifted, garage destroyed, power lines down, and damage to a Putt-Putt golf course.
07/23/00	69	$15,000	Power lines down along SH 65.
08/11/00	52	$15,000	
09/02/00	62	$0	
08/04/02	52	$0	Estimated 60 mph wind gust.
12/23/02	52	$20,000	Wind damage. This December 23rd tornado and severe thunderstorm outbreak developed as a strong upper level low pressure system moved out of the southwestern U.S. and off to the east and northeast across the state of Texas. Abundant low level moisture was already in place across southeast Texas. Very strong shear, or turning and strengthening of the winds with height, was expected to last throughout the day. A warm front moved northward throughout the day and became a focus for the development of showers and thunderstorms. With the strong shear present, a significant number of thunderstorms quickly became severe. During an eighteen hour stretch, ten tornadoes and several large hail events were reported mainly north and west of the Houston area. Locations from the Houston area to the beaches felt the brunt of this event in the evening when a squall line rapidly moved eastward toward the coast. Three injuries and over $800,000 in damage occurred with this outbreak.
06/02/03	65	$7,000	18-wheeler overturned on Interstate 10.

DATE	WIND SPEED	PROPERTY DAMAGE	REMARKS
11/23/04	55	$20,000	Restaurant and homes damaged.
11/23/04	60	$35,000	Tree on carport with damage to two vehicles. Storage building had roof damage. Four power poles on Poskey Road were snapped.
04/29/06	55	$35,000	One business damaged with numerous trees down near the hospital in the town of Winnie.
02/24/07	39	$2,000	
08/03/08	52	$8,000	EVENT NARRATIVE: Thunderstorm winds downed trees and power lines north of Interstate 10 across Speights Road. EPISODE NARRATIVE: A series of storms and outflow boundaries originating to the north and northeast of our area moved to the southwest and generated some strong winds across portions of southeast Texas.
02/10/09	35	$0	EPISODE NARRATIVE: A powerful low pressure system with an associated Pacific Cold Front brought high winds to the western portions of West Central Texas. Sustained winds of 40 mph with gusts to 55 mph and possibly higher caused sporadic damage across the region. EVENT NARRATIVE: An estimated sustained west wind of 40 mph with gusts to around 55 mph lasted approximately one to two hours.
06/06/11	52	$0	EPISODE NARRATIVE: For the second day in a row during record breaking heat, afternoon through early evening pulse severe thunderstorms developed. EVENT NARRATIVE: A thunderstorm downed some trees on State Highway 124.

*While the NCDC reports the event, it is unknown the effects on the TBCD jurisdictional area.

All people and assets in the planning area are considered to have the same degree of exposure to this hazard. Within the planning area, the risk to people and property from the high wind hazard cannot be distinguished by area; the hazard is expected to have a relatively uniform probability of occurrence across all of TBCD. Typically, assets of lighter construction (such as mobile homes) are most vulnerable to the high winds hazard. Data related to the number of structures by building type and past damages for specific building types was unavailable at the time of the 2012 Plan and therefore the loss estimates for the thunderstorm/high wind hazard are based on total property damage as reported by the NCDC.

As mentioned above, the severe thunderstorm/high wind results from the NCDC indicates that between 1950 and 2011 there have been 71 storms causing 2 fatalities, 1 injury $900,000 in property damage and an additional $3,000 in Crop Damages.

5.17.4 Probability of Future Occurrence

With a total of 71 damaging thunderstorm/high wind events between 1950 and 2011, the County experiences a significant thunderstorm/high wind event on average approximately 1.1 times a year. With over one event per year, there is a greater than a 100% annual probability of a future thunderstorm/high wind events occurring in the planning area. Based on the historical thunderstorm/high wind data, the probability of future events impacting TBCD is considered **high**.

5.17.5 Magnitude/Severity/Extent

Severe storms are frequent in Texas and occur throughout the year, with highest frequency during the spring and summers months. During these seasons, Chambers County is particularly subject to strong storms that are triggered, primarily, by rapid surface warming (an average of 10 degrees difference in daytime warming from March to April) which causes air to become unstable (to rise and shift unpredictably) and southward shifts in the jet stream that bring cold air masses into contact with warm fronts coming up from the Gulf of Mexico. Average rainfalls increase, in the area, by 50%, in contrast to that experienced during the winter months, during the months of April and May.

During the summer months, convective currents, spawned by rapid and intense surface heating, as well as increases in relative humidity, can bring about the formation of late afternoon thunderstorms that are accompanied by heavy downpours and dangerous lightning. As mentioned above, however, severe/life and property threatening thunderstorms can and have occurred, in Chambers County, in all seasons and at all times of the day and night.

The severity (magnitude or extent) of high winds is mainly measured by velocity, either sustained wind, or peak gusts. High wind effects may be exacerbated by the presence of debris, which are loose objects that become airborne missiles during high winds and can cause damage that winds would otherwise not create. Typical examples of windborne debris are gravel roof ballast and tree branches. Assets and people in areas with significant potential for missiles to be present are thus somewhat more exposed to secondary wind risks. Wind velocities from hurricanes and tornadoes are typically much higher than from thunderstorms, so building codes are usually calibrated based on potential sustained wind speed, or on 3-second peak gusts at a specific elevation about the surface.

The extent of thunderstorms may be measured by the cell intensity: ordinary cell, multi-cellular, and super cell. The most common type of thunderstorm is termed the “ordinary” cell, which is limited in size and lifespan, but can produce short bursts of severe weather. Several other variants also exist, but the most dangerous form is termed the “super cell” thunderstorm. The super cell is typically an isolated form and always has the potential to be severe because of its strong and persistent rotating updraft, which dissipates at the upper levels forming the characteristic anvil and overshoot of clouds. Vertical wind shear (i.e., wind speed increasing with height) is important in the development of severe storms such as super cells. The shearing effect serves to separate the updrafts from the downdrafts, thus creating a circulation. In a normal thunderstorm, the downdraft tends to fall back into the updraft, effectively dissipating the storm’s energy. Hail and heavy rain are associated with the downdraft zones and under some specific conditions may also form a tornado towards the left rear flank of the storm cell. This small but rapidly rotating column of air descends below the cloud base, reaching the surface with devastating consequences. As the storms translate at speeds typically in the range of 25 to 30 mph, these relatively narrow impact widths become long swaths of potentially very high damage. Super cells may have a lifespan of several hours and present an impact front as wide as 25 miles. Records of damage generally indicate "pulsing" whereby the ground level impacts tend to fluctuate, probably depending on the supply of material held aloft by the updrafts. Very severe super cells can exhibit almost continuous damage fronts for several hours as combinations of wind, rain, and hail. All these types of thunderstorms are possible in the planning area.

The overall extent of thunderstorms on the planning area is limited because while thunderstorms occur frequently in the area, they do not cause the planning area's critical facilities to shut down. Trinity Bay Conservation District can expect to experience as little as 1-4 MPH winds from thunderstorms which can cause light air direction of wind shown by smoke, but not by wind vanes and therefore can anticipate no damage to hurricane devastation like damage from winds greater than 70 knots or more. See Beaufort Wind Scale and conversion from knots to MPH.

Table 5-19 Beaufort Wind Scale

Wind speed in MPH	Description - Visible Condition
0	Calm smoke rises vertically
1 - 4	Light air direction of wind shown by smoke but not by wind vanes
4 - 7	Light breeze wind felt on face; leaves rustle; ordinary wind vane moved by wind
8 - 12	Gentle breeze leaves and small twigs in constant motion; wind extends light flag
13 - 18	Moderate breeze raises dust and loose paper; small branches are moved
19 - 24	Fresh breeze small trees in leaf begin to sway; crested wavelets form on inland water
25 - 31	Strong breeze large branches in motion; telephone wires whistle; umbrellas used with difficulty
32 - 38	Moderate gale whole trees in motion; inconvenience in walking against wind
39 - 46	Fresh gale breaks twigs off trees; generally impedes progress
47 - 54	Strong gale slight structural damage occurs; chimney pots and slates removed
55 - 63	Whole gale trees uprooted; considerable structural damage occurs

64 - 72	Storm very rarely experienced; accompanied by widespread damage
73+	Hurricane devastation occurs

5.17.6 Impact

All people and assets in Chambers County are considered to have the same degree of exposure to the severe thunderstorm/high wind hazard. Within the County, the risk to people and property from the high wind hazard cannot be distinguished by area; the hazard is expected to have a relatively uniform probability of occurrence across the entire County.

Thunderstorms/High winds can cause damage to rooftops, break windows from projectiles, or cause trees to fall on structures. It can also damage utility lines. Several meteorological conditions can result in winds severe enough to cause property damage. In Chambers County, most wind damage has been limited to downed trees, blocked roads, and disabled power lines. Typically, assets of lighter construction (such as mobile and other manufactured structures) are most vulnerable to the high winds hazard. Data related to the number of structures by building type and past damages for specific building types was unavailable at the time of the drafting of this Plan.

5.17.7 Overall Vulnerability

Reviewing the location and history of thunderstorms/high winds in Chambers County, all people and assets in the County are considered to have the same degree of exposure to the severe thunderstorm/high wind hazard. Therefore, all residents, residential and commercial property and infrastructure like roads and bridges, schools and critical facilities are vulnerable to a thunderstorm/high wind hazard.

Several meteorological conditions can result in winds severe enough to cause property damage. In the County, most wind damage has been limited to downed trees, blocked roads, and disabled power lines. Typically, assets of lighter construction (such as mobile and other manufactured structures) are most vulnerable to the high winds hazard. Data related to the number of structures by building type and past damages for specific building types was unavailable at the time of the Plan. The NCDC database indicates that between 1950 and August, 2011, Chambers County experienced two deaths and one injury from high wind events. During this same time period, property damage totaled $900,000 and additionally there was $3,000 in crop damage.

The following approach was used to estimate the potential losses to new future buildings. As indicated in Table 5-4, total value of buildings within the District are estimated at approximately $1.74B. Using historical loss data, it is estimated that these assets will experience annual losses in the amount of $2,263.00, which is .0000013% estimated annual estimated losses, as percentage of the total value of the assets. Given that there is no way to predict the geographic location of thunderstorms/high winds, existing and new construction is presumed to have approximately equal exposure.

In addition, the District only has authority to mitigate its own buildings for flood and wind, so this hazard will not be further analyzed as the more damaging winds that can impact the buildings are from hurricane and tornado winds which will be further analyzed.

5.18 TORNADOES

5.18.1 Hazard Description

Tornadoes pose a significant threat to life and safety in the State of Texas, Jefferson, Chambers Counties and consequently the planning area. The National Weather Service defines a tornado as a violently rotating column of air in contact with the ground and extending from the base of a thunderstorm. Tornadoes can form any time of the year; but the season of greatest activity runs from March to August. See Appendix A for a more detailed description of the tornado hazard.

Table 5-20 - Fujita Tornado Measurement Scale (Source: NOAA)

Category	Wind Speed	Examples of Possible Damage
F0	Gale (40-72 mph)	Light damage. Some damage to chimneys; break branches of trees; push over shallow rooted trees; damage to sign boards.
F1	Moderate (73-112 mph)	Moderate damage. Peel surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off roads.
F2	Significant (113-157 mph)	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.
F3	Severe (158-206 mph)	Severe damage. Roofs and some walls torn off well constructed houses; trains overturned; most trees in forest uprooted; cars lifted off ground and thrown.

Category	Wind Speed	Examples of Possible Damage
F4	Devastating (207-260 mph)	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	Incredible (261-318 mph)	Incredible damage. Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile sized missiles fly through air in excess of 100 yards; trees debarked; incredible phenomena will occur.

In February of 2007 the F-Scale (Table 5-20) was replaced with a more accurate Enhanced Fujita Scale (Enhanced F-scale). It was the Jarrell, Texas tornado of May 27, 1997 and the Oklahoma City/Moore tornado of May 3, 1999 that brought to the forefront the problem that perhaps the wind estimates were too high in the F-Scale. The changes to the original scale were proposed by a committee of meteorologist and engineers searching for a more accurate method of assessing the magnitude of tornadoes. Changes to the original Fujita scale were designed to ensure compatibility with the existing databases of tornado hazards, including the one maintained by the NCDC.

The Enhanced F-scale has the same basic design as the original Fujita scale, six categories from zero to five representing increasing degrees of damage.[17] It was revised to reflect better examinations of tornado damage surveys, so as to align wind speeds more closely with associated storm damage. The new scale also considers damages to a wider variety of structures and better accounts for variables such as differences in construction quality. Table 5-21 displays the wind speed ranges for the original Fujita Scale, the derived wind speeds (Enhanced F-scale), and the new Enhanced F-scale, in wide use since February of 2007.

Table 5-21 -Wind Speed Comparison of the Fujita Scale and Enhanced Fujita Scale (Source: NOAA – National Weather Service)

Fujita Scale			Derived EF Scale		Operational EF Scale	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
0	40-72	45-78	0	65-85	0	65-85

[17] *NOAA; Storm Prediction Center – Summary of Enhanced F-scale*

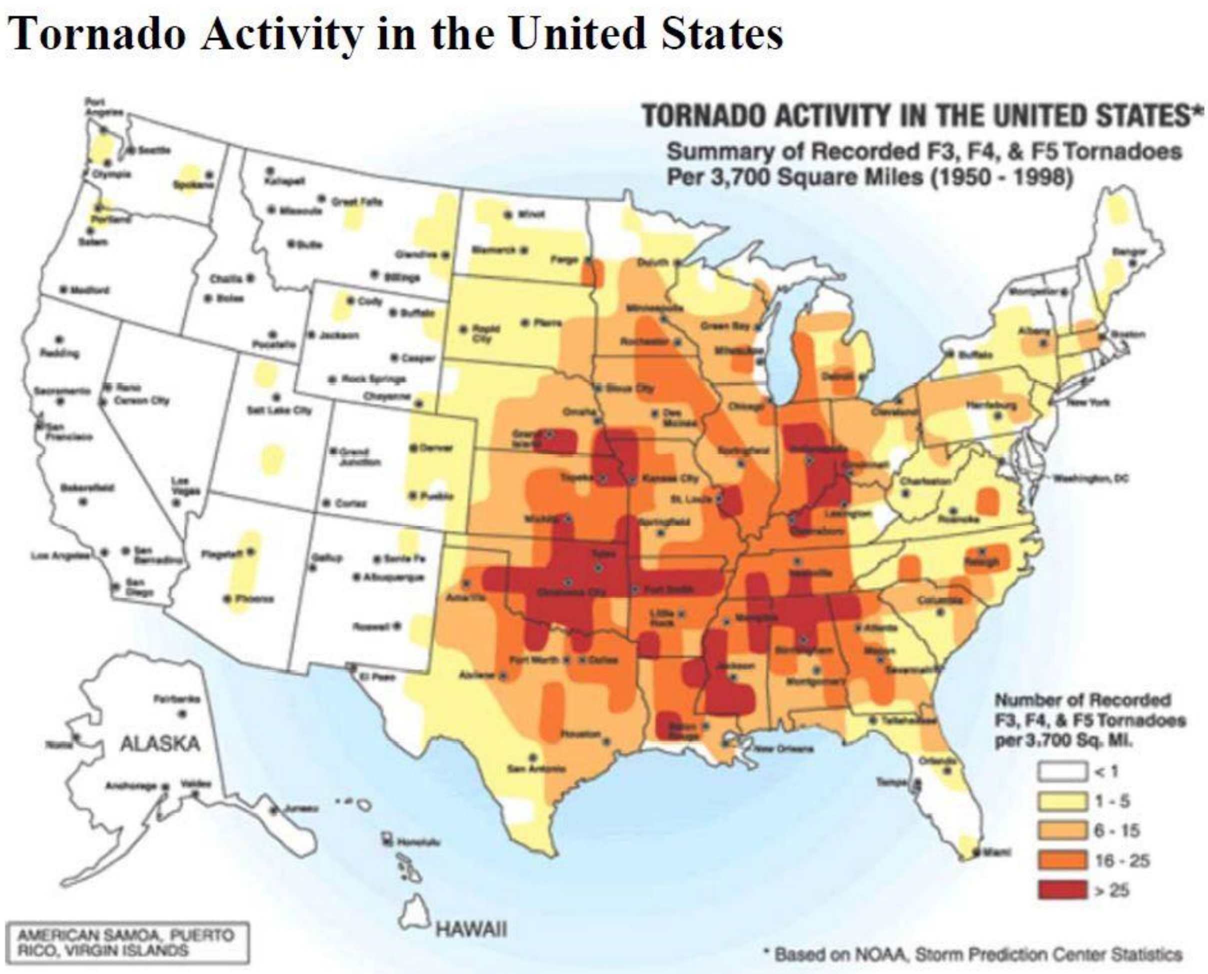
Fujita Scale			Derived EF Scale		Operational EF Scale	
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

5.18.2 Geographic Location

Figure 5-14 illustrates the frequency of tornado strikes in the U.S. per 1,000 square miles. With an average of 143 tornadoes touching down each year, Texas is considered the U.S. "tornado capital." While Texas tornadoes can occur in any month and at all hours of the day or night, they occur with greatest frequency during the late spring and early summer months during late afternoon and early evening hours. The tornado hazard affects the entire planning area approximately equally.

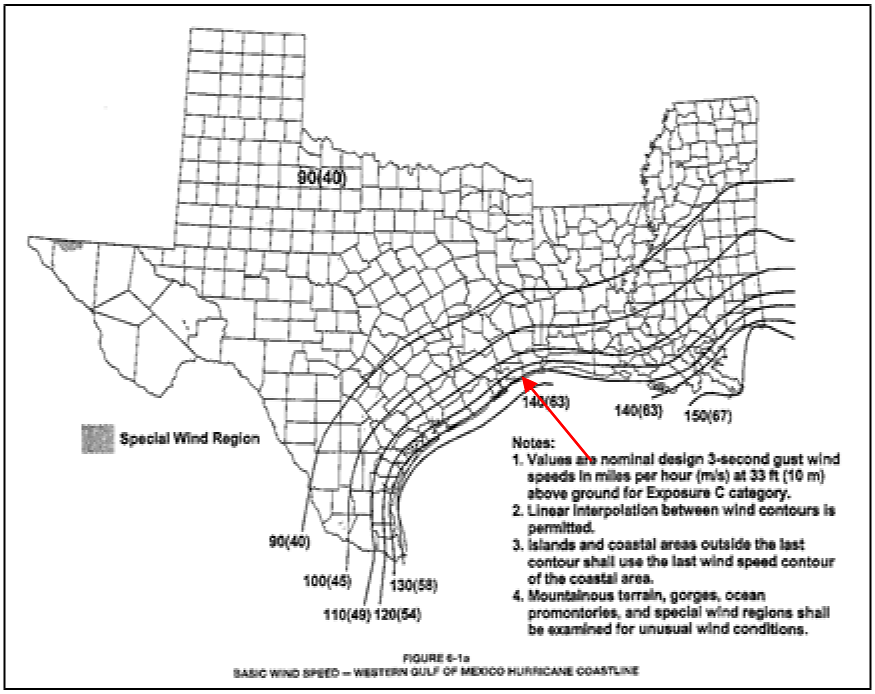
Generally, engineered commercial (and other non-residential) structures are less vulnerable to the effects of tornadoes than are residential structures, with exceptions.

Figure 5-14 - Tornado Activity in the U.S. (Source: NOAA – Storm Prediction Center)



The Figure below provides the "basic wind speed" map for Texas. The map was developed by the International Code Council (ICC) and is referenced in model building codes as the International Building Code (IBC). The map is used to assist with designing buildings to withstand reasonably anticipated winds in order to minimize property damage. The map shows that Trinity Bay Conservation District falls within the area where the "design wind" speed is between 110-130 miles per hour.

Figure 5-15 - Basic Wind Speed: Texas(Source: International Building Code)



5.18.3 Previous Occurrences

In TBCD, most damage has been limited to downed trees, blocked roads, and disabled power lines. According to NOAA/NCDC data between 1950 and 2011 there were a reported 8,762 Tornados in the State of Texas. These storms have injured over 8,200 people with 538 deaths related to tornadoes. Property damages were reported to exceed 3.72 million. In the planning area (Chambers County) there 37 tornados reported. These storms injured eight people and killed 4 of them. Property damages have totaled over $1.5 million dollars. Table 5-23 summarizes all the tornadoes within the county between 1950 and 2011.

Table 5-22 - Chambers County Tornadoes since 1950, 1950 - 2011 (Source: NOAA/NCDC)

DATE	F	FATALITIES	INJURIES	PROPERTY DAMAGE	REMARKS
05/12/54	1	0	0	$0	
08/13/59		0	0	$250	
07/09/61	0	0	0	$0	
06/03/62	0	0	0	$0	
05/27/69	3	3	0	$25,000	
03/09/71	2	0	1	$25,000	
03/23/73	0	0	0	$0	

DATE	F	FATALITIES	INJURIES	PROPERTY DAMAGE	REMARKS
10/28/74	2	0	0	$250,000	
10/28/74	3	1	0	$0	
04/10/75	0	0	0	$2,500	
09/19/80	1	0	1	$25,000	
06/05/81	2	0	1	$250,000	
06/05/81	0	0	0	$25,000	
09/02/81	1	0	0	$25,000	
07/14/82	1	0	0	$2,500	
05/20/83	0	0	0	$250,000	
05/20/83	0	0	0	$30	
10/15/89	0	0	0	$0	
03/18/92	1	0	0	$25,000	
05/18/93	0	0	0	$50,000	The Chambers County Sheriff Department reported a tornado sighted by law enforcement official between Mont Belvieu and Anahuac. Several patrol units experienced winds in excess of 60 mph pushing autos off Interstate 10 near Mont Belvieu.
11/16/93	1	0	0	$50,000	Houston Power and Light Company lost two long line transmission circuits in Mont Belvieu.
05/28/94	0	0	0	$0	
07/13/99		0	0	$0	
08/19/99		0	0	$0	Funnel clouds reported near Anahuac Wildlife Refuge and near intersection of I-10 and Hwy. 61.
04/03/00	1	0	0	$100,000	Tornado near FM 1985 with rice dryers demolished and major tree damage at several homes.
05/28/00		0	0	$0	Funnel cloud over Trinity Bay.
06/05/00		0	0	$0	Three funnel clouds reported.
08/31/01	0	0	0	$0	Tornado near Highway 65 between Monroe City and Winnie. Law enforcement reported no damage or injuries. A series of upper level disturbances produced heavy rain and

DATE	F	FATALITIES	INJURIES	PROPERTY DAMAGE	REMARKS
					some severe weather across the southern portions of southeast Texas. Rainfall rates of one inch per hour for up to 6 hours at a time were recorded in Jackson, Matagorda, and Wharton counties. This led to widespread street flooding with some roads being washed out. Heavy rainfall in Galveston, Brazoria, Fort Bend, and southeastern Harris counties also led to street flooding, as well as water in some homes. The storms also produced three tornadoes causing minor damage and no injuries.
11/17/03	0	0	0	$0	Tornado touch down near Beach City. A total of 24 tornadoes touched down during this 15 hour period of severe weather in southeastern Texas on November 17, 2003. In addition to these tornadoes, a major flood developed over Harris and surrounding counties during the middle of this tornadic outbreak. Over 300 homes, along with hundreds of vehicles, were flooded. These tornadic storms developed over parts of Wharton and Matagorda counties shortly after sunrise with the first confirmed tornado occurring just east of El Campo around 9:00 am. Strong 500mb upper level troughing over the western U.S. moved from west to east across the Southern Plains. The polar jet stream associated with this 500 millibar trough surged into west Texas and then curved sharply northeastward into the Central Plains. The sub-tropical jet stream was oriented west to east across deep southern Texas. This jet stream pattern was the impetus to strong lower level convergence due to the enhanced upper level divergence. Low level moisture had substantially increased

DATE	F	FATALITIES	INJURIES	PROPERTY DAMAGE	REMARKS
					and was about 200 percent of normal by 6 AM. Vertical wind profiles also showed a great deal of low level wind shear with the greatest shear occurring in the lowest 2000 feet. In addition, these veering wind speeds rapidly increased with height. A focus for the thunderstorm development was provided by a weak low level boundary which was aligned southwest to northeast, or generally along the U.S. Highway 59 corridor. This feature was nearly-stationary and thunderstorms repeatedly developed and moved along this boundary. The axis of heaviest rain was coincident with this boundary.
11/17/03	1	0	0	$300,000	Tornado touch down in White Harring Estates area between Oak Island and Smith Point. One home destroyed with seven other homes receiving damage. A total of 24 tornadoes touched down during this 15 hour period of severe weather in southeastern Texas on November 17, 2003. In addition to these tornadoes, a major flood developed over Harris and surrounding counties during the middle of this tornadic outbreak. Over 300 homes, along with hundreds of vehicles, were flooded. These tornadic storms developed over parts of Wharton and Matagorda counties shortly after sunrise with the first confirmed tornado occurring just east of El Campo around 9:00 am. Strong 500mb upper level troughing over the western U.S. moved from west to east across the Southern Plains. The polar jet stream associated with this 500 millibar trough surged into west Texas and then curved sharply northeastward into the Central Plains. The sub-tropical jet stream was oriented west

DATE	F	FATALITIES	INJURIES	PROPERTY DAMAGE	REMARKS
					to east across deep southern Texas. This jet stream pattern was the impetus to strong lower level convergence due to the enhanced upper level divergence. Low level moisture had substantially increased and was about 200 percent of normal by 6 AM. Vertical wind profiles also showed a great deal of low level wind shear with the greatest shear occurring in the lowest 2000 feet. In addition, these veering wind speeds rapidly increased with height. A focus for the thunderstorm development was provided by a weak low level boundary which was aligned southwest to northeast, or generally along the U.S. Highway 59 corridor. This feature was nearly-stationary and thunderstorms repeatedly developed and moved along this boundary. The axis of heaviest rain was coincident with this boundary.
11/17/03	1	0	5	$100,000	Tornado crossed the Old Trinity River Bridge on I-10, blowing over 10 semi trucks. One eastbound semi was dumped onto two cars. Another westbound semi was picked up, blown across a stone retaining wall, ripped through metal fencing and landed on a car in the westbound lane. Description of trucks were one loaded with 60K pounds of nuts and bolts, another with 42K pounds of paper towels, and a tanker truck filled with spring water. 5 injured transported to local area hospital. A total of 24 tornadoes touched down during this 15 hour period of severe weather in southeastern Texas on November 17, 2003. In addition to these tornadoes, a major flood developed over Harris and surrounding counties during the middle of this tornadic outbreak. Over 300 homes, along with

DATE	F	FATALITIES	INJURIES	PROPERTY DAMAGE	REMARKS
					hundreds of vehicles, were flooded. These tornadic storms developed over parts of Wharton and Matagorda counties shortly after sunrise with the first confirmed tornado occurring just east of El Campo around 9:00 am. Strong 500mb upper level troughing over the western U.S. moved from west to east across the Southern Plains. The polar jet stream associated with this 500 millibar trough surged into west Texas and then curved sharply northeastward into the Central Plains. The sub-tropical jet stream was oriented west to east across deep southern Texas. This jet stream pattern was the impetus to strong lower level convergence due to the enhanced upper level divergence. Low level moisture had substantially increased and was about 200 percent of normal by 6 AM. Vertical wind profiles also showed a great deal of low level wind shear with the greatest shear occurring in the lowest 2000 feet. In addition, these veering wind speeds rapidly increased with height. A focus for the thunderstorm development was provided by a weak low level boundary which was aligned southwest to northeast, or generally along the U.S. Highway 59 corridor. This feature was nearly-stationary and thunderstorms repeatedly developed and moved along this boundary. The axis of heaviest rain was coincident with this boundary.
11/22/04		0	0	$0	
07/08/06	0	0	0	$0	Tornado caused no damage near the Intracoastal Bridge on Highway 124 near the Chambers-Galveston county line.
06/15/07		0	0	$0	EVENT NARRATIVE: Funnel sighted near FM 1985 and Oyster Bayou. EPISODE

DATE	F	FATALITIES	INJURIES	PROPERTY DAMAGE	REMARKS
					NARRATIVE: Morning marine environment was conducive for the formation of funnel clouds. Scattered storms affected coastal communities during the morning hours that produced funnel clouds, very localized street flooding, and frequent lightning strikes.
07/05/07		0	0	$0	EVENT NARRATIVE: Funnel cloud sighted a couple of miles west of FM 146, near FM 1942. EPISODE NARRATIVE: Residual thunderstorm boundaries from previous day storms allowed a focus for various northern storms to form upon and slowly travel. Upper level low, combined with abundant moisture, produced numerous showers and thunderstorms through the 4th of July.
06/24/11		0	0	$0	EPISODE NARRATIVE: A brief funnel cloud was sighted from scattered showers and thunderstorms moving onshore. EVENT NARRATIVE: A funnel cloud was sighted moving to the north northwest near Winnie.
06/14/12		0	0	$0	EPISODE NARRATIVE: A southward moving early morning thunderstorm produced large hail in Houston County east of Crockett. EVENT NARRATIVE: A brief funnel cloud was reported with a thunderstorm occurring to the northwest of Winnie.
Totals	37	4	8	$1,505,280	

*While the NCDC reports the event, it is unknown the effects on the TBCD jurisdictional area.

5.18.4 Probability of Future Occurrence

It is possible for tornadoes of any intensity (up to EF-5) to occur anywhere within the planning area. Although the NCDC indicates the strongest recorded tornadoes in Chambers County were rated as F3s (two total) on the Fujita scale, the climate in southeastern Texas, and the potential for extreme atmospheric instability, allow for the possibility that tornadoes in the planning area could reach EF-5 severity. It should be noted that a normal probabilistic distribution of events would mean that events on the lower end of the scale would predominate, while more severe events will be less common.

According to the NCDC database, Chambers County experienced 37 tornadoes (23 F0s, 9 F1s, 2 F2s, and 2 F3s) between 1950 and 2011. Again, the majority of the tornadoes listed in the database did not indicate the specific location within the County. Therefore, the county-wide estimate of $1.5 million from the NCDC was used to estimate the potential dollar value of losses to existing buildings in TBCD. Dividing this prior loss by the span of years in which this loss was incurred (61 years), it is estimated that Chambers County, which duplicates the planning area boundaries, has a potential annual loss from tornadoes of $24,590.

Table 5-23 - Crosstab of Tornados in Chambers County Texas (Source: NOAA / NCDC)

Tornados	Count	# of FATALITIES	# of INJURIES	Amount of Property Damage
F0	23	0	0	$327,780
F1	9	0	6	$627,500
F2	3	0	2	$525,000
F3	2	4	0	$25,000
Total	37	4	8	$1,505,280

With a total of 37 tornado events between 1950 and 2011, Chambers County experiences on average approximately one tornados six months. With almost one event every year, there is a statistical annual probability of than 50% that a tornado of some magnitude will occur in Chambers County. It should also be noted that the majority of tornadoes here (and other places) are low-magnitude events that cause little or no damage. Based on the high, medium, and low ranges identified in Table 5-7, there is a **high** probability of future tornadoes occurring in TBCD.

5.18.5 Magnitude/Severity/Extent

Within Trinity Bay Conservation District the hazard is reasonably predicted to have uniform probability of occurrence across the entire County. All people and assets are considered to have the same degree of exposure. Historically, lightly constructed residential structures (in particular, manufactured housing, specifically mobile homes) within the planning area are most vulnerable to the tornado hazard. Data related to the number of structures by building type and past damages for specific building types was unavailable at the time of the 2012 Plan, and therefore the loss estimates for the tornado hazard are based on total property damage as reported by the NCDC.

Tornado damage severity is currently measured by the Enhanced Fujita Tornado Scale (F-Scale), named after Dr. T. Theodore Fujita who first introduced the scale in 1971. The original Fujita Scale, used until February of 2007, assigned numerical values based on wind speeds and categorizes tornadoes from 0 to 5. The scale was based on damage caused by a tornado related to the fastest ¼ mile wind speed at the height of a damaged structure. The letter "F" often precedes the numerical value. Table 5-19 provides a description of the Fujita Tornado Measurement Scale.

5.18.6 Impact

Tornadoes have and can cause considerable damage in the Trinity Bay Conservation District planning area. Tornadoes can damage or destroy residential and commercial structures, remove roofs and shingles and take down utility lines. Tornados can destroy personal property like cars and trucks as well as crops and anything in the path of the tornado can be thrown or destroyed. Debris can block roads making roads impassable for the general public as well as emergency personnel. Chambers County had four deaths and eight injuries due to tornadoes as reported by the NCDC database and damages to property was approximately $1.5 million.

5.18.7 Overall Vulnerability

Tornadoes pose a significant threat to life and safety in the TBCD planning area. While a tornado is on the ground, all citizens in its path are potentially in danger of injury or death. Residential and Commercial structures as well as Infrastructure (schools, critical facilities and roads and bridges) are also at risk from tornadoes. Historically, lightly constructed residential structures (in particular, manufactured housing, specifically mobile homes) located within the planning area are most vulnerable to the tornado hazard. Data related to the number of structures by building type and past damages for specific building types was unavailable at the time of the Plan update. This hazard, as it impacts TBCD buildings, will be mitigated in Section 8.

5.19 WILDLAND FIRE

5.19.1 Hazard Description

Wildfires are uncontrolled fires often occurring in wildland areas, and can consume houses or agricultural resources if not contained. Wildfires/urban interface is defined as the area where structures and other human development blend with undeveloped wildland. The U.S. Department of the Interior has developed the Wildland Fire Assessment System Web site to communicate information to the public via the Internet. Web visitors can view real-time maps showing potential for fire on any given day, including satellite-derived "greenness" maps. See Appendix A for a more detailed description of the wildland fire hazard.

5.19.2 Geographic Location

The risk of wildfire is not confined to a particular geographic region of the county, though, the risk of wildfire and damage from wildfire is highest in the urban-wildland interface. The urban/wildland interface is generally described as an area where development meets dense forest. Fires burning in this fuel type under drought conditions are extremely hard to contain, require concentrated firefighting resources, and threaten all homes and facilities in its vicinity. Figure 5-17 shows the potential for Wildland Fire in Chambers County Texas. The data comes from ArcGIS and the USGS LandFire data.

Wildfire Threat is the likelihood of a wildfire occurring or burning into an area. Threat is derived by combining a number of landscape characteristics including surface fuels and canopy fuels, resultant fire behavior, historical fire occurrence, percentile weather derived from historical weather observations, and terrain conditions. These inputs are combined using analysis techniques based on established fire science.

The measure of wildfire threat used in the Texas Wildfire Risk Assessment (TWRA) is called Wildland Fire Susceptibility Index, or WFSI. WFSI combines the probability of an acre igniting (Wildfire Ignition Density) and the expected final fire size based on rate of spread in four weather percentile categories. WFSI is defined as the likelihood of an acre burning. Since all areas in Texas have WFSI calculated consistently, it allows for comparison and ordination of areas across the entire state. For example, a high threat area in East Texas is equivalent to a high threat area in West Texas.

To aid in the use of Wildfire Threat for planning activities, the output values are categorized into seven (7) classes. These are given general descriptions from Low to Very High threat (as defined in Table below). The threat map is derived at a 30 meter resolution. This scale of data was chosen to be consistent with the accuracy of the primary surface fuels dataset used in the assessment. Table 5-25 allocates all of the acres in Chambers County to classes of wildfire threats. To better illustrate the location of wildfire threat within the County and the participating jurisdictions, Figure 5-16 shows the entire County by color, demonstrates classes of wildfire threat - if an incorporated area has a very high wildfire threat (as defined in Table 5-24) to a non-burnable threat. The WFSI scale is defined in Table 5-24 below.

Figure 5-16 - Wildland Fire Potential (Source: USGS, ArcGIS)

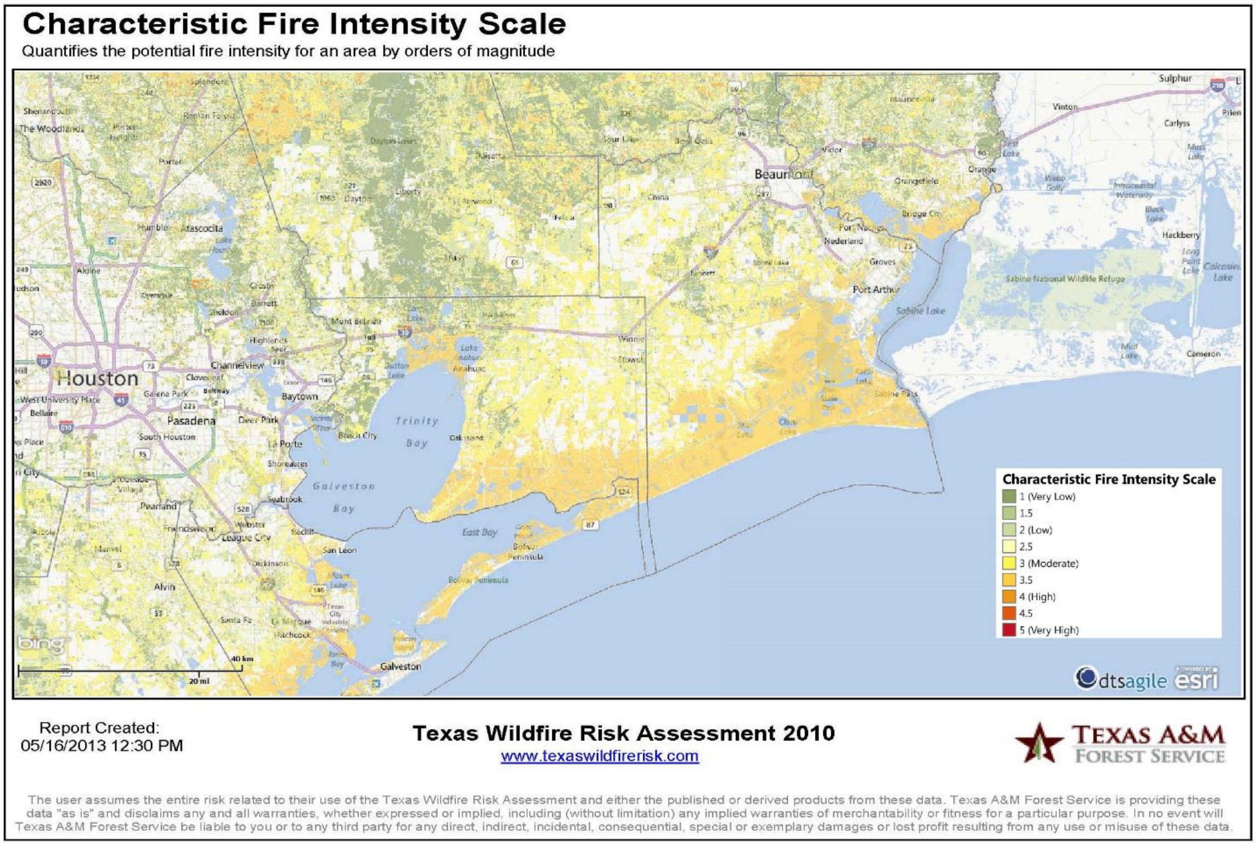


Figure 5-17 Wildfire ignitions in Chambers County 2005 to 2009

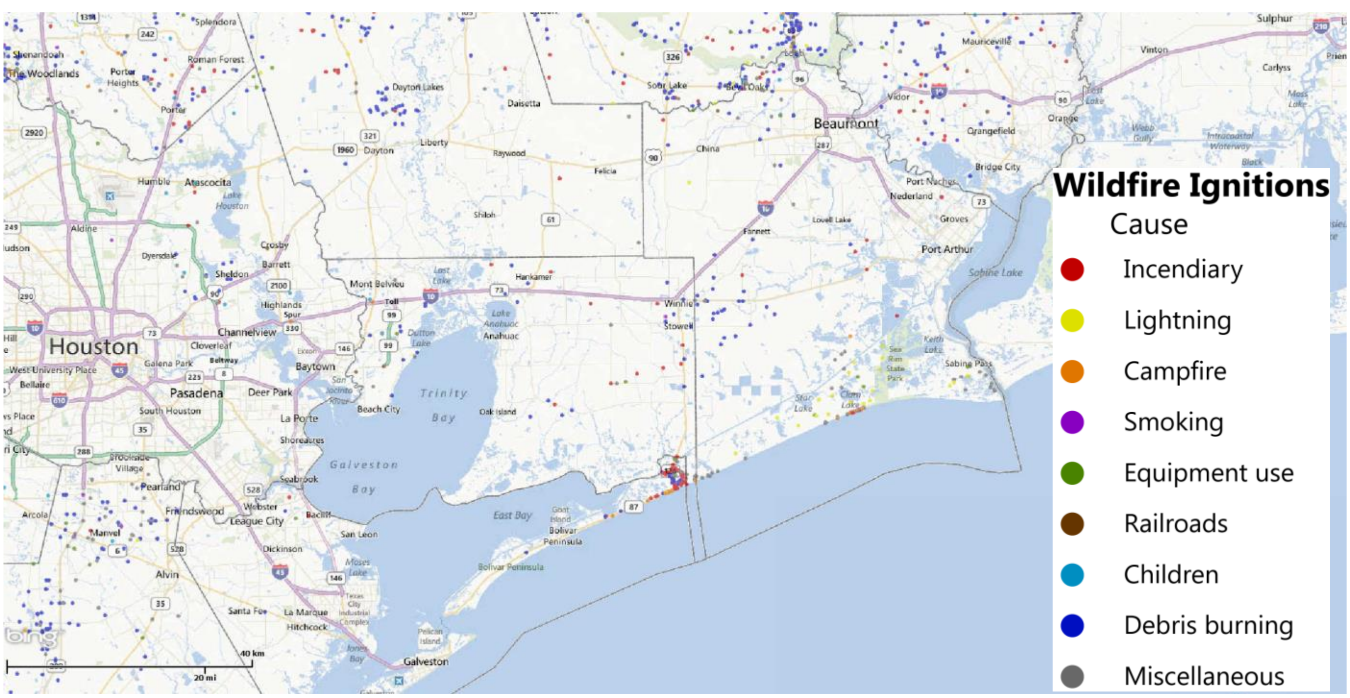


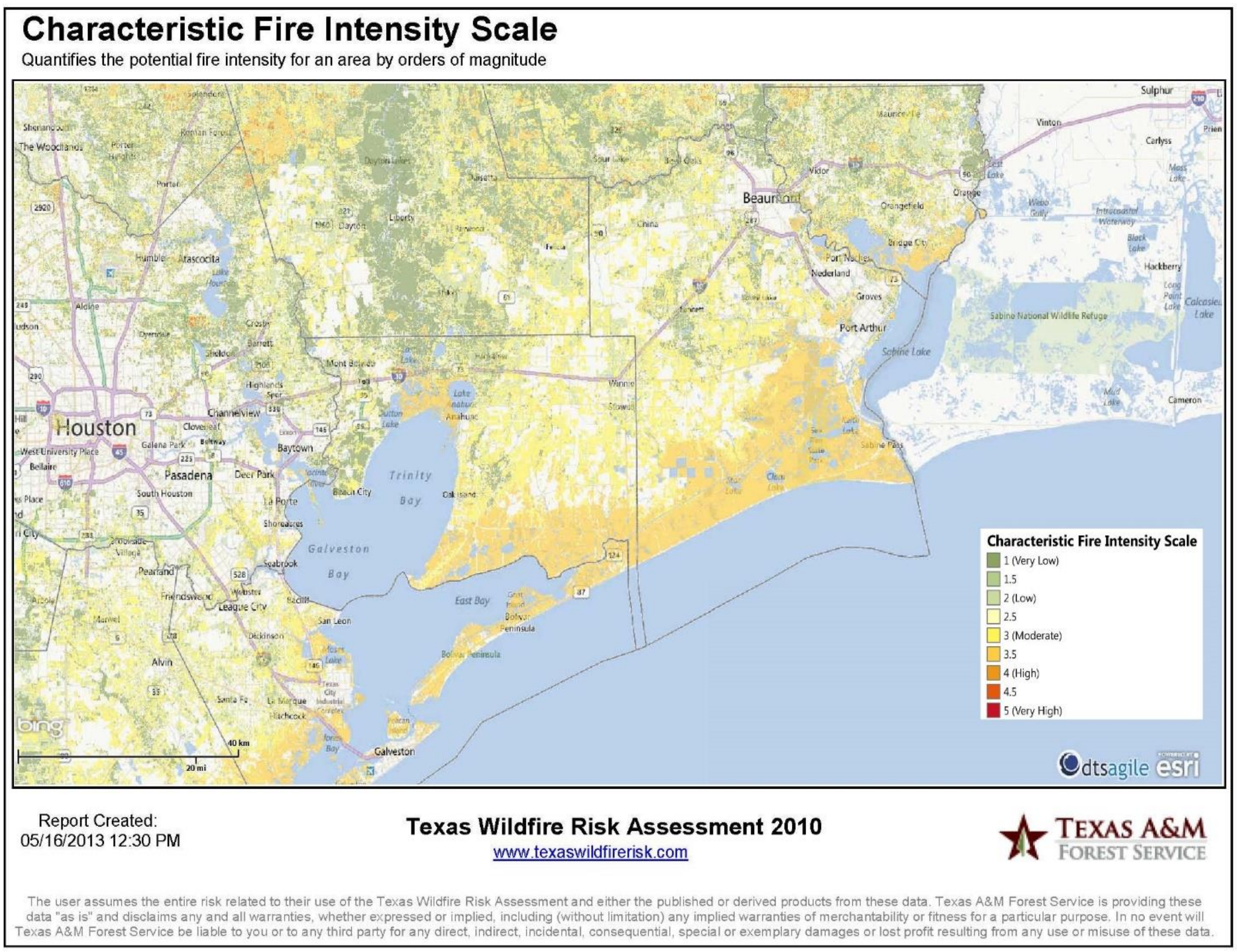
Table 5-24 WFSI Scale Definitions

Class	Acres	Percent
Non-Burnable	288,237	40.5%
1 (Low)	149,112	20.9%
2	104,463	14.7%
3 (Moderate)	19,707	2.8%
4	29,426	4.1%
5 (High)	28,122	3.9%
6	93,299	13.1%
7 (Very High)	87	0.0%
Total	712,452	100.0%

Class	Scale Definitions
0 Non-Burnable	0% likelihood of an acre burning
1 (low)	Less than 10% likelihood of an acre burning
2	10% to 20% likelihood of an acre burning
3 (moderate)	20% to 30% likelihood of an acre burning

4	30 % to 40% likelihood of an acre burning
5 (high)	40% to 50% likelihood of an acre burning
6	60% to 75% likelihood of an acre burning
7 (very high)	Greater than 75% likelihood of an acre burning

Figure 5-18 Wildfire Threat in Chambers County Texas



While most of Chambers County is low to moderate wildfire threat, the lower southern portion of the County is located in the high wildfire threat.

5.19.3 Previous Occurrences

According to the Texas Forest Service's 2009 Economic Impact of the Texas Forest Sector, Texas has more than 63.3 million acres of forestland, up from 60 Million in 2007, of which 12.1 million acres in East Texas alone. Of the 63.3 million acres, timberland accounts for 22.8 percent, or about 14.5 million acres, and the majority – around 83-percent – is located in East Texas. The economic influence of the forest sector is relevant in East Texas. About 35 percent of the direct industrial output ($5.7 billion) and employed 35 percent of total workers (22,061) in the sector, mainly from the primary solid wood products manufacturing firms and logging industries in the region. Over three-quarters of all forestry and logging industries and the great majority of primary forest product manufacturing industries are in East Texas. The forest sector of East Texas had a total economic impact of $8.2 billion in total industry output, $3.4 billion in value-added and 40,990 jobs to the state economy.

According to the NCDC database, the planning area (Chambers County) experienced six wildland fires between 2006 and 20011. Again, the majority of the wildfires listed in the database did not indicate the specific location within the County.

Table 5-25 - Chambers County Wildfire Incidents 1950 - 2011 (Source: NOAA/NCDC)

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	REMARKS
01/01/06	1	0	0	The Cole Fire started in southern Sterling County along highway 163 and spread quickly to the east for 15 to 20 miles in winds gusting upwards of 50 mph and humidities of 5 to 10 percent. This fire spread into Tom Green and extreme southwest Coke County. The fire did threaten the community of Water Valley, however was contained. The fire consumed around 40 thousand acres.
04/04/11	0	0	0	EPISODE NARRATIVE: Elevated fire weather conditions persisted April 1st and 2nd. Then on April 3rd, strong southwest winds developed behind the dryline and brought a very dry air mass into the area. This combination of very warm temperatures, very low relative humidities, and strong winds created critical fire weather conditions across a large

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	REMARKS
				part of West Central Texas. EVENT NARRATIVE: The wildfire burned 341 acres 13 miles north of Barnhart, on the Rocker B Ranch. Also, the fire threatened oil and gas wells in southern Irion County. The fire was 90 percent contained on April 6th.
02/25/08	0	0	0	EVENT NARRATIVE: A wildfire initiated along the Glasscock and Sterling County line during the morning. This wildfire, narrow in size, continued to sweep rapidly east towards Sterling City. As a southward moving cold front intersected the eastward moving fire near Water Valley, suddenly the narrow flame front expanded in size on the south flank as the winds shifted to the northwest. This large flame front located on the south side allowed the wildfire to expand and spread into Irion County and ended about 4 miles north of Mertzon. EPISODE NARRATIVE: A strong low pressure system produced strong downsloping southwest winds of 35 to 50 mph, temperatures near 90 degrees and relative humidities in the single digits. These ingredients produced extremely critical fire weather conditions across West Central Texas that resulted in several large wildfires. A cold front shifted the winds from southwest to north by late afternoon and aided to increase the size of some of the wildfires.
04/26/11	0	0	0	EPISODE NARRATIVE: Critical Fire Weather Conditions occurred on April 25 across much of West Central Texas as a dryline brought southwest to west winds of 20 to 25 mph, relative humidity levels below 20 percent, and temperatures in the 90s. Isolated thunderstorms ignited a large wildfire in Kimble County on April 26. A few of these fires continued through the end of April. EVENT NARRATIVE: The Scott Ranch Fire located 13 miles west-northwest of Mertzon burned approximately 11,233 acres. The fire was started

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	REMARKS
				when a chain swinging from a truck created sparks as it bounced on the road surface on a Scott Ranch road. Eight homes were threatened and saved. Oil and gas infrastructure were also threatened. Several utility poles were destroyed by the fire resulted in some power outages. Farm to Market Road 2469 was closed for a time but reopened. Winds blew so hard during the Scott Ranch fire that the fire crew had to retreat from one ranch at Ketchum Road, but they returned to that ranch once the winds died down and the visibility improved. Many utility poles were on fire at the base, while the rest of the pole leaned toward the road, held back by the tension of the lines. Fire had burned the bottoms of some entirely, leaving the remainder of the pole suspended in the air.
03/26/09	0	0	0	EPISODE NARRATIVE: The combination of very dry air and gusty winds provided conditions conducive to a wildfire. EVENT NARRATIVE: A wildfire burned 575 acres on the Keppler Creek Ranch.
02/27/11	0	0	0	EPISODE NARRATIVE: A strong low pressure system moving across North Texas brought very strong winds and low relative humidity values to West Central Texas on February 27. Plentiful fuels and these critical fire weather conditions resulted in some large wildfires. An elevated fire danger persisted between February 24 and the 26. EVENT NARRATIVE: A large wildfire was measured at 22,958 acres across Crockett and Irion Counties.

*While the NCDC reports the event, it is unknown the effects on the TBCD jurisdictional area.

5.19.4 Probability of Future Occurrence

With a total of six wildfire events between 2006 and 2011, Chambers County experiences on average approximately one wildfire every one year. It should be noted that if a wildfire spans a multiple months consecutively NCDC creates a separate entry for each month. With one event ever one year or a 100%

annual chance or wildfire the probability of future occurrence is considered **High** based on the high, medium, and low ranges identified in Table 5-7.

5.19.5 Magnitude/Severity/Extent

The frequency and severity of wildfires depends on both weather and human activity. In the planning area, severity has historically been low, and duration a matter of hours to a few days. However, Chambers County is at some risk for wildfire year-round (categorized above as low to high). There is always the possibility that a wildfire will take place in or around the County, and wildfires can spread quickly and may affect areas of the County in a very short period of time. Continued growth and development throughout the County have increased the threat to the built environment from wildfire.

Large quantities of fuel (mostly broken trees and other dead vegetation) have been deposited on the ground following several recent winter storms in which ice and snow accumulations toppled many trees and stripped others of branches and foliage. Wildfires can spread quickly and may affect areas of the County in a very short period of time.

5.19.6 Impact on Life and Property

As mentioned above, the risk of wildfires in unincorporated Chambers County low in the north and central part of the County and high in the southern part of the County. This risk is predominately to open space or low- to medium-density residential land uses. Residential structures are mostly wood-frame buildings with masonry veneer, although older structures may be unreinforced masonry, and there are numerous structures with wood or vinyl siding. Non-residential structures include a range of building types, with the most common being lightly engineered steel-frame low-rise. Many of these are masonry tilt-wall exteriors. There are no records of deaths or injuries and no recorded loss of property from wildfires in the planning area. Because the County does not maintain data about vegetated areas, fuel loads and the types of structures potentially exposed to wildfire, it is not possible to assess impacts with any certainty, particularly when risks from this hazard are also related to weather conditions, which are inherently unpredictable. However, it is possible to state generally that potential wildfire impacts to the large majority of the County and incorporated areas within are low to moderate as defined in Table 5-20. Using the Texas Forest Service Wildfire Threat scale, with Non-burnable (0) to Very High (7), Chambers County ranges from 0 – 7, with the majority of the County and incorporated areas within being either Low (1 - 2) and the southern part of the County being high (5 – 7).

Like most such areas, Chambers County has good fire detection and suppression capabilities. Coupled with relatively low fuel loads and limited interface between potential fuel and the built environment, this also suggests that the wildfire hazard is low (see above). This is borne out by research on the NCDC database and the planning team, which show a very low incidence of wildfires. If wildfire risk appears to be increasing for any reason, the County will consider trying to obtain more information about fuel loads and interface areas, but at this point, this is not a high priority.

Wildfire can cause damage or destruction to residential and commercial structures as well as infrastructure and lands (like parks) and crops. If in its path, utility lines can also be damaged or destroyed and roads can be blocked making it difficult for motorists, residents and emergency personnel to get in or out of a particular area. Wildfires are also taxing on the jurisdiction from a staff and resource perspective. Staff must be trained and prepared to put out the fire and some fires require more resources to put out than the jurisdiction has to handle it.

5.19.7 Overall Vulnerability

While most of Chambers County residents live in an area where there is low wildfire threat, those residents who live in the high wildfire threat area, as defined above, are most vulnerable. In reviewing the map above, the most vulnerable residents, residential and commercial properties, and infrastructure (schools, critical facilities, roads and bridges) are located in the southern part of Chambers County. Chambers County has had only one death and no injuries due to wildfire as reported by the NCDC database. Chambers County has had no reported property damages. However, It has been determined that the planning area, based on jurisdictional authority, and owned facilities will not be negatively impacted from wildland fires. For this reason, wildland fires have been eliminated from further consideration and there are no mitigation action items associated with wildland fires.

5.20 WINTER STORM

5.20.1 Hazard Description

Winter storms bring various forms of precipitation that occur only at cold temperatures. These kinds of precipitation include snow, sleet, or a rainstorm where ground temperatures are cold enough to allow icy conditions. These cold weather storms can also take the form of freezing rain or a wintry mix. Winter storms in Texas, although not as numerous or severe as in the northern states, do occur often enough and with sufficient severity to be a threat to people and property. Generally, the winter storm season in Texas runs from late November to mid-March, although severe winter weather has occurred as early as October and as late as May in some areas. On average, central Texas is affected by one to two winter storms each year. See Appendix A for a more detailed description of the winter storm hazard.

5.20.2 Geographic Location

In TBCD, where the climate is subtropical, winter storms of such severity that property damage results are extremely rare. The winter storm hazard affects the entire planning area. The Texas Department of Transportation has posted signage on a number of bridges to warn drivers that icy conditions may occur. Within Trinity Bay Conservation District, winter storm risks to people and property cannot be distinguished by area; the hazard is reasonably predicted to have uniform probability of occurrence across the entire planning area. All people and assets are considered to have the same degree of exposure. The winter storm hazard affects all residential and commercial building types about equally within the planning area.

5.20.3 Previous Occurrences

The NCDC data indicated that between 1996 and 2012, there were sixteen winter storm events that affected the planning area as a whole or in-part (Table 5-26).

Table 5-26 - Winter Storm Events in the planning area, 1950 – 2012 (Source: NOAA/NCDC)

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	REMARKS
02/01/96	0	0	$0	An ice storm over a large part of west central Texas caused extremely slick roads and numerous accidents. Regional airports were closed during the day on the second. The arctic artic air that caused the freezing rain also brought wind chill temperatures to ten below zero.
11/07/00	0	0	$10,000	A winter storm dumped heavy amounts of snow across the central and western sections of West Central Texas during the late night hours of the 7th and morning hours of the 8th. Amounts of 4 to 6 inches were common west of an Eldorado to San Angelo to Abilene to Haskell line, with higher amounts across Nolan and Fisher counties. A report of 10 inches was received just southeast of Sweetwater, with 7 inches reported in Sweetwater and 8 inches in Sylvester. Since many trees still had all of their leaves, the heavy snowfall caused many branches to break. The heavy snow and falling tree branches caused power lines to snap, with about ten thousand customers suffering some disruption of electricity during the storm.
12/25/00	0	0	$0	A slow moving upper level storm system produced an ice storm across West Central Texas, greatly hampering post Christmas holiday travel. The northern and western counties saw the most accumulations, with areas northwest of a Sonora to Brady to Brownwood line picking up accumulations of freezing rain and sleet totaling at least a quarter inch. Scattered thunderstorms produced pockets of much

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	REMARKS
				heavier accumulations, with up to 2 inches reported across parts of Sterling and Coleman counties. Numerous accidents were reported as area roadways quickly became hazardous. Unfortunately, one fatality was reported in Nolan County in a traffic accident on an icy Interstate 20.
11/28/01	0	0	$0	An intense winter storm produced widespread 4 to 6 inch snow totals, with localized 10 to 12 inch readings, across the central and western sections of West Central Texas during the morning hours of the 28th. The snow fell mainly along and northwest of an Ozona to San Angelo to Coleman line. Snow packed roads made for slick travel conditions, with several hundred accidents reported and 3 fatalities. With the hazardous travel conditions, many businesses and schools closed for the day.
01/01/02	0	0	$0	A winter storm produced snow accumulation across parts of the Concho Valley and Heartland during the morning hours of the 1st. The heaviest snow fell along a band from San Angelo to Coleman, where reports of 3 to 4 inches were received. Most other areas saw totals of only 1 to 2 inches. With travel already slowed by the holiday and with schools not in session, disruption to the area was light. Only a few minor traffic accidents were noted, with no injuries reported.
12/22/04	0	0	$0	An area of snow developed generally north of a line from Mertzon to San Angelo to Brownwood. Snowfall amounts generally ranged between 1 and 3 inches with isolated amounts up to 4 inches in northern Coleman County. Some areas still had snow on the ground Christmas morning.
11/30/06	0	0	$0	EPISODE NARRATIVE: A potent upper level storm system moved across West Central Texas behind a strong Arctic airmass. These systems produced some wintry precipitation across all of the Big Country, portions of the Concho Valley and the Heartland counties. This was the first event of the season that affected the opening of several school districts and other planned community activities. The Abilene

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	REMARKS
				School District closed schools for the day. Only a few accidents were reported. A mixture of precipitation types occurred. The first type was light freezing rain, that quickly transitioned to sleet and snow as thunderstorms developed. The Abilene airport reported thundersnow for a time during the event. While this event fell just below warning criteria, this event will be counted as a winter storm for the following reasons: it was the first of the season that developed during an unseasonably warm fall, and it significantly impacted commerce. The northwest Big Country did meet the local warning criteria with four inches of snow across Nolan, Fisher, Jones and Haskell counties. Elsewhere, amounts of snow were about one inch or less with some light freezing rain and sleet. In addition, warm temperatures the day before kept the ground temperatures above freezing.
01/13/07	0	0	$1,000	EPISODE NARRATIVE: An arctic cold front moved through West Central Texas on Friday the 12th. Light freezing rain and drizzle developed behind the front as temperatures quickly dropped to below freezing. The freezing rain event gradually moved to the south and overspread all of West Central Texas by Sunday the 14th. Ice accumulations of up to two inches were reported along and north of I20 with one quarter to one half inch reported between Highway 87 and I20 across the Heartland and Northern Concho Valley. Around one quarter of an inch was reported between the I10 corridor and Highway 87. A few power outages were reported across the western Big Country. Numerous traffic accidents were reported across the area. As the ice storm gradually started to wind down Sunday evening, the weight of the ice caused an Abilene television transmitter tower to collapse. This tower collapse also destroyed a NWS weather radio anntena that was mounted on this tower.
01/16/07	0	0	$0	EPISODE NARRATIVE: Right on the heels of the Ice Storm that affected the region a few days before, another surge of arctic air moved into West Central

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	REMARKS
				Texas on Monday the 15th. With the active sub-tropical jet overhead, and disturbances moving through the jet, snow began to fall Tuesday morning Janurary 16th across the Northern Edwards Plateau and along the I10 corridor. The snow spread north and east into the Concho Valley including San Angelo. The snow continued to spread northeast across the Northwest Hill Country and into Coleman and Brownwood by Tuesday afternoon. The snow eventually spread across the I20 corridor across the southern Big Country early Wednesday morning. The Snow began to taper off early Wednesday morning across the area from northwest to southeast. The heaviest snowfall amounts were noted along and south of Interstate 10 where 4 to 8 inches of snow were reported. Further north, snowfall amounts ranged from a trace to an inch along Interstate 20. One to three inches of snow were measured between the I20 and the I10 corridors. This heavy snow closed Interstate 10 for two days between Junction and Ozona. Further north, many roads were ice and snow covered and many school districts either delayed or closed schools on the Wednesday the 17th. Ozona Emergency Management opened a shelter at the Ozona Convention Center for stranded motorists. The ice and snow also caused a few power outages across Sweetwater.
04/07/07	0	0	$3,000	EPISODE NARRATIVE: A significant winter weather event with unseasonably cold temperatures affected West Central Texas on Easter Weekend. Winter weather events seldom occur in this region during April. An unseasonably cold airmass developed across the northern Plains, Midwest and Great Lakes Regions on April 5th and 6th. A strong high pressure system dropped south from Canada, and pushed this cold air southward across the Plains states and into Texas. Temperatures dropped into the 30 to 35 degree range across West Central Texas, by the early morning of Saturday, April 7th. The temperatures held steady or slowly dropped a few degrees during the day

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	REMARKS
				Saturday, and remained in the upper 20s to lower 30s Saturday night. To make matters worse, an upper level disturbance approached Texas from southern New Mexico, and interacted with the cold and moist air in the region. This brought a few rounds of mixed winter precipitation to the area. The precipitation was mostly in the form of snow across the Big Country. Farther to the south, a mix of sleet, snow and some freezing rain fell. The precipitation was heavy at times, especially when it was accompanied by scattered thunderstorms which moved east across the area. Thunder sleet was reported at San Angelo on Saturday and was accompanied by a heavy burst of sleet and snow. There was a widespread area of sleet and snow that moved across West Central Texas. The Following is a list of sleet and snowfall reports across the area on April 7th: SNOW REPORTS Glen Cove (Coleman County) 6 Inches Brownwood (Brown County) 4 Inches Silver Valley (Coleman County) 4 Inches Brownwood 3SE (Brown County) 3 Inches Anson (Jones County) 3 Inches Albany (Shackelford County) 3 Inches Ballinger (Runnels County) 2 Inches Putnam (Callahan County) 2 Inches Baird (Callahan County) 2 Inches Haskell (Haskell County) 2 Inches Lake Abilene (Taylor County) 2 Inches Rotan (Fisher County) 2 Inches Lohn (McCulloch County) 2 Inches SNOW AND SLEET REPORTS Brady (McCulloch County) 2 Inches (Lots of sleet) Paint Rock (Concho County) 2 Inches (Lots of sleet) Water Valley (Tom Green County) 2 Inches (Much of it sleet) Mertzon (Irion County) 2 Inches (Half sleet) Water Valley (Coke County) 1 Inches (Mostly sleet) San AngeloNWS (Tom Green County) 1 Inches (Mostly sleet) Concho Park (Concho County) 1 Inches (Lots of sleet) London (Kimble County) 1 Inches (Sleet) Colorado Bend (San Saba County) 1 Inches (Sleet) Sonora (Sutton County) 1/2 Inches (Sleet) Northern Crockett County 1/2-1 Inches (Sleet) Despite the warm ground, the precipitation fell heavily enough to cause significant accumulations,

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	REMARKS
				especially on elevated surfaces such as bridges and overpasses. This created Easter weekend travel problems with several weather-related accidents reported. About 50 traffic accidents were reported throughout the area Saturday and into Saturday night. There were even a few road closures near Menard, and the Houston Harte Expressway in San Angelo was closed for a time Saturday evening through Sunday morning. The icy conditions kept road crews busy throughout Saturday into early Sunday. In addition, many Easter-related activities were either moved indoors or had to be postponed, due to the weather. The impacts of the cold weather and wintry precipitation will be felt for sometime to come. The area farmers are still trying to determine how much their crops, such as Pecans and Wheat, were damaged by the prolonged freezing temperatures. Several sheep were lost to the cold and damp conditions as well. The record books for April had a workout over the Easter Weekend. The following is a Record Event Report about the unseasonably cold temperatures: For Abilene, the high temperature of 36 degrees on the 7th was a record low maximum temperature for that d
01/23/08	0	0	$0	EVENT NARRATIVE: The freezing drizzle produced an icy glaze on the Houston Harte Expressway that resulted in about 16 accidents. EPISODE NARRATIVE: Light freezing drizzle developed during the early morning hours across a large part of West Central Texas mainly along and north of a line from Mertzon to Eldorado to Menard and Coleman. Most of the accidents occurred in San Angelo during rush hour traffic.
01/27/09	0	0	$0	EPISODE NARRATIVE: An arctic airmass moved into West Central Texas on Monday. The combination of warm moist air overunning the low level cold air and a strong upper level disturbance produced mainly freezing rain and sleet across much of West Central Texas Tuesday and Tuesday night. The ice caused several accidents across the region on Tuesday and

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	REMARKS
				Tuesday night and many schools across the region had late starts on Wednesday. EVENT NARRATIVE: Law Enforcement reported 1/2 to 3/4 inch of ice or more on the divide and on roads across the county. The roads were icy.
04/07/09	0	0	$0	EPISODE NARRATIVE: A late freeze occured across West Central Texas during the morning hours. The coldest temperatures were located south of a Mertzon to Eden line and west of an Eden to Junction line. Readings were 20 to 25 degrees across this area. EVENT NARRATIVE:
01/09/10	0	0	$0	EPISODE NARRATIVE: An arctic high pressure system resulted in bitter cold temperatures across West Central Texas. EVENT NARRATIVE: The low temperatures across Brown County ranged from 4 to 8 degrees.
01/09/12	0	0	$0	EPISODE NARRATIVE: A slow moving, strong upper level low pressure system coupled with near freezing temperatures at the surface brought heavy snow to portions of West Central Texas. The heaviest snow fell in the higher elevations of the Concho Valley and the western Big Country while lighter snow fell in the Northern Edwards Plateau. EVENT NARRATIVE: A law enforcement official estimated about five inches of snow along U.S. Highway 163, approximately 2 miles north of Barnhart. National Weather Service Cooperative Observers both reported an inch of snow at Mertzon and 7 miles northwest of Tankersley.
02/12/12	0	0	$0	EPISODE NARRATIVE: Upper level disturbances moving across West Central Texas and freezing surface temperatures brought areas of light snow to the region. Approximately 1 to 2 inches of snow fell across most of the area except east of a line from Brownwood to Brady to Mason. EVENT NARRATIVE: An inch of snow was measured 12 miles north northwest of Mertzon.
Total - 16	0	0	$14,000	

*While the NCDC reports the event, it is unknown the effects on the TBCD jurisdictional area.

5.20.4 Probability of Future Occurrence

Based on past winter storm events, it would be possible for TBCD to experience an occasional snow or ice storm. With a total of sixteen winter storm events between 1996 and 2012, the County experiences a significant winter storm on average approximately once every year. With one event every year, there is a 100% annual probability of a future winter storm event occurring in the planning area making the probability **high.**

5.20.5 Magnitude/Severity/Extent

With the County's generally moderate climate, any frozen precipitation falling in Chambers County poses a potentially hazardous situation due to ice, wind, and cold temperature. During these cold periods, the weather is often volatile, changing from warm and sunny to freezing in just a few hours. Many homes generally have inadequate cold-weather pipe protection, so are at a greater risk of freezing and bursting water pipes when the outdoor temperature drops to 20°F. In Chambers County, where the climate is considered subtropical, winter storms of such severity that property damage results are rare.

Heavy snow is a somewhat rare event for the central part of eastern Texas, but freezing rain and sleet can impact the County more frequently and more severely. Accumulations of up to a foot or more of snow are possible in the planning area, though this is very rare. An occasional ice storm is also possible, with accumulations up to a ¼ inch of ice coating all surfaces such as road and trees. An extreme cold event with temperatures in the single digits and wind chills below zero are possible in Chambers County.

5.20.6 Impact on Life and Property

Chambers County has sustained damage from winter storm events. While infrequent, such storms have affected the Entire County, restricting travel, and downing trees, interrupting electrical power, and causing water main breakage. Although the NCDC database has not categorized any previous storms in Chambers County as blizzards, this is perhaps the most severe type of winter storm, characterized by low temperatures, strong winds, and heavy blowing snow.

5.20.7 Overall Vulnerability

Winter storms have and can cause roofs to collapse from the weight of the snow as well as take down utility lines and cause roads to be impassable until the snow is removed, causing difficulties for motorists and emergency personnel. If the snow cannot be removed in a timely manner, disruption to local businesses from inability for customers and employees to get to the businesses as well as vendors and inventory. In addition, snow removal and materials are costly to the jurisdiction and can result in prioritizing snow removal or finding funds from other sources in the jurisdiction's budget to cover the costs. However, TBCD does not have jurisdictional authority over winter storm hazards, therefore the hazard has been eliminated from further analysis or mitigation actions.

5.21 FLOOD

5.21.1 Description of the Flood Hazard

A flood is defined as the inundation of land by the rise and overflow of a body of water. Floods most commonly occur as a result of heavy rainfall causing a river system or stream to exceed its normal carry capacity. Flood events can also occur due to hurricane storm surge and from a hurricane or tropical storm. Floods can also occur due to dam failure and cause subsidence. Flooding is one of the most pervasive natural hazard threats in Texas.

There are two types of flooding that can impact Chambers County: riverine and flash flooding. Riverine flooding is s a natural occurrence where a waterway exceeds its bank full capacity and inundates the floodplain. Riverine flooding is affected by the intensity and distribution of the rainfall, soil moisture, seasonal variation in vegetation, and water-resistance of the surface area due to impervious surfaces (e.g. pavement). Flash flooding is a localized flood that results from a short duration of intense rainfall across a limited geographic area. During these events, storm water systems can be overwhelmed and cause flooding of the surrounding area.

5.21.2 Geographic Location

Flooding impacts the entire planning area. According to the Chambers County Flood Insurance Study (FIS) the principal flooding sources are the Neches River, Pine Island Bayou and its tributaries, Walker Branch and Walker Branch Taylor Bayou and its tributaries, Rhodair Gully, Mayhaw Bayou; Hillebrandt Bayou (a major tributary of Taylor Bayou) with its tributaries, Willow Marsh Bayou, Bayou Din and its tributaries, Bayou Din Tributary, Kidd Gully and Cotton Creek. Sabine Lake receives drainage from the basin of the Sabine River as well as the Neches River. (See floodplain maps in Section 6).

Flooding in Chambers County results from stream overflow (caused by rainfall runoff, ponding and sheet flow), and from tidal surges and associated wave action (caused by hurricanes and tropical storms) transmitted through the streams. High tides can further intensify the stream overflow caused by rainfall runoff. Lastly, because of the flatness of the terrain, many inland areas are characterized by shallow flooding during heavy rain events.

5.21.3 Previous Occurrences

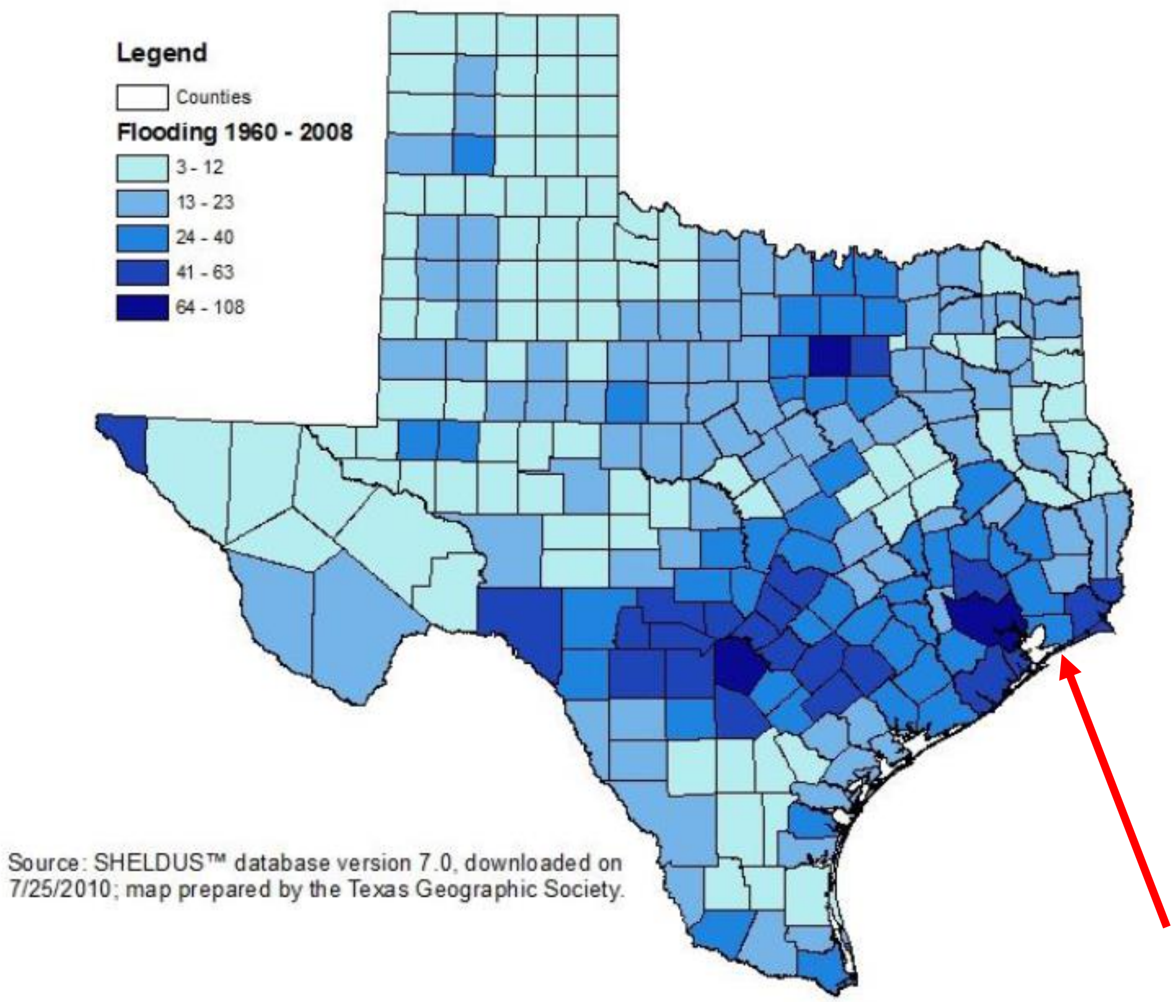
Floods have been and continue to be the most frequent, destructive, and costly natural hazard facing the State of Texas. Ninety percent of the State's damage reported for major disasters is associated with floods. Figures maintained by the NCDC and the Centers for Disease Control indicates that Texas leads the country with more flood-related deaths than any other state (Table 4-1). Deaths due to floods/flash floods accounted for 38% of all weather-related deaths statewide and .08% in Chambers County.

The Flood Insurance Study shows that damaging floods occurred in 1886, 1915, 1943, 1949, 1957, 1961, 1963, 1979 and 1979. Many of these dates are associated with Hurricane events.

However, these are not the only flood events that have occurred in Chambers County.

Figure 5-19 below is a map from the 2007 State of Texas Hazard Mitigation Plan that displays both previous flood occurrences and location of floods, by county, for the State of Texas between 1961 and 2003. The map is classified into five value ranges using the natural breaks (Jenks) method. The State Plan indicates that the highest class (64-108 floods) contains three counties, including Tarrant, Harris, and Bexar. These three counties are considered the highest at risk for experiencing a flood event again.

Figure 5-19 Flood Occurrences in Texas 1961-2003(Source: State of Texas Hazard Mitigation Plan)



The red arrow in the figure above points to Chambers County. Records indicate that the streams and bayous draining in TBCD have flooded throughout the area's history. Most recently, since 1994 TBCD has been impacted by 34 flood events. These flood events resulted in over $1.1 million in flood insurance payments.

The NCDC indicates that Chambers County has experienced 34 flood events between 1994 and 2013. Of this total, six flood events have resulted in property damage in excess of $50,000. As noted in the Texas State HMP the data includes every loss causing and/or deadly event between 1960 through 1975 and from 1995 onward. For the period 1976 through 1994 the data includes only those events that caused at least one fatality or more than $50,000 in property or crop damage.. Property damages for these events totaled just over $1.1 million. The NCDC reported one death and no injuries from the 34 flood events. The flood events with are summarized below.

5.21.4 Probability of Future Occurrence

Based on past and recent history, certain parts of TBCD clearly have a **high** probability of flooding repeatedly in the future. With a total of six significant floods between 1994 and 2013, Trinity Bay Conservation District experiences a significant flood event on average slightly less than once every year. The six events have occurred over a period of ten years which calculates one event every 3.16 years or to a 31.5% annual probability of future significant flood occurrences and a 100% annual probability of future flood occurrence, making the probability of future occurrence high.

Table 5-28 Flood Events in Chambers County, 1950 - 2011(Source: NOAA/NCDC)

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	CROP DAMAGE	REMARKS
10/17/94	1	0	$500,000	$50,000	
06/30/95	0	0	$10,000	$0	Four inches of rain fell causing street flooding in the county.
07/30/95	0	0	$300,000	$0	Continuous rainfall with some areas receiving up to 12 inches. Widespread street flooding reported by sheriff.
12/17/95	0	0	$10,000	$0	Widespread street flooding.
08/29/96	0	0	$0	$0	On August 29th, moderate flooding occurred in the Concho River basin along Spring Creek, Dove Creek, Middle Concho River and the South Concho River. Flooding of a few houses occurred at the headwaters

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	CROP DAMAGE	REMARKS
					of Spring Creek in the town of Mertzon, and one house was flooded along Dove Creek at the site of the river gage near the town of Knickerbocker. Foster Park, located at the river gage site on Spring Creek near Tankersley, was also flooded. The river rose to just a foot below the park pavilion. At Dove Creek at Knickerbocker, the crest was 20.1 feet (bankfull stage is 14 feet). The Middle Concho River above Tankersley reached a crest of 24.3 feet (flood stage is 18 feet) and flooded a few roads. The flooding quickly subsided on the evening of August 29th as water rushed into the Twin Buttes Reservoir in southwest San Angelo. The amount of water in the reservoir rose from near 22,000 acre feet to 60,280 acre feet as the height rose 18 feet. This water was a welcomed sight to residents of the Concho Valley, as the drought this year had left lakes and reservoirs very low.
09/27/96	0	0	$50,000	$0	Flooding problems on HWY 124 and Winnie, and Mont Belvieu on HWY 146. 12 homes flooded in Winnie. 5 homes flooded in Anahuac.
10/05/96	0	0	$0	$0	Strong gradient winds produced by a combination of high pressure across the eastern U.S. and Tropical Storm Josephine caused coastal flooding along the Upper Texas Coast. Tides ranged from 2 to 5 feet above astronomical predicted levels and caused substantial beach errosion,

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	CROP DAMAGE	REMARKS
					damaged beach houses and low lying coastal roads. 7 homes were destroyed and 75-80 homes damaged.
01/27/97	0	0	$5,000	$0	Widespread street flooding.
02/20/97	0	0	$50,000	$0	Widespread showers and thunderstorms developed in the early morning hours of the 20th as a potent upper level storm system approached the Concho Valley, then spread over the rest of west central Texas during the afternoon. Rainfall totals of three to five inches occurred in much of the area. River flooding occurred on Dove Creek at Knickerbocker, which reached a crest of 19.06 feet at 645 am on the 20th. Flood stage is 14 feet.
04/25/97	0	0	$5,000	$0	Street flooding throughout the county.
01/06/98	0	0	$5,000	$0	High water on HWY 146 & I-10.
01/06/98	0	0	$5,000	$0	HWY 146 & I-10 closed due to high water. FM 565 flooded.
01/13/98	0	0	$1,000	$0	High water on FM 563.
01/21/98	0	0	$5,000	$0	Street flooding across the county. HWY 146 & I-10 flooded.
01/22/98	0	0	$0	$0	Runoff from earlier heavy rains continued producing minor street flooding across the area.
09/14/98	0	0	$5,000	$0	High water on HWY 124 near Winnie and on Bayshore Rd. in Oak Island.

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	CROP DAMAGE	REMARKS
10/18/98	0	0	$0	$0	Flooding continues
10/18/98	0	0	$5,000	$0	I-10 at HWY 565 flooded.
05/20/00	0	0	$50,000	$0	Flooding on SH 124 with street flooding in Anahuac. Rainfall totals up to 8 inches in western part of county. A stationary front combined with deep tropical moisture to produce widespread slow moving thunderstorms over Houston, Galveston, and surrounding areas. Northeast Harris and western Liberty Counties were the hardest hit by a large supercell thunderstorm which remained nearly stationary for several hours. The storm produced over 18 inches of rainfall in Liberty in only 5 hours with widespread flash flooding from near Intercontinental Airport eastward to the Liberty/Dayton areas. Over 300 homes and businesses were damaged in western Liberty County with 60 to 80 people rescued from flood waters. Strong winds resulted from some of the storms, downing trees and power lines, especially near Liberty and Dayton. A storm survey revealed an F0 tornado south of Dayton.
06/08/01	0	0	$0	$0	Flooding from the remnants of T.S. Allison. Damage included in previous report.
06/09/01	0	0	$0	$0	Flooding from the remnants of T.S. Allison. Damage included in previous report.

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	CROP DAMAGE	REMARKS
10/22/02	0	0	$8,000	$0	Heavy rains in the upper end of Dove Creek caused rises that flowed over highway 915. This caused the roadway to wash out. A stalled frontal boundary over south Texas in combination with a upper level storm system moving out of the Southwest Portion of the United States resulted in heavy rains and flooding for the second time this month across the Edwards Plateau and the Northwest Hill Country. Rainfall amounts during the week of the 21st through the 25th were between 2 and 6 inches over much of the area. However, Crockett and Sutton Counties bore the brunt of the flooding with anywhere from 4 to 17 inches of rain.
11/05/02	0	0	$25,000	$0	Numerous roads closed due to high water on extremely saturated grounds.
12/04/02	0	0	$9,000	$0	Flooding around Highway 124 near Winnie; numerous roads underwater and impassable.
03/13/03	0	0	$5,000	$0	Street Flooding in and around Mont Belvieu.
08/31/03	0	0	$3,000	$0	Roads in Smith Point flooded.
08/31/03	0	0	$3,000	$0	Portions of Highway 124 flooded.
09/01/03	0	0	$3,000	$0	High water across Hwy 124 between Winnie and High Island.
06/23/04	0	0	$25,000	$0	Flooding in and around Mont Belvieu.

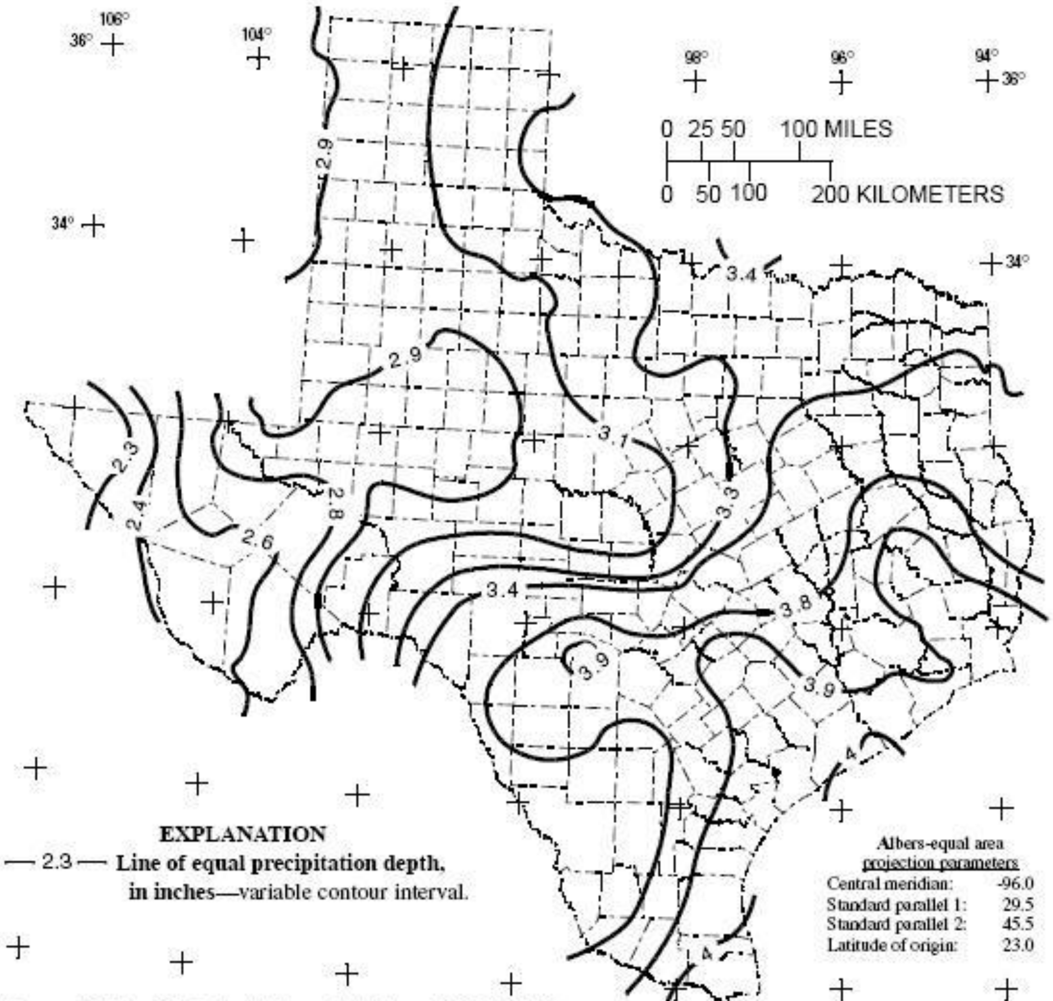
DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	CROP DAMAGE	REMARKS
06/25/04	0	0	$10,000	$0	Flooding at intersection of Interstate 10 and Highway 124 in Winnie.
05/29/06	0	0	$50,000	$0	Flooding in and around the city with at least twenty homes receiving water damage.
07/06/07	0	0	$40,000	$0	EVENT NARRATIVE: Water entered a Post Office building. EPISODE NARRATIVE: An upper level low, combined with abundant moisture, produced numerous showers and thunderstorms throughout the coastal communities in and around Galveston, Texas.
08/05/08	0	0	$5,000	$0	EVENT NARRATIVE: Interstate 10 was closed near SH 61 due to heavy rains from Tropical Storm Edouard. EPISODE NARRATIVE: Tropical Storm Edouard moved ashore along the upper Texas coast between High Island and Sabine Pass in the McFaddin National Wildlife Refuge and produced minimal damage totalling $100,000. Damage from Edouard included minor storm tide flooding along portions of the Bolivar Peninsula ($95,000) and brief flash flooding along portions of Interstate 10 in Chambers County ($5,000). 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. Interstate 10

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	CROP DAMAGE	REMARKS
					was closed in central Chambers County near State Highway 61 due to Edouard's heavy rainfall estimated to be between 3 and 5 inches.
04/24/09	0	0	$1,000	$0	EPISODE NARRATIVE: A series of thunderstorms produced heavy rainfall and strong winds across portions of Harris, Galveston, and Chambers counties leaving motorists stranded along several flooded area highways. Additional severe thunderstorms produced hail and flash flooding across the northern counties of Southeast Texas. EVENT NARRATIVE: Heavy rainfall due to slow moving thunderstorms produced brief road closures along Interstate 10, with four feet of water reported over the road at the intersection of Highway 61 and the interstate.
	1	0	$1,193,000	$50,000	

*While the NCDC reports the event in Chambers County, the effects on the TBCD jurisdictional area are unknown.

5.21.5 Magnitude/Severity/Extent

Flood severity is measured in various ways, including frequency, depth, velocity, duration and contamination, among others. In Chambers County, characterizing the severity of the flood hazard depends on what part of the County is being considered, but generally speaking the issues relate to how often floods occur. Historically, floods are and continue to be the most frequent, destructive, and costly natural hazard facing the State of Texas. One of the more common methods for determining flood severity is how often an area floods. In Chambers County the NCDC indicates there have been 34 floods between 1994 and 2009, a period of 15 years.



Base modified from U.S. Geological Survey digital data at 1:250,000 (2003)

Figure 54. Depth of precipitation for 50-year storm for 1-hour duration in Texas.

Based on the above USGS map, the planning area can expect, on average, an increase of 4.0” of water on the ground in a 50 year event.

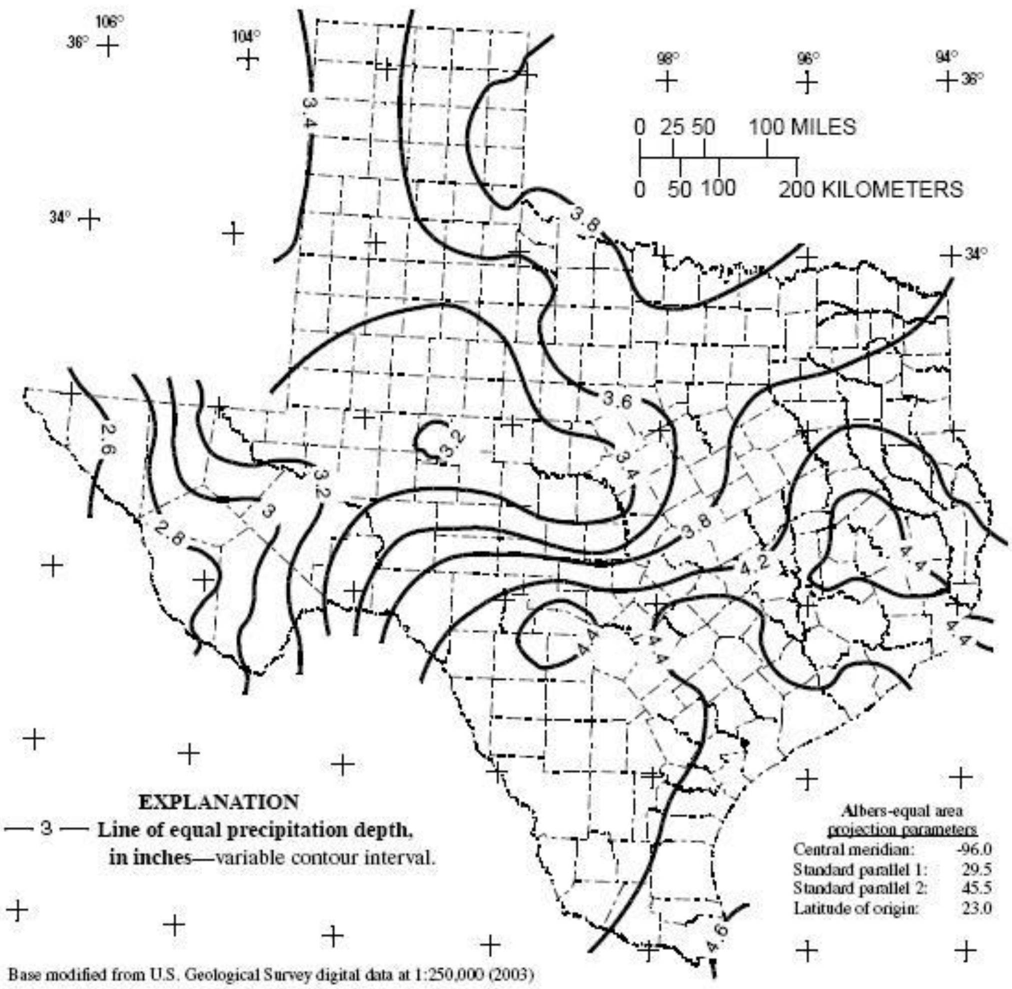


Figure 66. Depth of precipitation for 100-year storm for 1-hour duration in Texas.

Based on the above USGS map, the planning area can expect, on average, an increase of 4.4" of water on the ground in a 100 year event.

Flash flooding is the most persistent flood related problem currently facing Chambers County, and occurs when rainfall associated with a thunderstorm, or multiple training thunderstorms, causes low-lying areas to become saturated with water so quickly that absorption is impeded and runoff either collects quickly or flows rapidly downhill. Intense local thunderstorms in the summer can also cause flooding problems. These thunderstorms may occur at any time during the year but are more prevalent in the spring and summer months.

5.21.6 Impact

Floods can have a tremendous impact on life and property in the planning area. Severe flood events can result in injury and possibly death (particularly flash floods). Floods are also disruptive to daily life, potentially displacing people and families for days, weeks or months in some cases. Floods can also cause significant damage to property, including both commercial and residential structures, including contents.

Flooding in Chambers County can cause damage to residential and commercial structures, utilities and even critical facilities if not built to withstand a flood. In addition, floods can wash out roads making it difficult for emergency vehicles to reach residents who are trapped by the washed out roads. Flooding can also cause debris build up as floods move objects and then once the water recedes, the debris is left to be removed. Chambers County had one death reported by the NCDC database, there have been approximately $1.2 million in damages to some structures and the County has faced some disruption of service due to power outages.

5.21.7 Overall Vulnerability

The most vulnerable population, property and infrastructure from flooding in Chambers County are residents, residential and commercial structures, and infrastructure, like roads, bridges, critical facilities and schools located in the floodplain. From an economic vulnerability perspective, those businesses located in the floodplain are also at risk for losing business due to temporary closure of roads and their place of business if the building was flooded. See Section 6, for a more detailed risk assessment for floods.

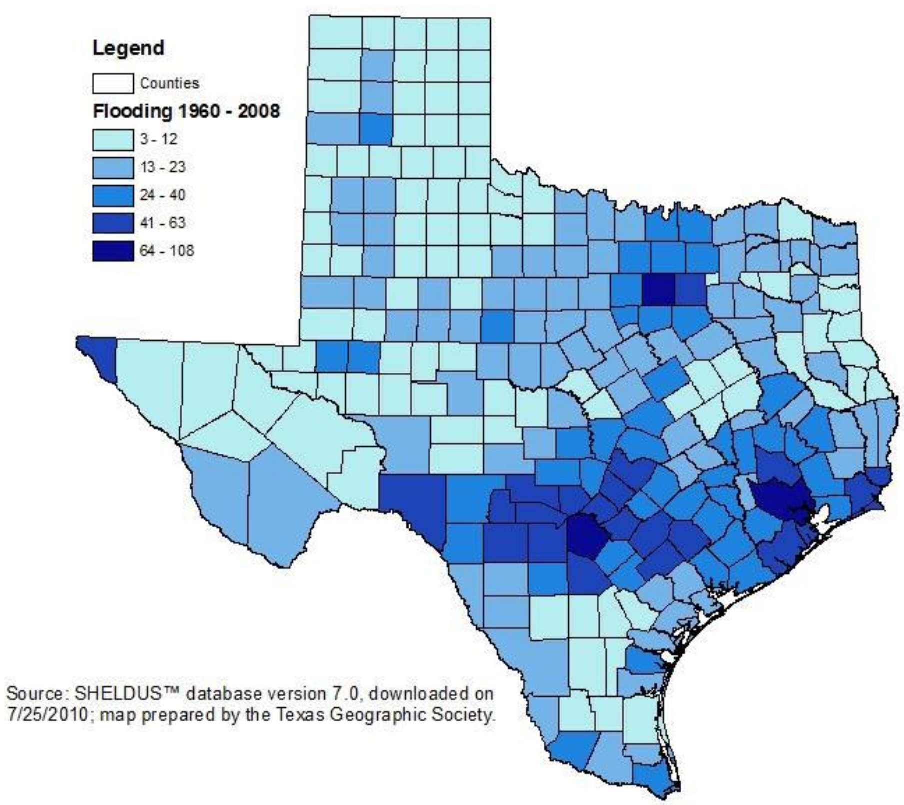
6 SECTION 6 – RISK ASSESSMENT OF FLOOD AND WIND HAZARD

6.1 FLOOD HAZARDS: OVERVIEW

Floods have been and continue to be the most frequent, destructive, and costly natural hazard facing the State of Texas. Ninety percent of the State's damage reported for major disasters is associated with floods. Figures maintained by the NCDC and the Centers for Disease Control indicates that Texas leads the country with more flood-related deaths than any other state. Deaths due to floods, hurricanes, tropical storms and flash floods accounted for 21.8% of all weather-related deaths statewide and .08% in Chambers County.

Figure 6-1 below is a map from the State of Texas Hazard Mitigation Plan that displays both previous flood occurrences and location of floods, by county, for the State of Texas between 1961 and 2008. The map is classified into four value ranges using the natural breaks (Jenks) method. The State Plan indicates that the planning area, Chambers County, falls under the third highest class (24 - 40 floods).

Figure 6-1 - Flood Occurrences in Texas 1961-2008 (Source: State of Texas 2010 Hazard Mitigation Plan)



The NCDC indicates that Chambers County has experienced 34 flood events between 1994 and 2013. Of this total, 6 flood events have resulted in property damage in excess of $50,000 per event. Property damages for these events totaled over $1 million. The six flood events with damages greater than $50,000 are summarized below in Table 6-1.

Table 6-1 - Flood Events in the planning area resulting in Property Damage in Excess of $50,000, 1950 – 2010 (Source: NOAA/NCDC)

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	CROP DAMAGE	REMARKS
10/17/94	1	0	$500,000	$50,000	
07/30/95	0	0	$300,000	$0	Continuous rainfall with some areas receiving up to 12 inches. Widespread street flooding reported by sheriff.
09/27/96	0	0	$50,000	$0	Flooding problems on HWY 124 and Winnie, and Mont Belvieu on HWY 146. 12 homes flooded in Winnie. 5 homes flooded in Anahuac.
02/20/97	0	0	$50,000	$0	Widespread showers and thunderstorms developed in the early morning hours of the 20th as a potent upper level storm system approached the Concho Valley, then spread over the rest of west central Texas during the afternoon. Rainfall totals of three to five inches occurred in much of the area. River flooding occurred on Dove Creek at Knickerbocker, which reached a crest of 19.06 feet at 645 am on the 20th. Flood stage is 14 feet.
05/20/00	0	0	$50,000	$0	Flooding on SH 124 with street flooding in Anahuac. Rainfall totals up to 8 inches in western part of county. A stationary front combined with deep tropical moisture to produce widespread slow moving thunderstorms over Houston, Galveston, and surrounding areas. Northeast Harris and western Liberty Counties were the hardest hit by a large super cell thunderstorm which

DATE	FATALITIES	INJURIES	PROPERTY DAMAGE	CROP DAMAGE	REMARKS
					remained nearly stationary for several hours. The storm produced over 18 inches of rainfall in Liberty in only 5 hours with widespread flash flooding from near Intercontinental Airport eastward to the Liberty/Dayton areas. Over 300 homes and businesses were damaged in western Liberty County with 60 to 80 people rescued from flood waters. Strong winds resulted from some of the storms, downing trees and power lines, especially near Liberty and Dayton. A storm survey revealed an F0 tornado south of Dayton.
05/29/06	0	0	$50,000	$0	Flooding in and around the city with at least twenty homes receiving water damage.
	1	0	$1,000,000	$50,000	

*While the NCDC reports the event in Chambers County, the effects on the TBCD jurisdictional area are unknown.

Based on past and recent history, certain parts of TBCD clearly have a high probability of flooding repeatedly in the future. With a total of 34 floods between 1994 and 2013, TBCD experiences 1.78 floods, on average, every year. With flood events happening more once a year the probability of future events is considered **high**.

6.1.1 Defining Flood Hazards

When rainfall runoff collects in rivers, creeks, bayous, and streams and exceeds the capacity of channels, floodwaters overflow onto adjacent lands. Floods result from rain events, whether short and intense, or long and gentle. In recent years, most flooding in TBCD has been associated with storms that originate as hurricanes and tropical storms that subsequently move inland. Flood hazards are categorized as follows:

Flash floods not only occur suddenly, but also involve forceful flows that can destroy buildings and bridges, uproot trees, and scour out new channels. Most flash flooding is caused by slow-moving thunderstorms, repeated thunderstorms in a local area, or heavy rains from hurricanes and tropical storms. Although flash flooding occurs often along mountain streams, it is also common in urban areas, where much of the ground is covered by impervious surfaces and drainage ways are designed for smaller flows. Flood Insurance Rate Maps typically show the 1%-annual-chance (100-year) floodplain for waterways with at least one square mile of drainage area. The flood hazard areas for waterways with less than one square mile of drainage area typically are not shown.

Riverine floods are a function of precipitation levels and water runoff volumes, and occur when water rises out of the banks of the waterway. Flooding along waterways that drain larger watersheds often can be predicted in advance, especially where it takes 24 hours or more for the flood crest (maximum depth of flooding) to pass. In Chambers County, riverine flooding is caused by large rainfall systems and thunderstorm activity associated with seasonal cold fronts. These systems can take as long as a day to pass, giving ample opportunity for large amounts of rain to fall over large areas. The Flood Insurance Rate Maps show the 1%-annual-chance floodplains.

Urban drainage flooding occurs where development has altered hydrology through changes in the ground surface and modification of natural drainage ways. Urbanization increases the magnitude and frequency of floods by increasing impervious surfaces, increasing the speed of drainage collection, reducing the carrying capacity of the land, and, occasionally, overwhelming sewer systems. Localized urban flooding is not usually shown on the Flood Insurance Rate Maps in areas with less than one square mile of contributing drainage area. Note: Additional descriptions of the flood hazard can be found in Appendix A.

The ***Flood Insurance Rate Maps*** (FIRMs) prepared by FEMA offer the best overview of flood risks. FIRMs are used to regulate new development and to control the substantial improvement and repair of substantially damaged buildings. Flood Insurance Studies (FISs) are often developed in conjunction with FIRMs. The FIS typically contains a narrative of the flood history of a community and discusses the engineering methods used to develop the FIRMs. The study also contains flood profiles for studied flooding sources and can be used to determine Base Flood Elevations for some areas.[18]

The revised FIS for Chambers County is dated 06/151983. Chamber County also has preliminary maps as part of FEMA RiskMap 6 which are currently under public review. The FIS compiles data from all previous flood information and include data collected on numerous waterways. The FIS indicate that riverine flooding results primarily from overflow of the streams and drainage ditches caused by rainfall runoff, ponding, and sheet flow. Storms occurring during the summer months are often associated with tropical storms moving inland from the Gulf of Mexico. Thunderstorms are common throughout the spring,

[18] FEMA –Flood Insurance Study definition

summer, and fall months. The frequent hurricanes and tropical storms interrupt the summer with high winds, heavy rainfall, and high storm surges. FIRM maps show flood zones:

- AE Zones along rivers and streams for which detailed engineering methods were used to determine Base Flood Elevations (BFEs). AE Zones (or A1-30 Zones) are shaded in gray.
- A Zones, which are areas inundated by the 100-year flood for which BFEs and Flood Hazard Factors (FHFs) have not been determined.
- AH Zones, which are areas inundated by types of 100-year shallow flooding where depths are between one and three feet, and for which BFEs are shown, but no FHFs are determined.
- B Zones and Shaded X Zones, which are areas of "moderate" flood hazard, typically associated with the 500-year flood (or 0.2% annual chance).
- C Zones and unshaded X Zones are areas of "minimal" flood hazard, typically considered to be "out of the floodplain." Although local drainage problems and ponding may still occur, these minor flood problems typically are not shown on the FIRM.

Figure 6-2 identifies the area with-in TBCD that are indicated to be in the SFHA (shaded light blue). The map shows these areas to be found along bayous and streams throughout the planning area. Figures 6-3 is the FIRMETTE that shows where the TBCD building is located.

Figure 6-2 – Areas of TBCD in the SFHA Map (Source: FEMA – Q-3 Data, August, 2011)

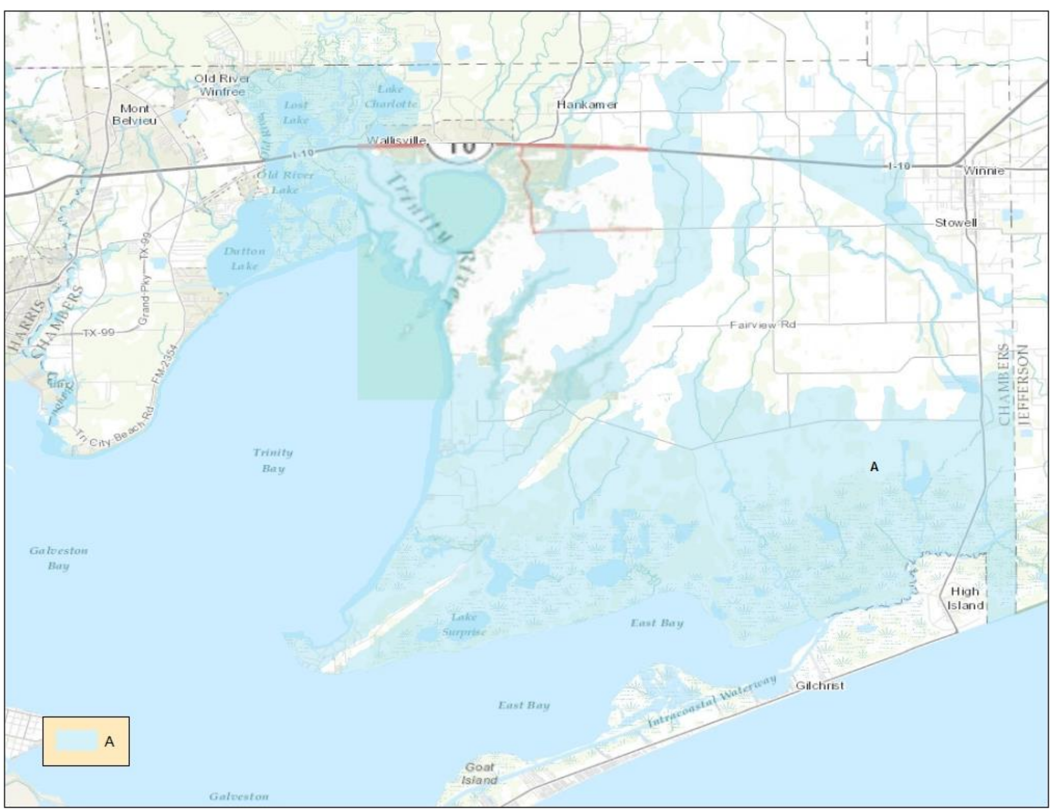
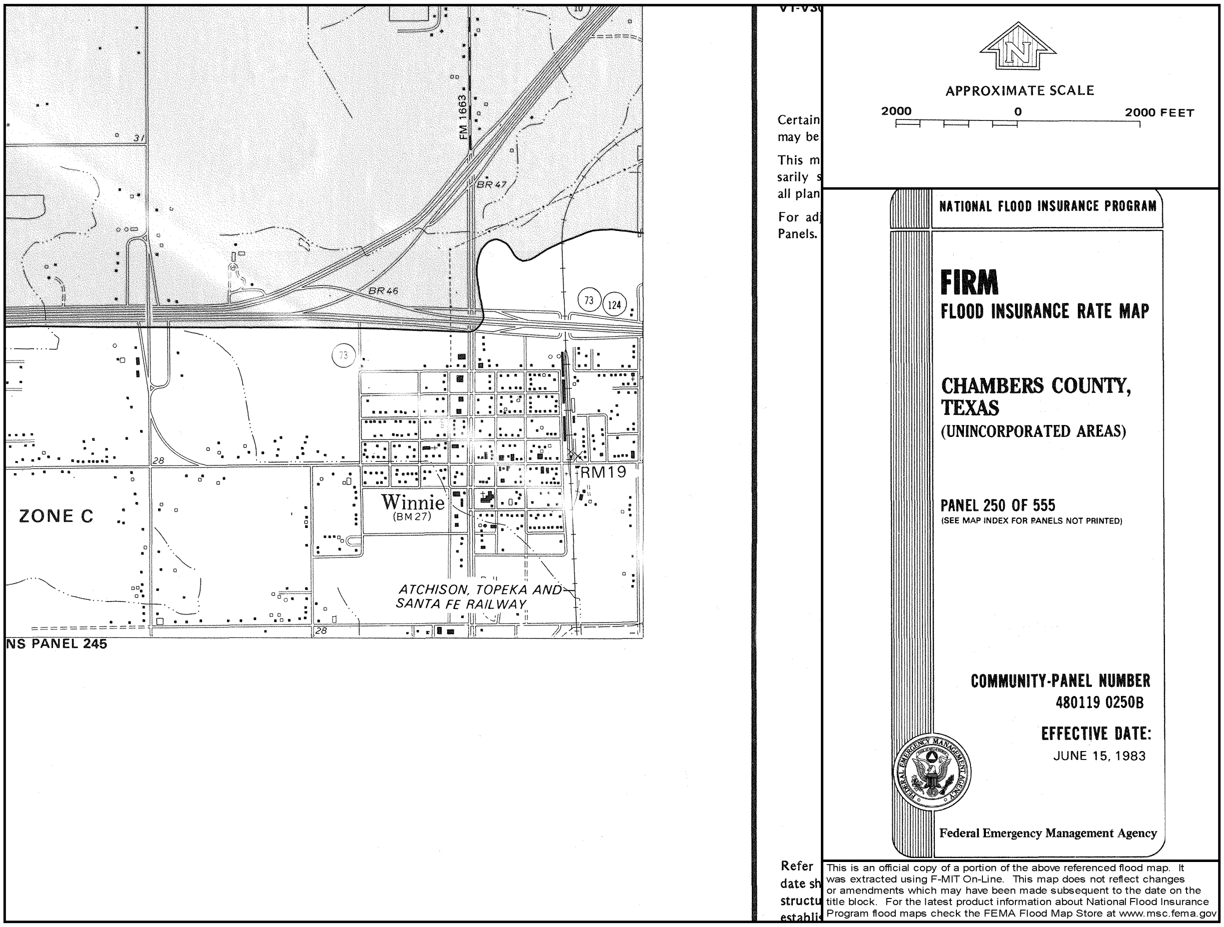


Figure 6-3 – FIRMETTE (Source: FEMA Map Service Center)



6.1.2 Storm Surge Flooding

Storm surges occur when the water level of a tidally-influenced body of water increases above the normal high tide. Storm surges occur with coastal storms caused by massive low-pressure systems with cyclonic flows that are typical of hurricanes. Storm surges are particularly damaging when they occur at the time of a high tide, combining the effects of the surge and the tide. This increases the difficulty of predicting the magnitude of a storm surge since it requires weather forecasts to be accurate to within a few hours. See Appendix A for a more detailed description of the storm surge hazard.

The storm surge hazard associated with hurricanes and other severe storms are responsible for coastal flooding and erosion along the Texas Gulf Coast. In addition to flooding coastal areas, storm surge can also reach further inland impacting lakes and rivers. Storm surge in Trinity Bay Conservation District is primarily the result of hurricanes that approach land from the Gulf of Mexico moving water inland from the Gulf of Mexico. The effects of storm surge can be felt in TBCD jurisdictional area from hurricanes that make landfall as far away as Southwest Texas, Mississippi, or Alabama.

Storm surges inundate coastal floodplains by tidal elevation rise in inland bays and ports, and backwater flooding through coastal river mouths. Severe winds associated with low-pressure systems cause increase in tide levels and water surface elevations. Storm systems also generate large waves that run up and flood coastal areas. The combined effects create storm surges that affect the beach, marsh, and low-lying floodplains. Shallow offshore depths can cause storm driven waves and tides to pile up against the shoreline and inside bays. See Table 6-2 for factors that can influence the severity of coastal storms.

Storm surge is considered the next most dangerous part of a hurricane after severe winds, and causes nine out of ten hurricane-related deaths, according to the National Weather Service. The level of surge in a particular area is mainly determined by the slope of the continental shelf. A shallow slope off the coast, will allow a greater surge to inundate coastal communities.

Table 6-2 Factors that Influence the Severity of Coastal Storms

Factor	Extent
Wind Velocity	The higher the wind velocity the greater the damage.
Storm Surge Height	The higher the storm surge the greater the damage.
Coastal Shape	Concave shoreline sections sustain more damage because the water is driven into a confined area by the advancing storm, thus increasing storm surge height and storm surge flooding.
Storm Center Velocity	Then slower the storm moves, the greater damage. The worst possible situation is a storm that stalls along a coast, through several high tides.
Nature of Coast	Damage is most severe on low-lying island barrier shorelines because they are easily over washed by wave action.
Previous Storm Damage	A coast weakened by even a minor previous storm will be subject to greater damage in a subsequent storm.

Human Activity	With increased development, property damage increases and more floating debris becomes available to knock down other structures.

The NCDC database indicates there have been no storm surge events to impact Chambers County between 1950 and 2011

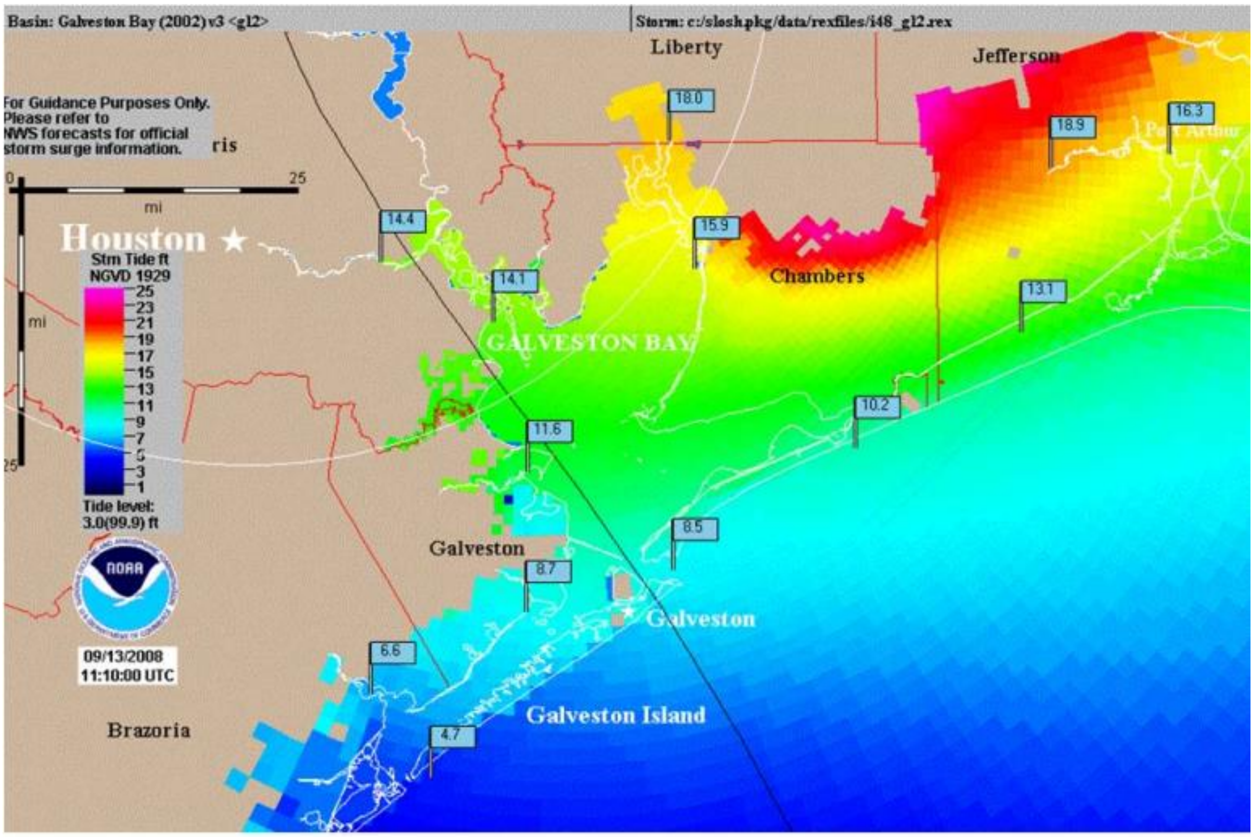
Ike originated from a tropical wave off the coast of Africa on August 28, 2008. Ike became a tropical depression on September 1 and turned into a tropical storm later that day. Ike became a hurricane on the 3rd, and reached an estimated peak intensity of 145 mph (Category 4) on September 4 when it was located 550 miles northeast of the Leeward Islands. Ike moved across the Turks and Caicos Islands and the Great Inagua Island. The hurricane made landfall on the coast of Cuba on the 8th as a Category 4 storm. It moved into the Gulf of Mexico the next day. Ike had a large wind field as it moved northwestward across the Gulf of Mexico for three days, with tropical-storm-force winds extending up to 275 miles from the center and hurricane-force winds extending up to 115 miles from the center. The hurricane gradually intensified as it moved across the Gulf toward the Texas coast. Ike made landfall over the north end of Galveston Island on the morning of September 13 as a Category 2 hurricane with maximum sustained winds of 110 mph. The hurricane weakened as it moved inland across eastern Texas and Arkansas and became extratropical over the middle Mississippi Valley on the 14th, and eventually moved into the Ohio valley and Canada.

Storm surges of 15 to 20 feet above normal tide levels occurred along the Bolivar Peninsula of Texas and in much of the Galveston Bay area, with surges of up to 10 feet above normal occurring as far east as south central Louisiana. Storm total rainfalls from Ike were as much as 19 inches in southeastern Texas and 14 inches in Cuba.

In its path through the Gulf of Mexico, Ike caused extensive damage and took many lives across the Caribbean and along the coast of Louisiana and Texas. Estimates have that 74 people were killed due to flooding and mud slides in Haiti and two in the Dominican Republic. Seven deaths were reported in Cuba.

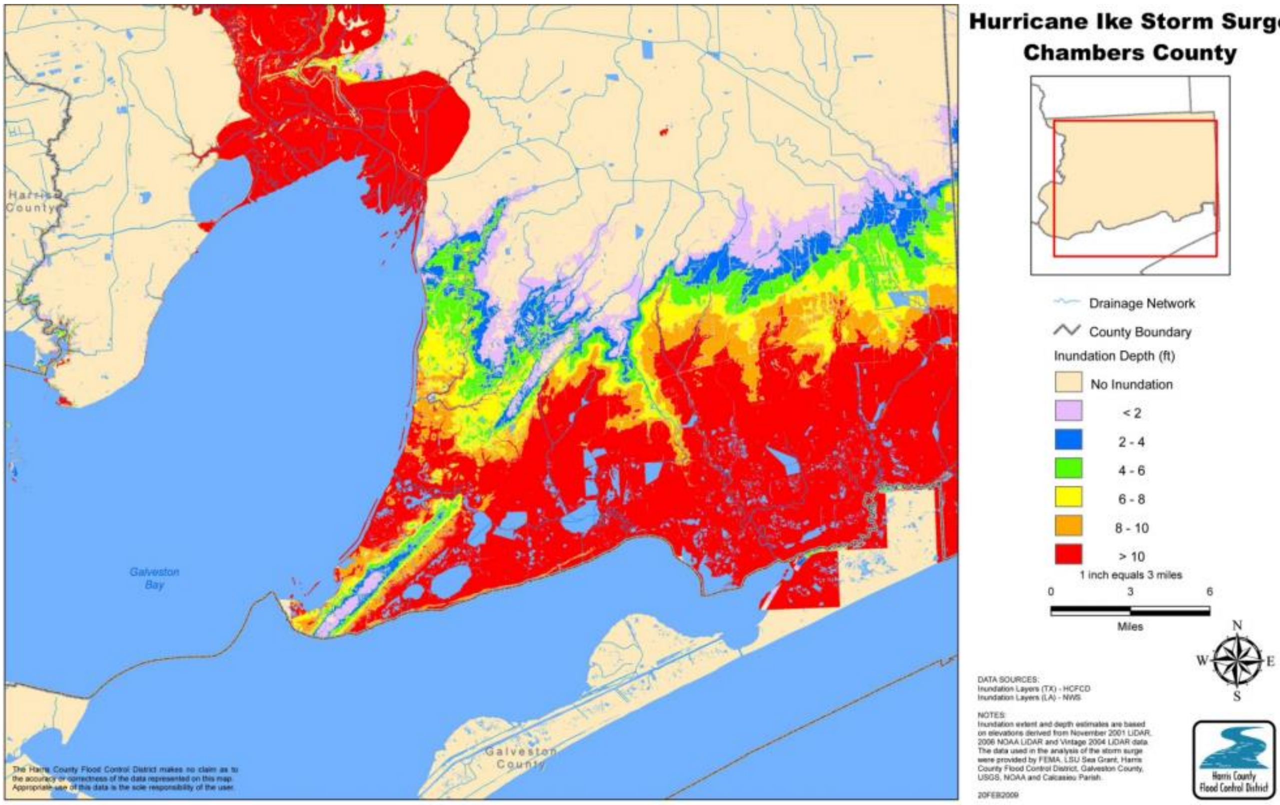
Ike’s storm surge destroyed the Bolivar Peninsula of Texas. Storm surge, winds and flooding from heavy rains caused widespread damage in other areas of southeastern Texas, western Louisiana, and Arkansas. Twenty people were killed in these areas, with many others still missing. Property damage from Ike as a hurricane is estimated at $19.3 billion. Additionally, as an extratropical system over the Ohio valley, Ike was directly or indirectly responsible for 28 deaths and more than $1 billion in property damage

Figure 6-4 Hurricane Ike Inundation Map for Southeastern Texas and Louisiana (Source: HGAC GIS Clearinghouse, JSWA GIS)



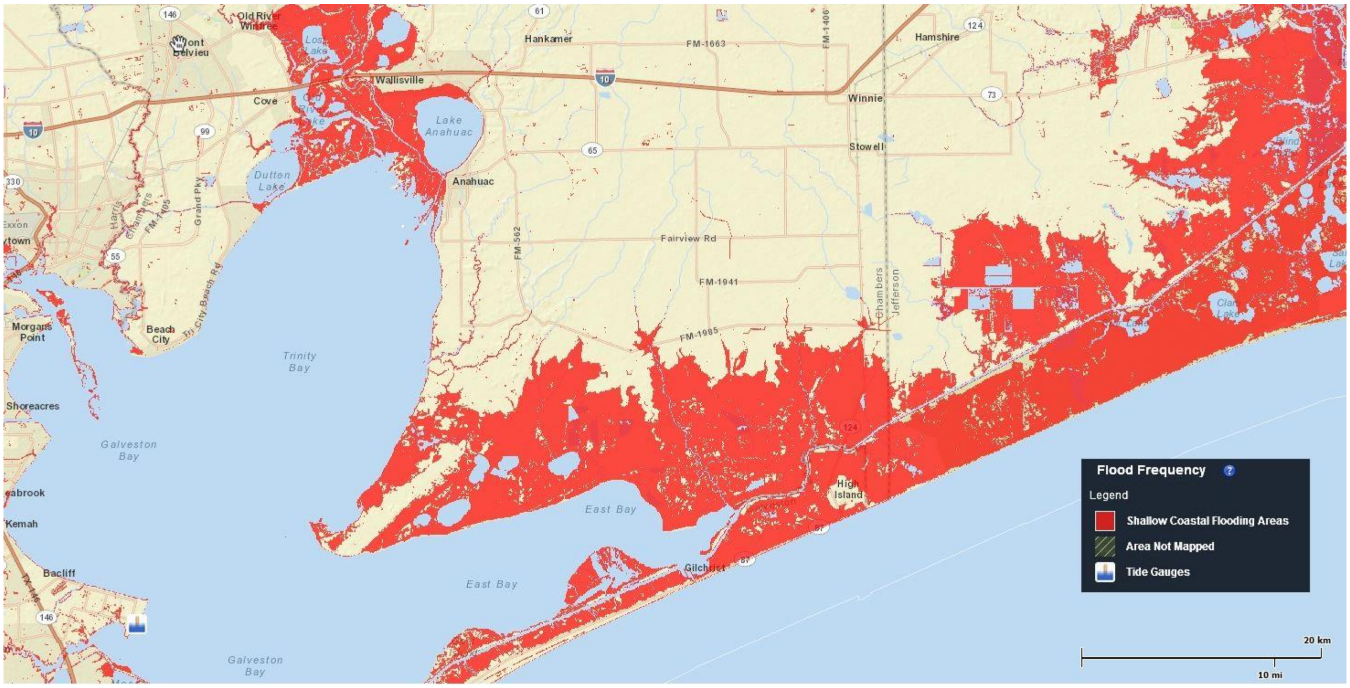
Source: NOAA, SLOSH Model

Figure 6-5 displays the storm surge zone from Hurricane Ike for Chambers County.



Maximum storm surge inundation levels (water depth) across Chambers County, Texas, during Hurricane Ike. Areas shaded in red indicate where the water depths exceeded 10 ft. Image courtesy of the Harris County Flood Control District. (NHC, 2009)

Figure 6-6 Chambers County: Flood Frequency Map (Source: National Weather Service – Lake Charles, Louisiana)



Based on past storm surge events, the probability of future events impacting TBCD is considered low. See Table 5-7 for the definition of high, medium and low probability. As mentioned elsewhere, future probability is only one component of the risk calculation. Evaluations of storm surge maps indicate that storm surge from a category 3 hurricane would result in as much as ten feet of water above the ground nearest to the coast and diminishing to zero feet as the surge moves further inland. Storm surges occur when the water level of a tidally-influenced body of water increases above the normal high tide. Storm surges occur with coastal storms caused by massive low-pressure systems with cyclonic flows that are typical of hurricanes. Storm surges are particularly damaging when they occur at the time of a high tide, combining the effects of the surge and the tide. This increases the difficulty of predicting the magnitude of a storm surge since it requires weather forecasts to be accurate to within a few hours. See Appendix A for a more detailed description of the storm surge hazard.

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6.1.3 Flood Risk

This subsection of the HMP provides a general background regarding flood risk in Trinity Bay Conservation District, and calculations of potential future flood losses in the planning area, based primarily on National Flood Insurance Program (NFIP) insurance claims data.

6.1.4 Background

To develop more specific data about flood-prone buildings, as part of the Plan development, the MPC worked with personnel from the Conservation District, Chambers County Appraisal District to obtain access to various Geographic Information System (GIS) databases. These tools make it possible for a computer running a GIS software application to relate physical features on the ground in mapping applications and analyses.

In addition to the hazard history discussion elsewhere in this HMP, there are a few other means to generally characterize flood vulnerability in TBCD. These are discussed in turn below.

6.1.5 Buildings and Parcels in Proximity to the Special Flood Hazard Area

The number of buildings in the floodplain can be a good general proxy for flood risk, although year-to-year weather patterns clearly have a large influence on flooding potential. Using GIS and historical knowledge, it is estimated that 8,033 residential non-mobile home buildings, 777 mobile homes and 3,258 Commercial buildings are located in the flood-prone areas of Trinity Bay Conservation District. Therefore, not counting buildings that are susceptible but that are outside of the mapped floodplain, approximately 6.95% of all buildings in the planning area are prone to some degree of flooding.

Table 6-3 - Flood Prone Properties Located Within TBCD

	Residential	Mobile Homes	Commercial
Total number of buildings	15,449	1,495	6,265
Number of est. flood prone buildings (Note 1) (as % of total bldgs)	8,033 (39.76%)	777 (3.84%)	3,258 (16.12%)

Note 1: Estimate of flood prone buildings is derived from GIS analysis of Appraisal District records using the FEMA Q3 data for SHFA determination.

There is also considerable information available about the number of parcels in the floodplain, although this is not as good a measure of potential flood risk as the building information above (because, generally, flood risk in developed areas is related to potential impacts to structures and contents). Nevertheless, the data offers additional insight into potential exposure to floods.

According to the 2010 US Census, Chambers County Texas has a population of 35,096. There were 13,291 housing units reported. The planning area has a total of 872 square miles. This can be broken into 599 square miles of land area and 273 square miles covered by water. Of this total, 282 square miles (or 41.2%) are located within the Special Flood Hazard Area (SFHA) or 100-year floodplain. The GIS Department also indicated Trinity Bay Conservation District has a total of 33,287 parcels, of which 13,648 have some exposure to the 100-year floodplain. Table 6-4 summarizes the number of parcels in TBCD and the number of parcels within the 100-year floodplain, broken out by residential and commercial land use categories. The table is ordered by the number of parcels in the 100-year floodplain and indicates the Residential category has the highest number of parcels within the floodplain followed by Other. The Single Family Residential category has 6,334 parcels in the 100-year floodplain which represents 46% of the 13,648 total parcels for this category.

Table 6-4- Number of Parcels in TBCD by Land Use Category and the Number of Parcels in the Floodplain, ordered by Number of Parcels in the Floodplain (Source: JSWA)

Land Use Code	Count	Percentage	In SHFA	Percentage
Mobile Home	1,495	4.49%	613	4.49%
Commercial	6,265	18.82%	2,569	18.82%
Other	10,078	30.28%	4,132	30.28%
Residential	15,449	46.41%	6,334	46.41%
Grand Total	33,287	100.00%	13,648	100.00%

6.1.6 NFIP Policies in Force

Flood insurance policies and claims information can be used to identify buildings in mapped floodplains (where lenders require insurance) and where flooding has occurred (where owners are sufficiently concerned that they purchase flood insurance even if not required). This characterization of flood risk is described in the following text.

NFIP Policies In-Force. Data provided by FEMA indicate that as of March 2012, federal flood insurance policies were in-force on 2,953 buildings in Chambers County. These insurance policies are administered by the National Flood Insurance Program (NFIP). This represents a dollar value of property and contents coverage in excess of $858 Million.

For the most part, two factors prompt people to purchase flood insurance – when mortgage lenders require it and when actual flood damage makes it clear to homeowners that a building is, indeed, located in a flood-prone area. Thus, the number and distribution of flood insurance policies is one way to characterize potential risk throughout the planning area.

NFIP Claims Paid. Between 1978 and March 2012, there were 1,008 flood insurance claims (building and contents combined) in Chambers County. These totals include four cities as well as unincorporated Chambers County. Many of these properties are located outside the 100-year floodplain. Review of the NFIP claims data for planning area indicates that the large majority of these claims were for residential properties. Total claims paid for building and contents payments exceed $26.5 million. Table 6-5 summarizes the NFIP claims data for the jurisdictions within the planning area.

Table 6-5- NFIP Claims Statistics for the planning area (Source: FEMA NFIP query June, 2012, FEMA. NFIP - Flood Insurance Statistics)

Community Name	Paid Claims	Policies in force	Total Paid Claims
ANAHUAC, CITY OF	50	134	$1,064,791
BEACH CITY, CITY OF	60	388	$1,269,107
CHAMBERS COUNTY *	870	2132	$24,103,364
COVE, TOWN OF	0	22	$0
MONT BELVIEU, CITY OF	25	257	$91,815
OLD RIVER-WINFREE, CITY OF	3	20	$126,476
	1008	2953	$26,655,553

6.1.7 Flood Loss Estimates for NFIP Repetitive Loss Properties

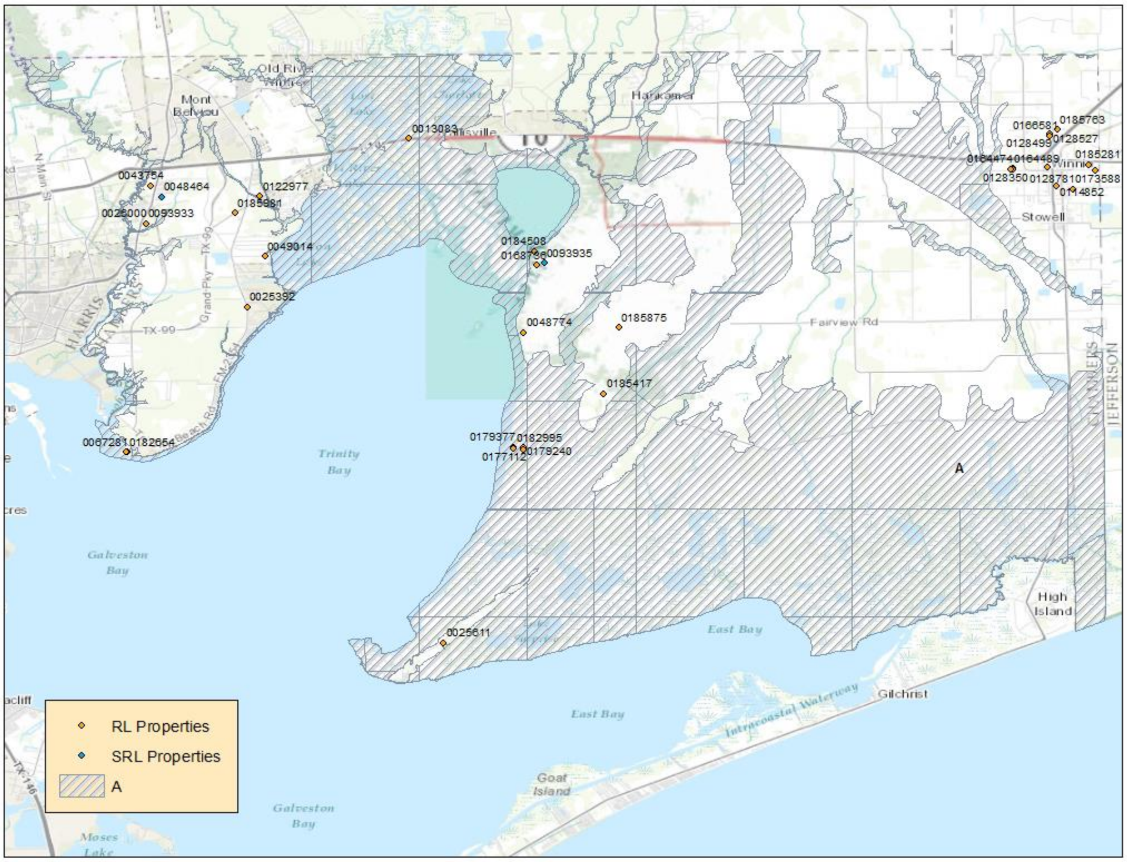
This subsection provides estimates of potential future flood losses (risk), based on analysis of National Flood Insurance Program (NFIP) data on repetitive flood loss (RL) properties. The NFIP defines repetitive loss properties as those that have received least two NFIP insurance payments of more than $1,000 each in any rolling ten-year period. As of November, 2011, the planning area (Chambers County) had 47 such properties, based on a query of the FEMA BureauNet NFIP interface. Of the 47 RL properties in TBCD, 40 were characterized as residential properties and seven were non-residential. The RL properties for Trinity Bay Conservation District are summarized by municipality in Table 6-6. The Table indicates that Chambers County Unincorporated has the highest number of RL properties in TBCD. Chambers County Unincorporated has not only the highest number of properties, but also has the highest building, contents, and total claims value compared to the incorporated areas of Chambers County.

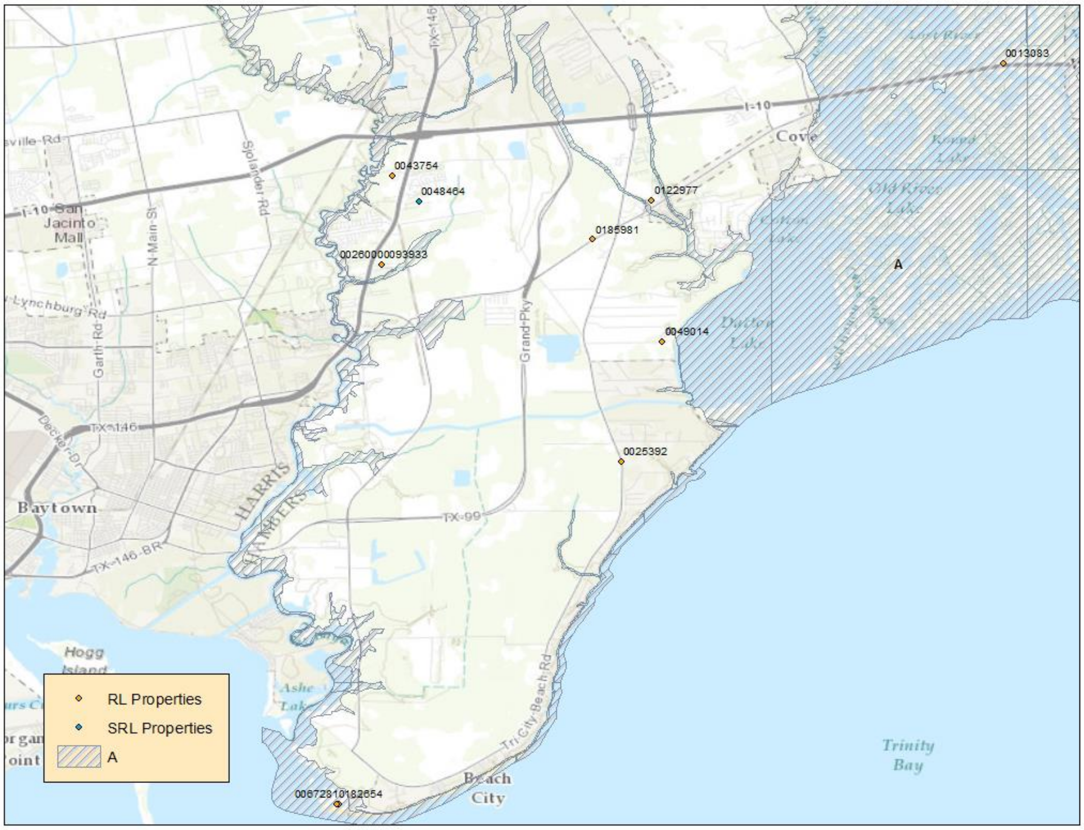
Table 6-6 - Summary of NFIP RL Statistics, Trinity Bay Conservation District, Ordered by Number of Properties in Each Municipality (Source: FEMA NFIP Query Nov, 2011)

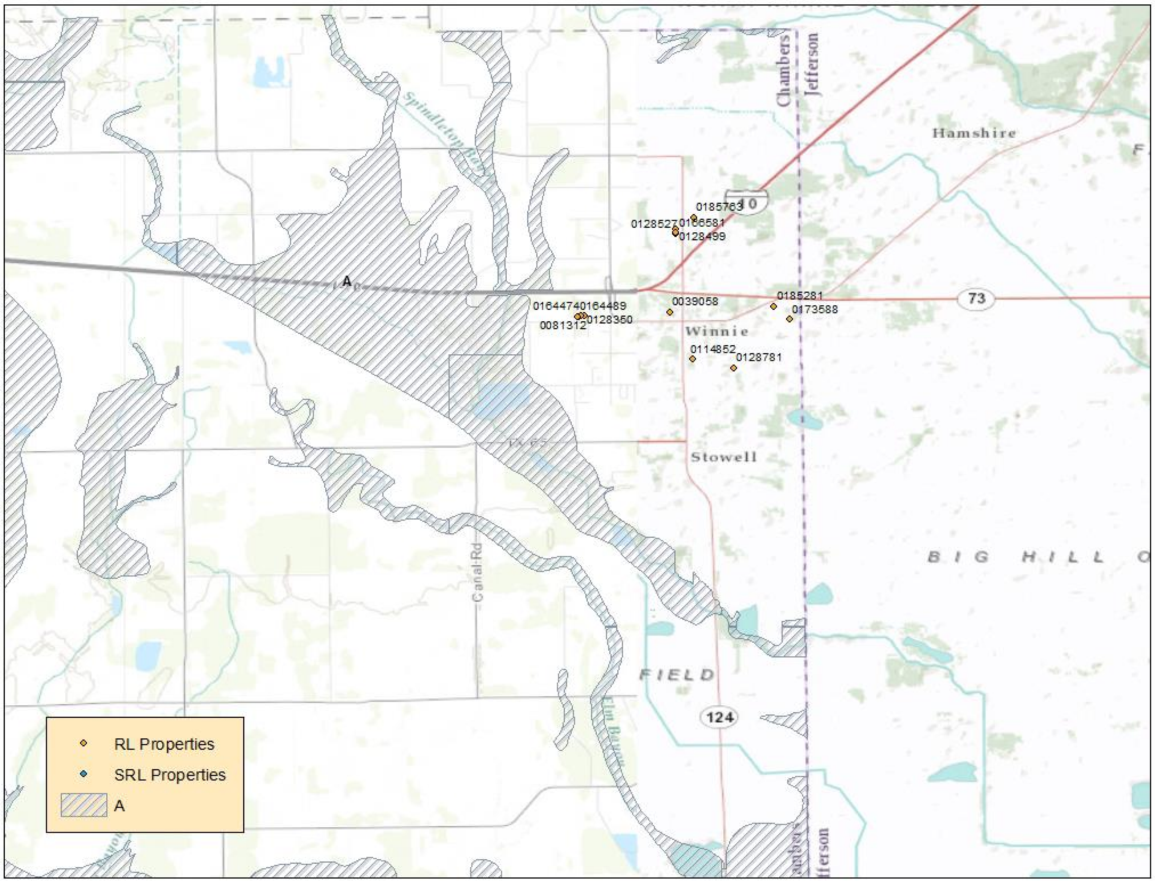
Community	Number of RL Properties	Building Payment	Contents Payment	Losses
CHAMBERS COUNTY *	42	$2,117,786	$679,379	118
ANAHUAC, CITY OF	2	$121,982	$21,175	7
MONT BELVIEU, CITY OF	2	$49,636	$0	4
OLD RIVER-WINFREE, CITY OF	1	$111,095	$13,296	2
Grand Total	47	$2,400,499	$713,850	131

Figure 6-7 is a map of the residential and non-residential RL properties located within the planning area. The map also identifies severe repetitive loss (SRL) properties which are discussed later in this section.

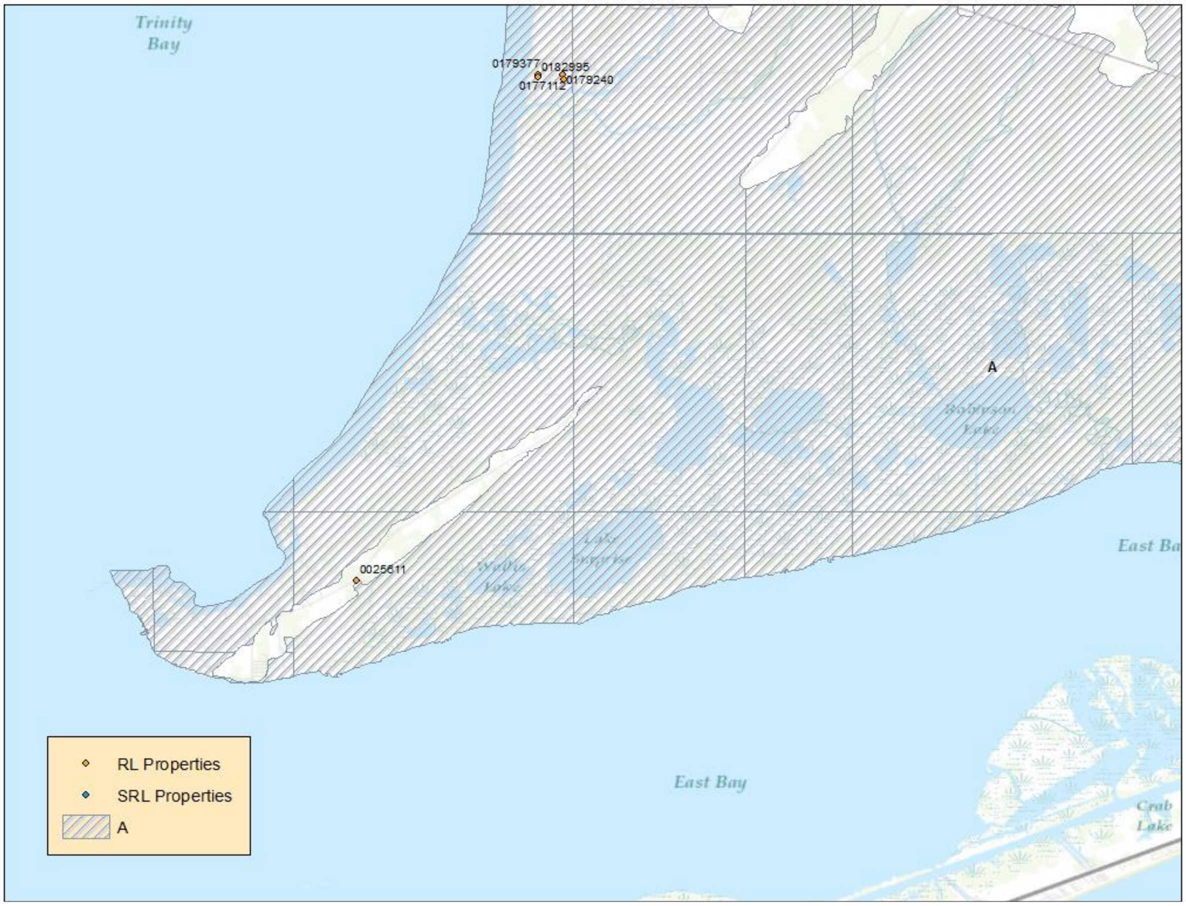
Figure 6-7 - Maps of Repetitive Loss Properties and Severe Repetitive Loss Properties in TBCD (Sources: FEMA/NFIP, GIS)

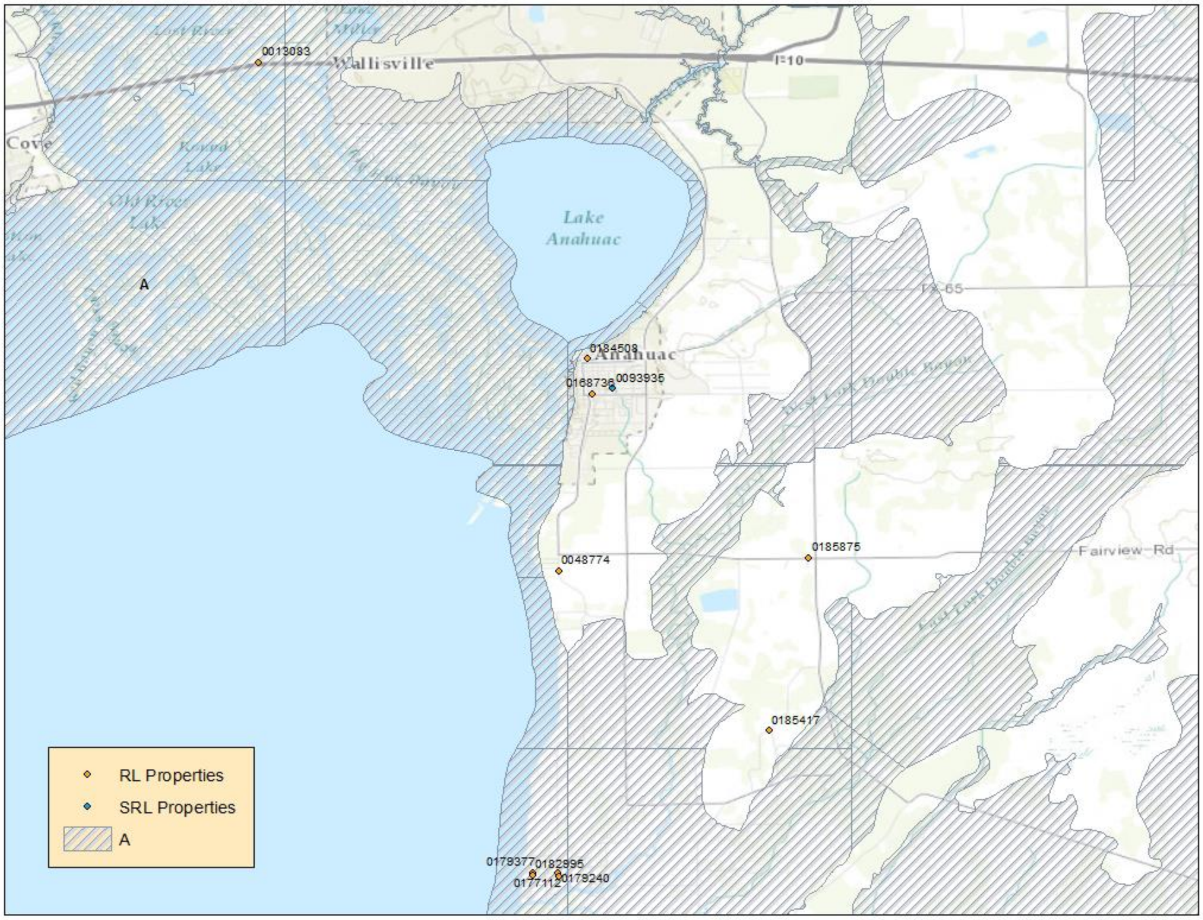



RL Properties
SRL Properties
A
0013083
0043754
0048464
0122977
0185981
00260000093933
0049014
0025392
00672810182654
I-10
Cove
Baytown
TX-146
TX-99
Grand Pky
Tri City Beach Rd
Beach City
Trinity Bay
Hogg Island
HARRIS
CHAMBERS
Garth Rd
N Main St
Sjolander Rd
I-10 San Jacinto Mall
Lynchburg Rd
Decker Dr
TX-146-BR
Old River Lake



Hamshire
Winnie
Stowell
BIG HILL
FIELD
Chambers
Jefferson
Canal Rd
0185763
0128527
0166581
0128499
0164474
0164489
0081312
0128360
0039058
0185281
0173588
0114852
0128781
73
124
10
A
RL Properties
SRL Properties
A


Trinity Bay
0179377
0182995
0177112
0179240
A
0025611
East Bay
East Ba
RL Properties
SRL Properties
A



6.2 RESIDENTIAL REPETITIVE LOSS PROPERTIES

6.2.1 Background and General Statistics

As mentioned, there are a total of 40 residential RL properties in the planning area. The 40 properties are located within the unincorporated areas of Chambers County and the two jurisdictions within Chambers County. Table 6-7 provides a summary of residential RL claims for the unincorporated areas of Chambers County and the two municipalities that have RL properties. The table includes the number of RL properties in each municipality, building and contents damages, the total number of claims, and the average claim amounts. The figures are from an NFIP query performed in November, 2011. The table shows that for the 40 residential RL properties in Chambers County (to include incorporated areas) there have been 110 RL claims totaling just over $2.5 million.

Table 6-7 - Summary of Residential NFIP RL Statistics, TBCD, Ordered by Number of Properties in Each Municipality (Source: FEMA NFIP Query June, 2012)

Jurisdiction	Count	Building	Contents	Total	Claims	Average Claim
CHAMBERS COUNTY *	37	$1,885,676	$402,188	$2,287,864	101	$22,652
ANAHUAC, CITY OF	2	$121,982	$21,175	$143,156	7	$20,451
OLD RIVER-WINFREE, CITY OF	1	$111,095	$13,296	$124,391	2	$62,195
Grand Total	40	$2,118,753	$436,658	$2,555,411	110	$23,231

The table indicates that Chambers County Unincorporated is the jurisdiction with the highest number of residential RL properties in TBCD. Chambers County Unincorporated has not only the highest number of properties, but also has the highest building, contents, and total claims value compared to the unincorporated areas of Chambers County. The average claim amount is similar for ANAHUAC and the unincorporated areas of Chambers County.

6.2.2 Flood Risk - Residential Repetitive Loss Properties

Residential flood risk is calculated by a simple methodology that uses the FEMA default present-value coefficients from the benefit-cost analysis software modules. To perform this calculation, the repetitive loss data was reviewed to determine an approximate period over which the claims occurred. This method should not be used for risk assessments for individual properties because of the generalizations that are used, i.e. that an unknown number of properties in the County have been flooded, but did not have flood insurance, and therefore do not appear in the data. Flood claims in the most recent query occurred between 1979 and the present, a period of 34 years.

As shown in Table 6-8, there have been 131 claims in the 34-year period, for an average number of claims per year of 3.8, though it is typical for losses to be clustered around significant flood events. Based on a 100-year horizon and a present value coefficient of 14.27 (the coefficient for 100 years using the mandatory OMB discount rate of 7.0 percent), the projected flood risk to these properties is shown at the bottom of the table. It must be understood that individuals can obtain and cancel flood insurance policies, and the flood hazard depends on many variables, including the weather, so this projection is simply an estimate of potential damages. Nevertheless, it offers a useful metric that can be used in assessing the potential cost effectiveness of mitigation actions.

Table 6-8 - Projected 100-year Flood Risk in the planning area for Residential Repetitive Loss Properties (Source: FEMA NFIP query Nov, 2011)

Data	Value
Number of properties	47
Period in years	34
Number of claims	131
Average claims per year	3.85
Total value of claims	$3,114,349
Average value of claims per year	$808,921
Projected risk, 100-year horizon	$11,543,315

6.3 NON-RESIDENTIAL REPETITIVE LOSS PROPERTIES

6.3.1 Background and General Statistics

As noted earlier, as of Nov 2013, Chambers County had seven non-residential RL properties in the NFIP database. Table 6-9 provides a summary of non-residential RL claims for the unincorporated areas of TBCD and the municipality that include non-residential RL properties. The table identifies the number of RL properties in each jurisdiction, building and contents damages, the total number of claims, and the average claim amounts. Of the seven total non-residential properties, two are located within the City of Mont Belvieu and the others are located in unincorporated Chambers County.

Table 6-9 - Summary of Non-Residential Repetitive Flood Loss Claims in TBCD, Ordered by Number of Properties in Each Municipality (Source: FEMA NFIP Query Nov, 2011)

Jurisdiction	Count	Building	Contents	Total Paid	Losses	Average
CHAMBERS COUNTY *	5	$232,110	$277,192	$509,302	17	$29,959
MONT BELVIEU, CITY OF	2	$49,636	$0	$49,636	4	$12,409
Grand Total	7	$281,746	$277,192	$558,938	21	$26,616

The data indicates that unincorporated Chambers County has the highest number of non-residential repetitive loss properties and total number of claims. Unincorporated Chambers County also has by far the highest building damages, contents, and total claims value for non-residential properties in Trinity Bay Conservation District.

6.3.2 Non-Residential Repetitive Loss Properties - Loss Estimation

As with the residential flood loss history, the past claims information can be used to project future flood losses. The methodology is the same as what is described in the residential section. As shown in Table 6-10, there have been 21 non-residential RL claims in the 34-year period, for an average number of claims per year of slightly less than one. Similar to the residential RL data, the .62 claims per year is the average over a 34 year period and it is typical for losses to be clustered around significant flood events. Based on a 100-year horizon and a present value coefficient of 14.27 (the coefficient for 100 years using the mandatory OMB discount rate of 7.0 percent), the projected flood risk to these properties is $234,590.

Table 6-10 - Projected 100-year Flood Risk in TBCD for Non-residential Repetitive Loss Properties (Source: FEMA NFIP query Nov, 2011)

Data	Value
Number of properties	7
Period in years	34
Number of claims	21
Average claims per year	.62
Total value of claims	$558,938
Average value of claims per year	$16,439
Projected risk, 100-year horizon	$234,590

Flood Loss Estimates for NFIP Severe Repetitive Loss Properties

6.4 RESIDENTIAL SEVERE REPETITIVE LOSS PROPERTIES

6.4.1 Background and General Statistics

This subsection provides estimates of potential future flood losses (risk), based on analysis of National Flood Insurance Program (NFIP) data on repetitive flood loss (RL) properties. In 2004 FEMA began to develop the Severe Repetitive Loss (SRL) Grant Program in an effort to reduce or eliminate flood damages to residential properties that met certain minimum requirements. The Agency initiated the program early in 2008. An SRL property is defined as a residential property that is covered under an NFIP flood insurance policy and (1) has at least four NFIP claim payments (including building and contents) over

$5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or for which at least two separate claims payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building.

As of Nov 2011, a query of the FEMA BureauNet NFIP interface indicates that Chambers County had two properties on the SRL list. The SRL properties are located in the unincorporated areas of Chambers County and one of the incorporated places within the planning area.

Table 6-11 - Summary of Severe Repetitive Loss (SRL) Properties in Trinity Bay Conservation District, Ordered by Number of Properties in Each Municipality (Source: FEMA NFIP Query Nov, 2011)

Community Name	# of SRL Properties
ANAHUAC, CITY OF	1
CHAMBERS COUNTY *	1

The data there were two SRL properties having 12 claims for a total of $136,211. The average claim amount is slightly lower at $23,329 than the average for all properties in Chambers County.

6.5 SEVERE REPETITIVE LOSS PROPERTIES

6.5.1 Loss Estimation (combined residential and non-residential)

Similar to the RL data, the SRL flood risk was calculated using the FEMA default present-value coefficients from the benefit-cost analysis software modules. See the residential RL subsection "Flood Risk to Residential Properties" for a detailed explanation of the methodology. Flood claims in the SRL query also occurred between 1979 and the present, a period of 34 years.

With the limited number of SRL properties in the planning area further analysis was deemed to be unnecessary.

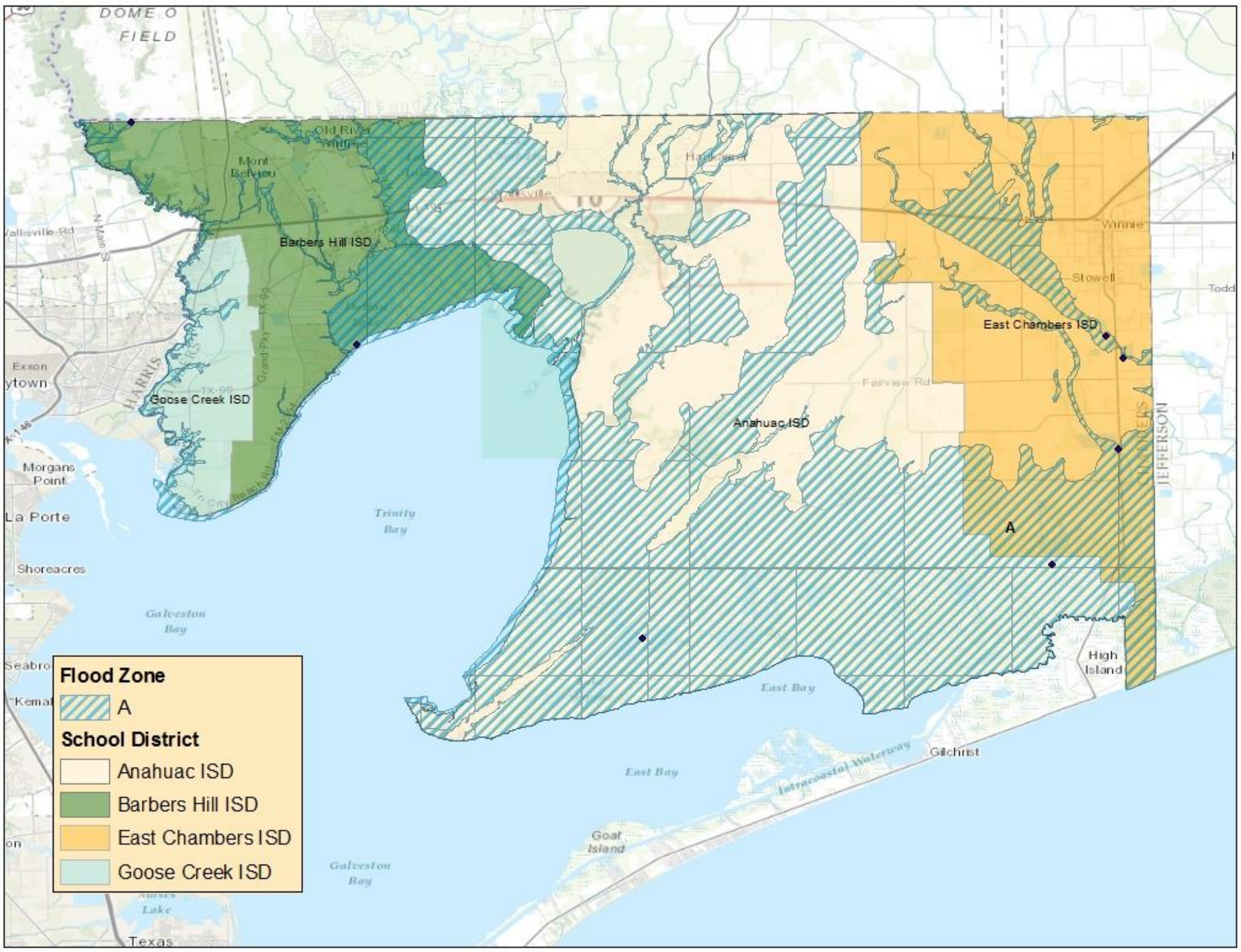
The information in this section should be used for planning purposes only, i.e. as the basis for additional steps in risk assessment, and eventually (where warranted) targeted mitigation actions to reduce the risk. For example, a property that has received a number of claim payments not much higher than $1,000 would be considered an unlikely candidate for mitigation using public funds. It may, however, be an excellent candidate for damage-reduction actions taken by the owner.

6.6 FLOOD RISKS – PUBLIC BUILDINGS

Trinity Bay Conservation District owns one building on State Highway 124 in Stowell, Texas. This building is not located in the Special Flood Hazard Area and has never experienced flooding.

Public Schools. There are seven Independent School Districts located in Chambers County with 153 schools throughout the County (ISDs). A map from the Chambers County plan outlines where the schools fall in relation to the floodplain area.

Figure 6-9 – Schools and School Districts in Chambers County. Sources: Chambers County 2011 Hazard Mitigation Plan

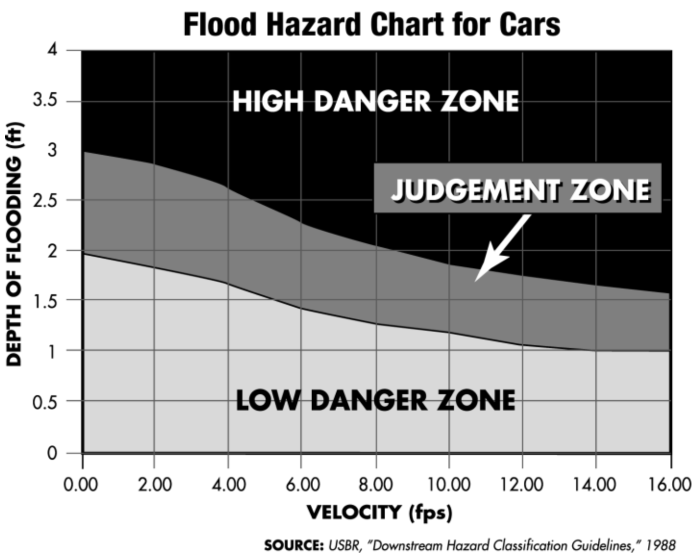


6.7 FLOOD RISKS – ROADS

Nationwide, flooded roads pose the greatest threat to people during floods. Most of the more than 200 people who die in floods each year are lost when they try to drive across flooded roads. Driving into water is the number one weather-related cause of death in Central Texas. Statewide, between 1960 and 1996, 76% of flood-related deaths were vehicle-related.[19]

As illustrated in Figure 6-10, flood hazards for cars vary with both velocity and depth of floodwaters. Many cars will float in less than 24 inches of water. Fast-moving water can quickly wash cars off the road or wash out a low section of road.

Figure 6-10 - Flood Hazard Chart for Cars (Source: Downstream Hazard Classification Guidelines, 1988)



Although most roads in the area are unlikely to have deep or fast-moving water during flood conditions up to the level of the 100-year flood, many are still known to flood regularly.

The Texas Department of Transportation (TXDOT) maintains the freeways that run through the district and the County. These major roadways include the following:

Interstates

I-10 runs generally East/West from Jefferson to Harris Counties in Texas.

State Highways

SH 61 runs generally South/North Anahuac to Jefferson County

SH 73 runs generally East/West from Jefferson County to I-10.

SH 99 runs generally South/North

[19] Texas Environmental Center

SH 146, like US 99 and 124, runs generally S/N

When building new State roads or upgrading existing roads, the TXDOT considers the NFIP's floodplain and floodway requirements to evaluate the impact of new and replacement structures. Chambers County and the local jurisdictions consider floodplain and floodway impacts in its planning and design for area roads. Within the local jurisdictions, developers must satisfy the jurisdiction's drainage criteria and other aspects of road designs in order for the jurisdiction to accept ownership.

Replacing roads and bridges damaged or washed out by floods costs millions of dollars each year. If the damage is caused by a Presidentially-declared disaster, FEMA may pay up to 75% of the repair or replacement costs, with the remaining 25% covered by the State and local governments. The full costs of a damaging event that is not declared a major disaster must be borne by the State and local communities.

TXDOT inspects State bridges for structural integrity and to determine if erosion is a risk. Where erosion has been identified, stabilization measures have been put into place.

Although most roads in the area are unlikely to have deep or fast-moving water during flood conditions up to the level of the 100-year flood, many are still known to flood regularly. Within Chambers County, there are approximately 300 miles of roads. TXDOT maintains the freeways that run through the Cities. Due to the extensive flooding to roads in the County, it would be near impossible to generate a list of flood-prone roads. Due to this reason, many of the Cities and the County do not close roads due to flooding. However, they do close major underpasses where water tends to get much deeper. This is accomplished by waiting until the water is deep enough to warrant closure. There are water depth signs at these major underpasses.

When building new state roads or upgrading existing roads, TXDOT considers the floodplain and floodway requirements to evaluate the impact of new and replacement structures. The Cities and the County consider floodplain and floodway impacts their planning and design for area roads. The Cities require developers to satisfy the drainage criteria in order for the Cities to accept ownership.

6.8 FLOOD RISKS – LOCAL DRAINAGE

Many areas and streets experience accumulations of rainfall that are slow to drain away, which may cause disruption of normal traffic, soil erosion, and water quality problems. Local drainage problems contribute to the frequency of flooding, increase ditch maintenance costs, and are perceived to adversely affect the quality of life in some neighborhoods.

Many areas prone to shallow, local drainage flooding are not shown on County's Flood Insurance Rate Maps. One measure of the magnitude of this problem is the number of flood insurance policies in-force on buildings that are outside of the mapped floodplain. Local drainage flooding throughout some subdivisions in the planning area is a problem, even during frequent rainstorms. It is a concern because access for emergency services (fire, emergency medical) can be limited. While the depth of water generally is relatively shallow, a number of homes have been flooded repetitively and are identified by FEMA as repetitive loss properties.

6.9 SUMMARY: EXPOSURE TO FLOOD RISKS

As described in earlier in this section, digital maps of the floodplain are used for flood hazard identification and assessments of risk. The data, combined with the footprint information for buildings, allow determination of residents and assets of the built environment that are at risk only by identifying whether such assets are in or out of the flood hazard area. No other characterization of flood risk can be made, i.e., depth of flooding or whether houses are in the floodway or the flood fringe.

Table 6-12, based on a form provided in the State's Mitigation Handbook (DEM 21) is a summary of flood risks. For the purpose of this table, number of people per home is based on the U.S. Census value of 2.87 occupants per household for Chambers County. Special facilities include fire stations and schools.

Table 6-12- State Mitigation Handbook - DEM 21: Vulnerability and Risk Assessment Worksheet for the Flood Hazard

People/Property at Risk in the Floodplain	Total
People (estimate)	35,096
Housing Units	13,291
Commercial Facilities	6,265
District-Owned Buildings	1($1.5M)
Special Facilities (schools; fire stations)	

Estimate of Annualized Damage from Floods

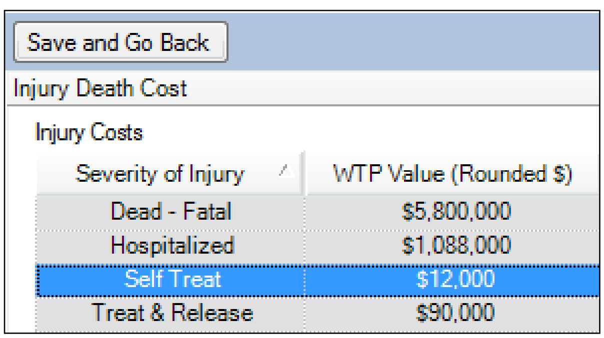
The Plan uses the following approach to estimate the potential total estimated annualized damages. From actual historical paid losses combined with historical knowledge of the total of uninsured losses, it is estimated that buildings within planning area have experienced over $66 million in flood losses. These losses occurred from April 1979 to 2011 and included five primary events (and several smaller, less costly events).

6.10 TORNADOES

Relative to other parts of the nation, the overall tornado risk is moderate in Trinity Bay Conservation District. The MPC determined that there is significant enough exposure to the tornado hazard to warrant a more detailed risk assessment to characterize the potential future losses. The calculation is done using FEMA's Benefit-Cost Analysis (BCA) software (version 4.8). It should be noted that this software was designed to assess risk at a single site or building, so the methodology must be adapted to reflect an assessment of an entire community. Furthermore, the software bases the risk calculation (and by extension, benefits, when risk is reduced) on avoided injuries and casualties, not damage to structures or loss of operations. These limitations mean that the results of the analysis should be regarded as a preliminary indication of potential life safety risk, based on very basic inputs. Evaluation of specific mitigation alternatives requires technical information that was not available during the drafting of the plan.

The FEMA BCA analysis methodology and tornado element of the software are based entirely on avoided injuries and fatalities. The calculation is based on the population or occupancy at risk rather than the square footage or value of buildings or functions. The software uses default values for various levels of injury related to tornadoes. These values are shown in Figure 6-8 and include $5.8 million for death and $1.088 million for injuries requiring hospitalization.

Figure 6-11 - Injury and Death Costs (FEMA Benefit-Cost Analysis [BCAR] Tool, Version 4.8)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Injury Death Cost

Injury Costs

Severity of Injury	WTP Value (Rounded $)
Dead - Fatal	$5,800,000
Hospitalized	$1,088,000
Self Treat	$12,000
Treat & Release	$90,000

6.10.1 Tornado Risk – Public Assets

The tornado risk assessment for Trinity Bay Conservation District was completed for the building owned by the district. The analysis was completed based on data provided by district and entered into the tornado module of the FEMA BCAR software. Table 6-13 below summarizes the data inputs.

Table 6-13 – Trinity Bay Conservation District Tornado Risk Assessment - Project Information (Source: FEMA BCA Software, Version 4.8)

Data	Value
Loss estimation horizon (years)	100
Zip Code used (Administrative Office)	77665
Assumed structure design wind speeds (mph) of safe room	200
Assumed structure type	Small Professional Building (steel frame)
Occupancy Percentage	
Day	100%
Evening	25%
Night	5%

The software then uses these inputs to calculate the expected loss of life and number of injuries for tornado classes EF0 to EF5. The FEMA software used for assessing tornado risk is based exclusively on life safety, so there is a strong correlation between the occupancy of a facility and the risk. Based on the number of total occupants, the software calculates the population on site based on statistics related to the probabilities of tornadoes impacting the building, by time of day. Table 6-14 shows the summary of benefits from the tornado risk assessment. The Table includes the annual and 100-year risk for each building and indicates the Administrative Office has the highest 100-year risk. This facility has a 100-year risk of $20,946.

Table 6-14 - Estimated Tornado Risk to Trinity Bay Conservation District Public Facilities, 100 year Planning Horizon (Source: FEMA BCA Software [BCAR], Version 4.8)

Facility Description	Occupancy	Annual Risk	100-year Risk
Administrative office	3	$425	$5,277
Grand Total	3	$425	$5,277

6.11 HURRICANE AND TROPICAL STORM RISK IN TBCD

Trinity Bay Conservation District is located close enough to the Gulf Coast that high winds from hurricanes and tropical cyclones present significant risks to private and public assets and operations. This subsection presents the results of wind loss estimations for District assets that were completed with the FEMA benefit-cost analysis software (BCAR). Although this software is specifically intended to assess mitigation projects, it is possible to use it to estimate losses (risk), when sufficient data is available. It should be clearly understood that these results are general, and any site-specific risk assessment or mitigation project proposal should be analyzed in more detail, using additional details about structural characteristics, physical surroundings, and occupancies.

As part of the 2012 HMP, the District provided information about its facilities, including area, occupancy and structure type. Trinity Bay Conservation District owns a total of one facility. The facility is an Administrative office structure. To calculate future losses, the analysis uses information about District assets in conjunction with open-source hazard data and FEMA software. The section below describes the methodologies and results. It was necessary to estimate some data parameters for the calculations that are summarized below. These inputs were used to calibrate the software model. Selected data inputs are shown in Table 6-15 below.

Table 6-15- Trinity Bay Conservation District Hurricane and Tropical Storm Wind Data Parameters (FEMA Benefit-Cost Analysis [BCAR] Tool, Version 4.8)

Data	Value
Loss estimation (planning) horizon (years)	100
Displacement Costs ($/s.f./month)	$1.44
Zip code	77665
Exposure (urban and dense suburban or open)	Urban and dense suburban
Assumed wind debris source	Residential/commercial mix
Demolition threshold	50% (default)

The zip code 77665 for the Administration Office was entered into the BC module to identify the wind speeds for each of the recurrence intervals identified in Table 6-16, which shows the wind hazard profile for TBCD.

Table 6-16 - Hurricane Wind Speed (3 second gusts) Recurrence Intervals at Stowell, Texas (FEMA Benefit-Cost Analysis [BCAR] Tool, Version 4.8)

Wind Gust (3 seconds) (mph)

Recurrence Interval (yr)	Default Wind Speed (mph)
10	65
20	84
50	108
100	120
200	130
500	142
1000	149

Table 6-17 summarizes the abbreviations for FEMA HAZUS-based structure and contents damage functions, which determine the extent of damage when structures are exposed to wind forces of various magnitudes.

Table 6-17 - Abbreviations for HAZUS Structure Types (FEMA Benefit-Cost Analysis Tool, Version 4.8)

HAZUS Structure Type	Abbreviation
Masonry, engineered commercial building, low-rise (1-2 stories)	MECBL
Steel, pre-engineered metal building, Medium	SPMBM
Steel, pre-engineered metal building, Small	SPMBS

Table 6-18 summarizes the hurricane and tropical storm wind risk to public assets for Trinity Bay Conservation District, based on the methodologies and inputs described above. The Table shows that the Administrative Bldg. has a 100-year risk of $40,995.

Table 6-18 - Estimated Hurricane Wind Risk to TBCD Public Assets, ordered by 100-Year Risk (Source: BCA Software, V4.5.5.0)

Facility Description	HAZUS Type	Area (s.f.)	Building Replacement Value	Annual Risk	100-year Risk
Administrative office	SPMBS	1,800	$169,722	$2,873	$40,995
Grand Total	-----	1,800	$169,722	$2,873	$40,995

Again, it should be noted that these loss estimates are intended only as an initial assessment, for the purpose of allowing the District to determine priorities for additional study and/or mitigation actions

6.12 SUMMARY: EXPOSURE TO TORNADOES, HURRICANES AND TROPICAL STORMS

TBCD only has authority to mitigate its own buildings from tornadoes, hurricanes and tropical storms. Table 6-18 shows that the Administrative Bldg. has a 100-year risk of $40,995.

7 SECTION 7 - DISTRICT PROCESSES AND CABABILITY TO ADDRESS HAZARDS

7.1 ORGANIZATION OF TRINITY BAY CONSERVATION DISTRICT

Trinity Bay Conservation District (TBCD) is a conservation and reclamation political subdivision responsible for drainage, water treatment, and wastewater treatment for Chambers County. While TBCD does not participate in the NFIP, the County and jurisdictions that it supports do participate in the NFIP. TBCD has a five member Board of Directors, one member for each of the five precincts and a board attorney.

7.2 EMERGENCY RESPONSE

Emergency response is the responsibility of the Cities and County. The Cities and the County have early warning capability. Citizens in the area rely mostly on local weather, which is reported to be very capable.

7.3 COMMUNICATING ABOUT HAZARDS

TBCD works closely with the Cities and the County to ensure communication with residents about flood hazards in the area. The Cities actively communicate with residents using a variety of media, each of which have been used to convey information, including content about hazards.

The Cities and Counties use a system called Southeast Texas Alerting Network (STAN) for community and emergency notification. Recorded alert messages are placed on this system, the media is automatically notified, they inform the public as to the specifics of the alert and give the public the toll free STAN number to call and hear the original recorded message, if they so desire.

The Cities also use a system called 1st call, which is an automated system that will call a preset phone tree to inform residents of impending danger from a hazard. TBCD assists both the Cities and County in emergency response and post-event cleanup as requested

The Cities and County web sites post information about activities and upcoming events. Regulations are posted and public access to GIS maps are provided.

The local government public access channel is accessible to residents who subscribe to Time Warner Cable. Council meetings and other public meetings are shown on this channel. The channel is used to disseminate information during hazardous events. In addition, after major flooding, jurisdictions post information slides to include information on post-disaster permit requirements.

7.4 HOW TRINITY BAY CONSERVATION DISTRICT ADDRESSES HAZARDS

As part of the Plan development, members of the Mitigation Planning Committee (MPC) were interviewed to gain an understanding of awareness of hazards and how they are addressed, and to gather information about damage associated with past hazard events. During Hurricanes Rita and Ike, TBCD worked with the Counties and Cities to assess damages to various facilities. While there are several hazards that impact Chambers County, TBCD's jurisdiction is over flood and wind hazards that impact TBCD facilities. Therefore, TBCD works with the jurisdictions to identify impacts from its facilities on flood issues and determine viable solutions.

7.5 LOCAL REGULATION OF DEVELOPMENT

TBCD has no direct responsibility for oversight of development in the floodplain. TBCD has authority over wastewater treatment and storm water management.

TBCD supplies potable water from two water treatment facilities in Winnie and Anahuac. These are surface water treatment plants and produce quality government approved drinking water. The Winnie plant treats Neches River water purchased from the Lower Neches Valley Authority. The Anahuac treatment plant treats Trinity River Water purchased from the Chambers-Liberty Counties Navigation District. TBCD currently has four wastewater treatment plants. One in Winnie, Oak Island, Smith Point and Hankamer.

TBCD manages storm water through constructing and maintaining drainage ditches throughout the District. While they do not manage roadside ditches, they do manage over 1,400 miles of ditches throughout the district.

While they do not have authority over development, they do provide any jurisdiction with information on the Waterway and any impact actual or future development may have near the waterway.

Table 7-1 – Chambers County: Buildings Permits and Development Permits (2002 - 2011) (Source: City permit information provided by US Census Building Permits Estimate)

Year	Buildings	Units	Construction Costs
2012	293	293	$53,252,756
2011	216	216	$36,856,817
2010	226	226	$38,900,930
2009	266	409	$55,450,767
2008	316	316	$53,298,353

Year	Buildings	Units	Construction Costs
2007	457	457	$75,955,718
2006	368	368	$59,263,932
Totals	2,142	2,285	$372,979,273

7.6 FLOOD HAZARDS

Chambers County and the local jurisdictions administer a suite of regulations and ordinances that combine to comprehensively regulate flood hazard areas to minimize exposure of people and property. Within the Cities, administration of these provisions is the joint responsibility of the City's Floodplain Manager and the Building Code Official. Within the County, these ordinances are administered within the engineering department. As indicated previously, development permits are provided to the engineering department for review and comment.

Processing Floodplain Development Proposals. Most homes built in the floodplain are slab-on-grade, elevated by the placement of a minimum quantity of fill. Elevation Certificates are required for all construction in the floodplain. Chambers County regulations require that the lowest floor, including basement, be at least one foot above the Base Flood Elevation.

FUTURE DEVELOPMENT TRENDS IN TBCD PLANNING AREA

Population trends indicate the Chambers County is projected to be steadily increasing. 2000 Census has the population at 26,031 and the 2010 Census has the population at 35,096 with 2015 projections showing the population at 38,508. As mentioned elsewhere in this plan, TBCD's jurisdictional authority applies only to flood and wind to its own facilities. The Cities and County require elevations of new construction above FEMA minimum requirement of first floor elevations at BFE. For this reason, vulnerability to future buildings, infrastructure, and critical facilities (relative to TBCD's jurisdictional authority limited to flood mitigation), is low. TBCD has no plans to construct infrastructure or facilities in the floodplain, and would only do so if building in compliance with the Chambers County Floodplain Ordinance.

7.7 CONTINUED COMPLIANCE WITH THE NFIP

Participation in the National Flood Insurance Program (NFIP) is important to TBCD and residents of Chambers County and the incorporated Cities. This is evidenced by the Cities, and the County's commitment to regulating development and redevelopment, by adoption of provisions that exceed the minimum requirements, and by its active pursuit of mitigation opportunities. The Cities and Chambers County, with support from TBCD, are firmly committed to continued compliance with the NFIP.

TBCD is a conservation and reclamation district and a political subdivision of the State of Texas. Considering TBCD is a separate entity and does not directly participate in the NFIP, specific actions will be determined by representatives and officials with the incorporated areas and Chambers County within TBCD. With this in mind, TBCD did not identify and prioritize NFIP actions as part of the planning process. TBCD will continue to work closely with the local jurisdictions and Chambers County to identify and recommend actions that will ensure continued compliance with the NFIP.

7.8 FUTURE ACTIONS RELATED TO NFIP COMPLIANCE

As mentioned at the beginning of this Section, TBCD is a conservation and district and a political subdivision of the State of Texas. Considering TBCD is a separate entity and does not directly participate in the NFIP, specific actions will be determined by representatives and officials with the incorporated areas and Chambers County within TBCD. With this in mind, TBCD did not identify and prioritize NFIP actions as part of the planning process. TBCD will continue to work closely with the local jurisdictions and Chambers County to identify and recommend actions that will ensure continued compliance with the NFIP.

7.9 ONGOING AND PREVIOUS MITIGATION INITIATIVES

Dealing with flood hazards, the most significant natural hazard in the Chambers County area is not a new proposition. TBCD has completed drainage engineering evaluations throughout the District and has a better understanding of risk and potential mitigation initiatives to reduce these risks, but to date, TBCD has no ongoing or previous mitigation initiatives. It is hopeful this plan will drive future mitigation initiatives.

8 SECTION 8 - MITIGATION ACTIONS

8.1 REQUIREMENTS FOR MITIGATION STRATEGY

§201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

§201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

§201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

§201.6(c)(3) (iii): [The mitigation strategy section shall include] an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

8.2 IDENTIFYING PRIORITY ACTIONS

Throughout the planning process, the Mitigation Planning Committee (MPC) discussed hazards and the number of people and types of property that are exposed to these hazards.

As part of the planning process, factors that influenced prioritizing included the Committee's review of available information on flood hazards, other hazards, past hazard events, the number of people and types of property exposed to those hazards, and the elements of the development approval process. High priority was placed on those actions that are considered consistent with current District policies, those that are technically feasible and have high political and social acceptance, cost effective and those that can be achieved using existing authorities, budget levels, and staff.

As part of the planning process, the mitigation actions items were established to achieve the goals discussed in Section 4.2, TBCD's Mitigation Goals. Each action item identifies an appropriate lead person for each action, cost effectiveness, a schedule for completion and suggested funding sources. The MPC chose the (STAPLEE) methodology to prioritize mitigation actions. STAPLEE assesses actions based on six general criteria: Social, Technical, Administrative, Political, Legal, Economic, and Environmental. Table 8-1 describes the criteria used in the STAPLEE methodology.

Table 8-1 - STAPLEE Methodology Criteria

STAPLEE	Criteria Explanation
S – Social	Mitigation actions are acceptable to the community if they do not adversely affect a particular segment of the population, do not cause relocation of lower income people, and if they are compatible with the community's social and cultural values.
T – Technical	Mitigation actions are technically most effective if they provide long- term reduction of losses and have minimal secondary adverse impacts.
A – Administrative	Mitigation actions are easier to implement if the jurisdiction has the necessary staffing and funding.
P – Political	Mitigation actions can truly be successful if all stakeholders have been offered an opportunity to participate in the planning process and if there is public support for the action.
L – Legal	It is critical that the jurisdiction or implementing agency have the legal authority to implement and enforce a mitigation action.
E – Economic	Budget constraints can significantly deter the implementation of mitigation actions. Hence, it is important to evaluate whether an action is cost-effective, as determined by a cost benefit review, and possible to fund.
E - Environmental	Sustainable mitigation actions that do not have an adverse effect on the environment, that comply with Federal, State, and local environmental regulations, and that are consistent with the community's environmental goals, have mitigation benefits while being environmentally sound.

The MPC members developed and prioritized the actions using the STAPLEE criteria. The high priority action items in Table 8-2 were prioritized by the MPC based on the STAPLEE criteria and their potential to reduce risk to TBCD, including its operations, and physical assets. The highest priority actions are generally those that are most effective in reducing risks to multiple assets simultaneously.

The Planning Committee defined High, Medium, and Low priorities in the Action Plan as follows:

- High: Meets five of the seven STAPLEE criteria
- Medium: Meets four of the seven STAPLEE criteria
- Low: Meets three of the seven STAPLEE criteria

These priorities were applied to the action items. The items were sorted by high and medium/ low priority. A key criterion in the MPC's prioritization of actions was the cost-effectiveness of actions and projects. Cost effectiveness will continue to be central to TBCD's decision-making processes in identifying and funding mitigation actions.

8.3 MITIGATION ACTIONS

Table 8-2 identifies each High-priority mitigation actions (meets five of the seven STAPLEE criteria) and identifies the proposed lead office and support assignments, cost, and schedule for completion. The proposed timeframes are consistent with the five-year review cycle required for Plan updates. For each High and medium-priority action, the MPC characterized anticipated support by the TBCD Board of Directors, TBCD Management, and the community at-large, discussed funding limitations and status, and developed a qualitative statement regarding cost effectiveness. In this context, the cost of accomplishing the action was compared to the perceived benefits, including community-wide safety. In some cases, several of the high-priority actions and projects were subjected to preliminary feasibility assessments and benefit-cost analyses to determine if they were good candidates for mitigation actions.

Table 8-2 - TBCD: High and Medium Priority Mitigation Actions

No.	Action Item Description / Benefits	Lead Manager	Funding/Support	Schedule	Priority	Hazard	Cost-Effective-ness	Status as of 2013
1	**North Lake Addition Drainage Improvements –** Construction of a drainage outfall channel and a detention pond to serve the area north of Interstate 10 in the Winnie community.	TBCD	Part of TBCD budget as ongoing operations. TBCD will identify funding sources as needed and work in cooperation with other local jurisdictions and State/Federal government authorities to maximize potential for funding. Estimate: $2,300,000 Support: Strong	2014-2017	High	Floods Hurricanes, and Tropical Storms	Study has not been completed to determine cost effective-ness.	NEW
2	**Upgrade Mayhaw Extension ditch that runs under I-10 –** enlarge Mayhaw Extension crossing of Interstate 10 and for a distance of 2.5 miles downstream of I-10 to serve the east side of Winnie	TBCD	Part of TBCD budget as ongoing operations. TBCD will identify funding sources as needed and work in cooperation with other local jurisdictions and State/Federal government authorities to maximize potential for funding. Estimate: $4,800,000 Support: Strong	2014-2017	High	Floods Hurricanes, and Tropical Storms	Study has not been completed to determine cost effective-ness.	NEW
3	**Spindletop 1 –** Construct a detention pond on Spindletop Bayou to serve the lower west side of Winnie	TBCD	Part of TBCD budget as ongoing operations. TBCD will identify funding sources as needed and work in cooperation with other local jurisdictions and State/Federal government authorities to maximize potential for funding. Estimate: $3,500,000 Support: Strong	2014-2017	High	Floods Hurricanes, and Tropical Storms	Study has not been completed to determine cost effective-ness.	NEW

No.	Action Item Description / Benefits	Lead Manager	Funding/Support	Schedule	Priority	Hazard	Cost-Effective-ness	Status as of 2013
4	**Spindletop 2 –** Construct a detention pond on Ogden Ditch to serve the upper west side of the Winnie Community	TBCD	Part of TBCD budget as ongoing operations. TBCD will identify funding sources as needed and work in cooperation with other local jurisdictions and State/Federal government authorities to maximize potential for funding. Estimate: $3,500,000 Support: Strong	2014-2017	High	Floods Hurricanes, and Tropical Storms	Study has not been completed to determine cost effective-ness.	NEW
5	**Turtle Bayou 1 –** Enlarge Spring Branch Diversion, including one road crossing, to serve the south side of Hankamer	TBCD	Part of TBCD budget as ongoing operations. TBCD will identify funding sources as needed and work in cooperation with other local jurisdictions and State/Federal government authorities to maximize potential for funding. Estimate: $1,100,000 Support: Strong	2014-2017	High	Floods Hurricanes, and Tropical Storms	Study has not been completed to determine cost effective-ness.	NEW
6	**Turtle Bayou 2 –** Construct a Detention Pond on Whites Bayou to serve the area south of I-10 and north of Anahuac	TBCD	Part of TBCD budget as ongoing operations. TBCD will identify funding sources as needed and work in cooperation with other local jurisdictions and State/Federal government authorities to maximize potential for funding. Estimate: $3,500,000 Support: Strong	2014-2017	High	Floods Hurricanes, and Tropical Storms	Study has not been completed to determine cost effective-ness.	NEW

No.	Action Item Description / Benefits	Lead Manager	Funding/Support	Schedule	Priority	Hazard	Cost-Effective-ness	Status as of 2013
7	**Jenkins Weir Floodgates –** Reconstruct the failing Jenkins Weir to provide flood protection on the West Fork Double Bayou, north of I-10	TBCD	Part of TBCD budget as ongoing operations. TBCD will identify funding sources as needed and work in cooperation with other local jurisdictions and State/Federal government authorities to maximize potential for funding. Estimate: $2,600,000 Support: Strong	2014-2017	High	Floods Hurricanes, and Tropical Storms	Study has not been completed to determine cost effective-ness.	NEW
8	**Elm Bayou Drainage Improvements –** Enlarge the floodgate structure, enlarge road crossings and enlarge the ditch	TBCD	Part of TBCD budget as ongoing operations. TBCD will identify funding sources as needed and work in cooperation with other local jurisdictions and State/Federal government authorities to maximize potential for funding. Estimate: $4,600,000 Support: Strong	2014-2017	High	Floods Hurricanes, and Tropical Storms	Study has not been completed to determine cost effective-ness.	NEW
9	**Onion Bayou Crossing Improvements –** Enlarge the Onion Bayou floodgates and crossing structure	TBCD	Part of TBCD budget as ongoing operations. TBCD will identify funding sources as needed and work in cooperation with other local jurisdictions and State/Federal government authorities to maximize potential for funding. Estimate: $2,900,000 Support: Strong	2014-2017	High	Floods Hurricanes, and Tropical Storms	Study has not been completed to determine cost effective-ness.	NEW

No.	Action Item Description / Benefits	Lead Manager	Funding/Support	Schedule	Priority	Hazard	Cost-Effective-ness	Status as of 2013
10	**East Bay Watershed Drainage Improvements –** Enlarge the floodgate structure, enlarge road crossings and enlarge the ditch	TBCD	Part of TBCD budget as ongoing operations. TBCD will identify funding sources as needed and work in cooperation with other local jurisdictions and State/Federal government authorities to maximize potential for funding. Estimate: $4,300,000 Support: Strong	2014-2017	High	Floods Hurricanes, and Tropical Storms	Study has not been completed to determine cost effective-ness.	NEW
11	**Anahuac Outfall Enlargement –** Enlarge the Anahuac Outfall Ditch, including road crossings, to serve the majority of Anahuac	TBCD	Part of TBCD budget as ongoing operations. TBCD will identify funding sources as needed and work in cooperation with other local jurisdictions and State/Federal government authorities to maximize potential for funding. Estimate: $3,100,000 Support: Strong	2014-2017	High	Floods Hurricanes, and Tropical Storms	Study has not been completed to determine cost effective-ness.	NEW
12	**Mayhaw Lateral 1 –** Enlarge Mayhaw Lateral 1 and extend the channel to drain the area west of SH124 and south of Bucanner, including road crossings	TBCD	Part of TBCD budget as ongoing operations. TBCD will identify funding sources as needed and work in cooperation with other local jurisdictions and State/Federal government authorities to maximize potential for funding. Estimate: $1,700,000 Support: Strong	2014-2017	High	Floods Hurricanes, and Tropical Storms	Study has not been completed to determine cost effective-ness.	NEW

No.	Action Item Description / Benefits	Lead Manager	Funding/Support	Schedule	Priority	Hazard	Cost-Effective-ness	Status as of 2013
13	**Mayhaw Bayou –** Enlarge Mayhaw bayou, including road crossings, from Rice Festival Park to the County Line	TBCD	Part of TBCD budget as ongoing operations. TBCD will identify funding sources as needed and work in cooperation with other local jurisdictions and State/Federal government authorities to maximize potential for funding. Estimate: $3,400,000 Support: Strong	2014-2017	High	Floods Hurricanes, and Tropical Storms	Study has not been completed to determine cost effective-ness.	NEW
14	**Spindletop Lateral 4 –** Enlarge drainage channel to serve the area west of Meneely and north of Bucaneer	TBCD	Part of TBCD budget as ongoing operations. TBCD will identify funding sources as needed and work in cooperation with other local jurisdictions and State/Federal government authorities to maximize potential for funding. Estimate: $1,500,000 Support: Strong	2014-2017	High	Floods Hurricanes, and Tropical Storms	Study has not been completed to determine cost effective-ness.	NEW
15	**Generator for New Building**	TBCD	Part of TBCD budget as ongoing operations. TBCD will identify funding sources as needed and work in cooperation with other local jurisdictions and State/Federal government authorities to maximize potential for funding. Estimate: $100,000 Support: Strong	2014-2018	High	Floods, Hurricanes, Tropical Storms, Tornadoes and High Winds	Study has not been completed to determine cost effectiveness	NEW

No.	Action Item Description / Benefits	Lead Manager	Funding/Support	Schedule	Priority	Hazard	Cost-Effective-ness	Status as of 2013
16	**Harden portion of New TBCD Administration Building**	TBCD	Part of TBCD budget as ongoing operations. TBCD will identify funding sources as needed and work in cooperation with other local jurisdictions and State/Federal government authorities to maximize potential for funding. Estimate: $250,000 Support: Strong	2013-2017	High	Floods, Hurricanes, Tropical Storms, Tornadoes and High Winds	Study has not been completed to determine cost effective-ness	NEW
17	**Hurricane Shutters for New Administrative Building**	TBCD	Contingent upon federal grant funds - cost-share will be required in future budgets if federal grant funds are obtained for projects. Estimate: $100,000 Support: Strong	2017	High	Hurricanes, Tropical Storms, Tornadoes and High Winds	Cost Effective	NEW
18	Develop and adopt a master drainage plan in order for TBCD to exercise the authority granted under Chapter 49.211 of the Texas Water Code. Chapter 49.211 requires districts to adopt master drainage plans before adopting rules relating to the review and approval of proposed development drainage plans.	TBCD	Potential 50/50 grant from TWDB. Estimate: $50,000 Support: Strong	Medium	1 to 5 years	Flood	Cost effective	NEW

No.	Action Item Description / Benefits	Lead Manager	Funding/Support	Schedule	Priority	Hazard	Cost-Effective-ness	Status as of 2013
19	Create severe weather action plan, conduct drills, identify and promulgate evacuation and sheltering options.	TBCD	District Operating Budget, State funds, FEMA grant funds if project determined programmatically eligible, and if project is cost-effective Estimate: $25,000	Medium	1 to 5 years	Hurricanes, Tropical Storms, Tornadoes and High Winds	Cost effective	NEW
20	Due to the data deficiency identified as part of the Dam Failure Risk Assessment, work with Chambers County, TCEQ, and private Dam owners (where possible) to encourage the development of inundation maps for all high hazard Dams that may affect the planning area. When and if available, this data will be used for the next plan update to complete a more thorough risk assessment, to include extent and impact of potential dam failures.	TBCD	Staff Time	High	1 to 5 years	Flood, Dam Failure	Not independently Cost Effective	NEW

There were no low actions because these actions were not even considered because they were not a priority and not cost beneficial or even cost feasible. As stated elsewhere in this plan, TBCD has no authority to address hazards other than flood, and High Winds as related to District owned facilities.

It should be noted that TBCD is a conservation district. As such, TBCD has no authority to address hazards other than flooding in general, and tornadoes, hurricanes and tropical storms as related to District owned facilities. Chambers County and incorporated jurisdictions within TBCD are currently developing their own All-hazards mitigation plans or are a part of others. These plans include action items relating to all hazards, including floods. TBCD cooperates with these jurisdictions on the identification and implementation of mitigation projects, as allowed by law. This coordination is focused on mitigation projects designed to prevent future flood damage and wind damage to TBCD owned facilities.

Links to Mitigation Goal Statement

Table 8-3 - TBCD's Mitigation Goal Statement

Trinity Bay Conservation Districts Mitigation Goal Statement
The mitigation goals of TBCD are: ➢ To protect public health, safety, and welfare ➢ To reduce losses due to hazards by identifying hazards, minimizing exposure of citizens and property to hazards, and increasing public awareness and involvement ➢ To facilitate the development review and approval process to accommodate growth in a practical way that recognizes existing storm water and floodplain problems while avoiding creating new problems or worsening existing problems ➢ In cooperation with other local organizations to develop and initiate hazard mitigation actions and projects which will serve to protect the lives and property of citizens in the planning area. ➢ To seek solutions to existing problems

Table 8-4 shows how the proposed actions listed in Section 8.2 directly support TBCD's Mitigation Goal Statement. A number of actions individually support more than one element of the goal.

Table 8-4 - Linking Mitigation Goals & Actions

Element of Goal Statement	Actions Relating to Goal
Protect public health, safety, and welfare	1 – 20

Reduce losses due to hazards by identifying hazards, minimizing exposure of citizens and property to hazards, and increasing public awareness and involvement	1 – 20
Facilitate the development review and approval process to accommodate growth in a practical way that recognizes existing storm water and floodplain problems while avoiding creating new problems or worsening existing problems	18
In cooperation with other local organizations to develop and initiate hazard mitigation actions and projects which will serve to protect the lives and property of citizens in the Chambers County and TBCD planning areas, through development and initiation of hazard mitigation actions and projects	1 – 20
Seek solutions to existing problems	1 – 17, 19 and 20

9 SECTION 9 - TEXAS AGENCIES, ORGANIZATIONS & FEMA NFIP PROGRAM

9.1 OVERVIEW

Mitigation of flood hazards traces its roots to Congressional deliberations about how to address continued and repetitive flood disasters throughout the first half of the 20th Century. The National Flood Insurance Program, authorized in 1968, prompted State and local government actions primarily intended to recognize and account for flood hazards in decisions on local development. It was not until 1988 that the concept of mitigation planning was articulated in a statute, known as "Section 409" planning. In 2000, the statute was revised under the Disaster Mitigation Act of 2000.

At the federal level, the Federal Emergency Management Agency administers mitigation programs that foster planning and project implementation to address existing risks. At the State and regional levels, several agencies and organizations sponsor programs that bear on hazard mitigation. The following sections provide an overview of existing Texas agencies, organizations, and programs addressing hazard mitigation.

9.2 TEXAS DIVISION OF EMERGENCY MANAGEMENT

The Texas Division of Emergency Management (TDEM) (www.txdps.state.tx.us/dem) is designated by the Governor as the State's coordinating agency for disaster preparedness, emergency response, and disaster recovery assistance. TDEM is also tasked with coordinating the State's natural disaster mitigation initiatives, chairing the State Hazard Mitigation Team, and maintaining the State of Texas Emergency Management Plan. TDEM fosters local mitigation planning and administers Hazard Mitigation Grant Program (HGMP), the Pre Disaster Mitigation Grant (PDM) and Repetitive Flood Claims (RFC) funds provided through the Federal Emergency Management Agency.

9.3 TEXAS WATER DEVELOPMENT BOARD

The Texas Water Development Board (TWDB; www.twdb.state.tx.us) administers a variety of programs related to water. The TWDB is the agency charged with statewide water planning and administration of financial assistance programs for the planning, design, and construction of water supply, wastewater treatment, flood control, and agricultural water conservation projects. TWDB administers funding from FEMA under the Flood Mitigation Assistance Program (FMA) and the Severe Repetitive Loss (SRL) Program (see Section 2). TWDB also is designated by the Governor as the State Coordinating Agency for the National Flood Insurance Program. In this capacity, the agency assists communities with floodplain mapping matters and interpretation and enforcement of local floodplain management regulations.

9.4 TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

The Texas Commission on Environmental Quality (TCEQ; www.tceq.state.tx.us) is a diversified agency dealing with permitting, licensing, compliance, enforcement, pollution prevention, and educational programs related to preservation and protection of air and water quality and the safe disposal of waste. Related to mitigation of natural hazards are TCEQ programs that deal with drought, dam safety, and flood control and floodplain management.

9.5 FEMA NATIONAL FLOOD INSURANCE PROGRAM

In 1968, Congress authorized FEMA's National Flood Insurance Program (NFIP) for two primary purposes:

(1) to have flood-prone property owners contribute to their own recovery from flood damage through an insurance program; and

(2) to guide development such that it is less prone to flood damage. To facilitate implementation, the NFIP created Flood Insurance Rate Maps (FIRMs) that, based on best available information and engineering methodologies, show areas subject to flooding by the 1-percent-annual chance flood (also called the "100-year flood"). Communities use the maps to guide and regulate development. Citizens and insurance professionals use the maps to determine insurance needs.

It is notable that, whereas flood insurance claims are paid when damage is sustained from any qualifying flood event, federal disaster assistance is available only after a flood is determined to be a "major disaster." A major disaster exceeds State and local capabilities. In addition, disaster grants to individuals and families are limited to approximately $14,000 (average payment is $6,000). Therefore, owners of insured buildings that are in areas known to flood, especially as shown on FIRMs, are protected financially as long as they carry sufficient flood insurance coverage. Additional information on flood insurance coverage for property owners and consumers is available online at www.fema.gov/national-flood-insurance-program/information-homeowners-renters.

Basic federal flood insurance helps pay for property damage and loss of contents. Under certain circumstances – for example, if flood damage causes "substantial damage" – an additional mitigation claim payment is available to help owners bring buildings into compliance with NFIP flood protection standards (as of May, 2003, this additional payment is capped at $30,000). In addition, compliance is required when a building is substantially improved (includes repair of substantial damage). Substantial improvement is defined as improvements valued at 50% or more of the building's market value before improvement.

Table 9-1 - Flood Insurance in Texas (as of 3/31/2011) Source: NFIP Statistics online at www.fema.gov/nfip

With 656,335 NFIP policies in force (over 11.7% of all policies nationwide), Texas ranks second among all States in number of flood-insured properties (Florida is #1). Property owners in Texas have received over 238,000 claim payments totaling $5.49 Billion; only Louisiana has had more claims paid with just over $16 Billion.

10 SECTION 10 – PLAN MAINTENANCE AND IMPLEMENTATION

10.1 REQUIREMENTS FOR PLAN MONITORING AND MAINTENANCE

§201.6(c)(4)(i): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle

§201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.

§201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.

Distribution

The 2013 Trinity Bay Conservation District (TBCD) Hazard Mitigation Plan will be posted publically on the internet and notices of its availability will be distributed to the following:

1. The federal and State agencies that were notified and invited to participate in Plan development (see Sec. 1);
2. Incorporated Cities within Chamber County;
3. Citizens who attended public meetings and provided contact information or made request for information at TBCDs office; and
4. The stakeholders which, included civic organizations, local agencies, and elected officials who received notices of public meetings.

10.2 IMPLEMENTATION

Through the mitigation planning process, TBCD departments that are involved in managing hazards and implementing measures to minimize future risk considered a range of mitigation actions. High priority actions were identified and prioritized, and are shown in Table 8-2.

For each mitigation action, Table 8-2 identifies the lead agency, support agencies, priority level, and time period for implementation. Each lead agency is responsible for factoring the action into its work plan and schedule over the indicated time period. Annual meetings will be held to discuss the status of implementation and identify and obstacles that may impede progress toward achieving the mitigation goals and actions.

10.3 MONITORING & PROGRESS REPORTS

For the Plan, the planning committee determined that progress would be better monitored by annual meetings of the MPC. Upon adoption, the MPC will meet on an annual basis to discuss the status of the Plan and determine if any significant changes are warranted. As part of the meeting, the TBCD General Manager will note progress made on the mitigation action items listed in Table 8-2 to this end, the General Manager may convene a meeting of the appropriate District, City and County Departments to discuss and determine progress, and to identify obstacles to progress, if any.

In addition to annual meetings, the general manager will convene meetings after damage-causing natural hazard events to review the effects of such events. Based on those effects, adjustments to the mitigation priorities listed in Table 8-2 may be made or additional event-specific actions identified. Such revisions shall be documented as outlined in the following sub-section.

10.4 CIRCUMSTANCES THAT WILL INITIATE PLAN REVIEW AND UPDATES

This section identifies the circumstances or conditions under which Trinity Bay Conservation District will initiate Plan reviews and updates.

- On the recommendation of the General Manager or on its own initiative, the TBCD Board of Directors may initiate a Plan review at any time.
- At approximately the one-year anniversary of the Plan's re-adoption, and every year thereafter.
- After natural hazard events that appear to significantly change the apparent risk to assets, operations and/or citizens of TBCD.
- When activities of TBCD, County, or the State significantly alter the potential effects of natural hazards on District assets, operations and/or citizen. Examples include completed mitigation projects that reduce risk, or actions or circumstances that increase risk.
- When new mitigation opportunities or sources of funding are identified.

In addition to the circumstances listed above, revisions that warrant changing the text of this Plan or incorporating new information may be prompted by a number of circumstances, including identification of specific new mitigation projects, completion of several mitigation actions, or requirements for qualifying for specific funding. Minor revisions may be handled by addenda.

Major comprehensive review of, and revisions to this Hazard Mitigation Plan will be considered on a five-year cycle. To be adopted in 2014, the Plan will enter its next review cycle sometime in 2017, with adoption of revisions anticipated in 2018. The Mitigation Planning Committee will be convened to conduct the comprehensive evaluation and revision.

10.5 CONTINUED PUBLIC INVOLVEMENT

Upon adoption of the Plan, the public will be notified of any substantial changes to the document between adoption and the next scheduled Plan update. The public will be notified by public notice and in the Board Meeting that addresses the potential changes and will be provided time to review and provide comment to the document which will be posted publically on the internet and available in hard copy for review at the TBCD's office. Comments will be received to the General Manager of TBCD by email or mail and those comments will be considered before the final change is approved to move forward in the document. Any changes proposed by the MPC considered significant will be distributed to the list of stakeholders. The Stakeholders will be encouraged to review the changes and provide comments on any proposed plan revisions.

TBCD will involve the public in the plan maintenance process and during any Plan Updates, using the same methods as the original plan development which includes public notification when the revision process is started and provided the opportunity to review and comment on changes to the plan and priority action items prior to submittal of the final process document for approval by the State and FEMA. TBCD will host informational public meetings, provide draft documents on the internet for public review and comment, and announce publically Board of Director meetings that review and approve changes to the plan.

11 APPENDIX A – GENERAL DESCRIPTION OF NATURAL HAZARDS

The following is a general description for each of the hazards listed below.

General descriptions completed for the following natural hazards;

1. Tornadoes
2. Thunderstorms/High Winds
3. Hurricanes and Tropical Storms
4. Extreme Heat
5. Drought
6. Wildand Fire
7. Winter Storm
8. Seismic/ Earthquake
9. Landslides
10. Flood
11. Storm Surge
12. Dams/Dam Failure

11.1 TORNADOES

11.1.1 Definition of the Tornado Hazard

A tornado is a rapidly rotating funnel (or vortex) of air that extends toward the ground from a cumulonimbus cloud. Most tornadoes do not touch the ground, but when the lower tip of a tornado touches the earth, it can cause extensive damage. Tornadoes often form in convective cells such as thunderstorms or at the front of hurricanes. Tornadoes may also result from earthquake induced fires, wildfires, or atomic bombs (FEMA, 1997). The formation of tornadoes from thunderstorms is explained in Figure A-3.

11.1.2 Characteristics of Tornadoes

Tornadoes in the dissipating stage can appear like narrow tubes, or ropes, twisting into all manner of curls, twists, and s-shapes. These tornadoes, such as the one pictured above, are roping out, or becoming a rope tornado. Multiple-vortex tornadoes can appear as a family of swirls circling a common center, or may be completely obscured by condensation, dust, and debris, appearing to be a single funnel. In addition to these appearances, tornadoes may be obscured completely by rain or dust. These tornadoes are especially dangerous, as even experienced meteorologists might not spot them. As shown in the following table, tornadoes were measured by the Fujita Scale, an empirical system that determines the severity by observed damages (last column).

Appendix Table A-1 - The Fujita Tornado Scale (Source: FEMA 1997)

Category	Wind Speed	Description of Damage
F0	40-72 mph	Light damage. Some damage to chimneys; break branches off trees; push over shallow-rooted trees; damage to sign boards.
F1	73-112 mph	Moderate damage. The lower limit is the beginning of hurricane speed. Roof surfaces peeled off; mobile homes pushed off foundations or overturned; moving autos pushed off roads.
F2	113-157 mph	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.
F3	158-206 mph	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; cars lifted off ground and thrown.
F4	207-260 mph	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	261-318 mph	Incredible damage. Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile-sized missiles fly through the air in excess of 100-yards; trees debarked.

In February of 2007 the F-Scale (Table A-1) was replaced with a more accurate Enhanced Fujita Scale (Table A-2). It was the Jarrell, Texas tornado of May 27, 1997 and the Oklahoma City/Moore tornado of

May 3, 1999 that brought to the forefront the problem that perhaps the wind estimates were too high in the F-Scale. The changes to the original scale were proposed by a committee of meteorologist and engineers searching for a more accurate method of assessing the magnitude of tornadoes. Changes to the original Fujita scale were designed to ensure compatibility with the existing databases of tornado hazards, including the one maintained by the NCDC.

The Enhanced F-scale has the same basic design as the original Fujita scale, six categories from zero to five representing increasing degrees of damage.[20] It was revised to reflect better examinations of tornado damage surveys, so as to align wind speeds more closely with associated storm damage. The new scale also considers damages to a wider variety of structures and better accounts for variables such as differences in construction quality. Table A-2 displays the wind speed ranges for the original Fujita Scale, the derived wind speeds (Enhanced F-scale), and the new Enhanced F-scale, in wide use since February of 2007.

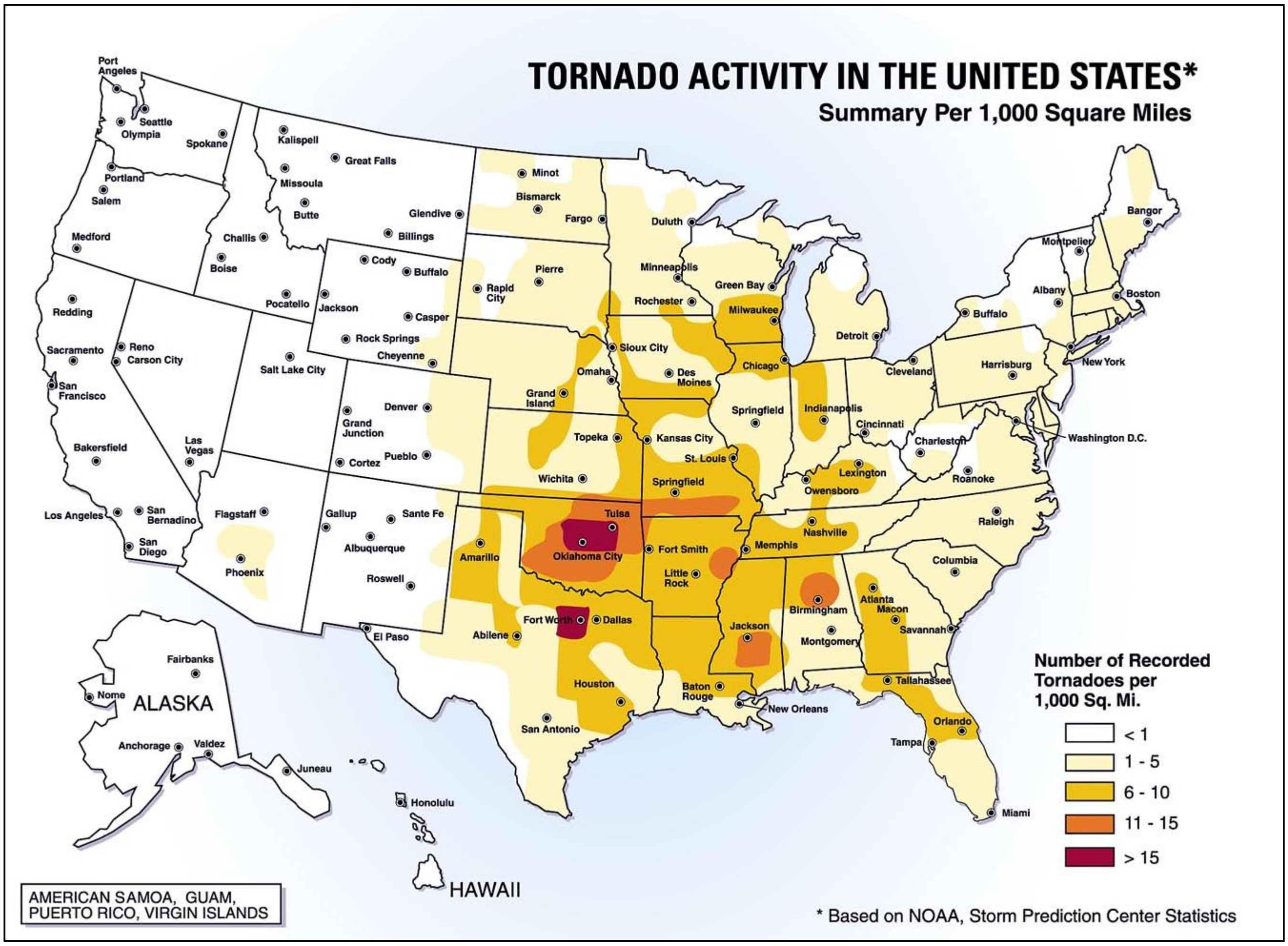
Table A-2 -Wind Speed Comparison of the Fujita Scale and Enhanced Fujita Scale (Source: NOAA – National Weather Service)

Fujita Scale			Derived EF Scale		Operational EF Scale	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

Figure A-1 illustrates the frequency of tornado strikes in the U.S. per 1,000 square miles. While tornadoes can occur in any month and at all hours of the day or night, they occur with greatest frequency during the late spring and early summer months during late afternoon and early evening hours.

[20] *NOAA; Storm Prediction Center – Summary of Enhanced F-scale*

Appendix Figure Error! No text of specified style in document.**-1 - Historic Tornado Activity in the United States, Summary per 1,000 Square Miles**



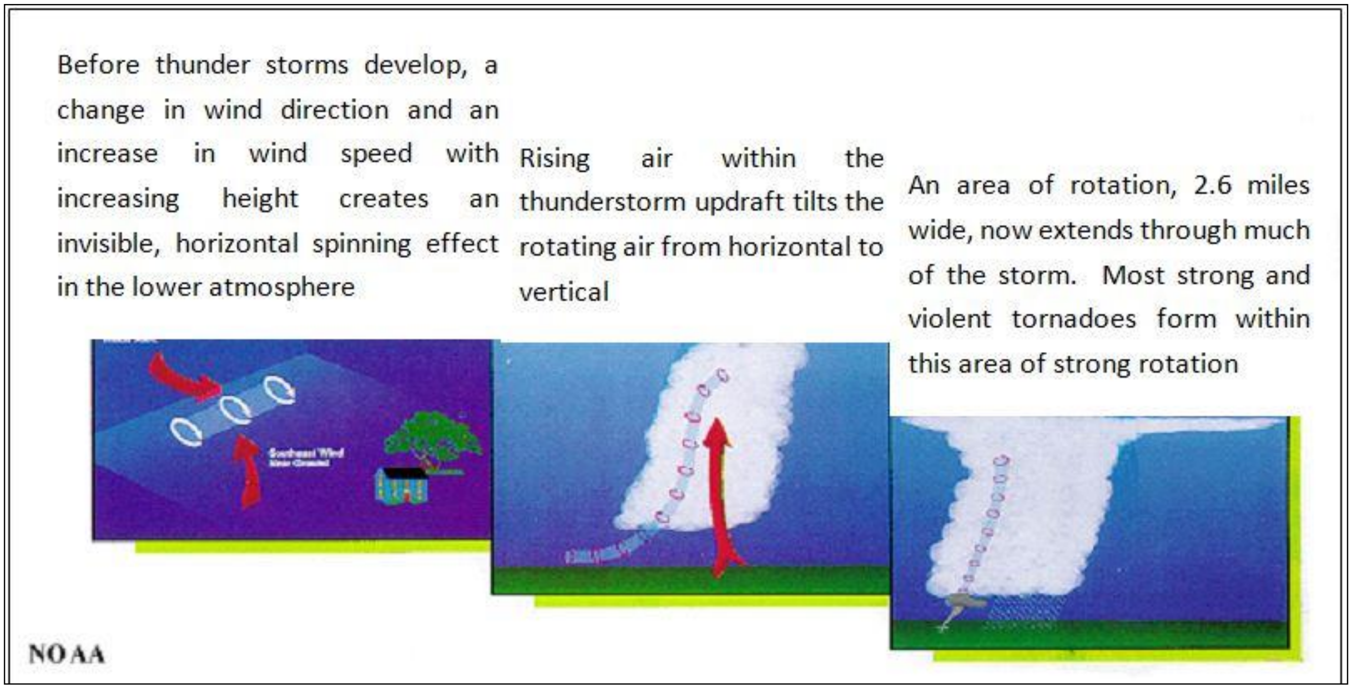
The severity and duration of tornadoes is a function of several factors, including weather conditions, topography and the class of the event. As noted earlier, tornado severity is measured with the Enhanced Fujita scale, an empirical system that classifies events after they occur. In some cases there are anomalous patterns for various reasons (including the reliability and completeness of reporting), but generally speaking smaller events are more probable, larger (more severe) ones are less likely.

Tornado duration is usually relatively short, varying from a matter of seconds to several minutes on the ground, although in rare cases they can last significantly longer. The path width of a single tornado generally is less than 0.6 miles. The path length of a single tornado can range from a few hundred yards to miles. A tornado typically moves at speeds between 30 and 125 mph and can generate internal winds exceeding 300 mph.

Appendix Figure A-2 - Strong Wind Effects (Source: FEMA)

Most tornadoes take on the traditional appearance of a narrow funnel, a few hundred yards across, with a small cloud of debris near the ground. Tornadoes can appear, however, in all manner of shapes and sizes.

Appendix Figure A-3 - Formation of Tornadoes (Source: NOAA)



Small, relatively weak land spouts might only be visible as a small swirl of dust on the ground. While the condensation funnel may not extend all the way to the ground, if associated surface winds are greater than 40 mph (64 km/h), it is considered a tornado. Large single-vortex twisters, often violent, can look like a large wedge stuck into the ground, and are known as wedge tornadoes or wedges. Wedges can be so wide that they appear to be a block of dark clouds. Even experienced storm observers may not be able to tell the difference between a low-hanging cloud and a wedge tornado from a distance.

11.2 THUNDERSTORMS/HIGH WINDS

11.2.1 Definition of the Thunderstorm/High Winds Hazard

Wind is the uneven horizontal movement of air resulting from the irregular heating of the earth's surface. It can range from local breezes produced by heat from land surfaces and lasting tens of minutes to powerful global winds resulting from solar heating of the earth. Severe winds typically result from hurricanes, nor'easters, tropical storms, tornadoes, thunderstorms, or winter storms.

By definition, the National Weather Service (NWS) classifies a thunderstorm as severe if it contains hail of three-quarter inches or larger and/or winds gusts of 58 mph or higher. Severe thunderstorm watches, meaning conditions are suitable for severe storm development during the next several hours, are issued for areas several hundred miles on a side by the NWS Storm Prediction Center in Norman, Oklahoma. A severe thunderstorm warning is issued by the local National Weather Service Office, usually for several counties or parts thereof for the next hour or so based upon spotter reports of conditions exceeding severe levels and/or by radar indications of the same.[21]

11.2.2 Characteristics of Thunderstorm/High Winds

High winds are capable of imposing large lateral (horizontal) and uplift (vertical) forces on buildings. Residential buildings can suffer extensive wind damage when they are improperly designed and constructed and when wind speeds exceed design levels. The effects of high winds on a building will depend on several factors:

- Wind speed (sustained and gusts) and duration of high winds
- Height of building above the ground
- Exposure or shielding of the building (by topography, vegetation, or other buildings) relative to wind direction
- Strength of the structural frame, connections, and envelope (walls and roof)
- Shape of building and building components
- Number, size, location, and strength of openings (windows, doors, vents)
- Presence and strength of shutters or opening protection
- Type, quantity, velocity of windborne debris

Proper design and construction of residential structures, particularly those close to water or near the coast, demand that every factor mentioned above be addressed. Failure to do so may result in building damage or destruction by wind.

Thunderstorms arise when clouds develop sufficient upward motion and are cold enough to provide the ingredients (ice and supercooled water) to generate and separate electrical charges within the cloud. Warm, moist air rising in sufficiently large volume with a high enough velocity results in a thunderstorm. The fuel for these storms is warm, moist air present near the surface of the earth. If the atmosphere around the cloud is unstable, that is the temperature of the air falls faster than that of the rising parcel air within the storm, then the updraft becomes ever warmer than the air outside, and therefore more buoyant. The release of latent heat when water vapor turns to liquid and then the liquid to ice further warms the rising parcel, stoking the “fires” of the updraft. A trigger is often necessary to get the warm bubble of air rising in the first place. Sometimes it can be a warm air thermal rising from a large, heated

[21] National Weather Service – Facts about thunderstorms

field or a sunlit mountain top, or the upward motion produced by fronts pushing air together so it has no place to go but up. [22]

11.3 HURRICANES AND TROPICAL STORMS

11.3.1 Definition of Hurricanes and Tropical Storms

Hurricanes, tropical storms, and typhoons, collectively known as tropical cyclones, are among the most devastating naturally occurring hazards in the United States. They present flooding, storm surge, and high wind hazards to the communities that they impact.

A hurricane is defined as a low-pressure area of closed circulation winds that originates over tropical waters. A hurricane begins as a tropical depression with wind speeds below 39 mph. As it intensifies, it may develop into a tropical storm, with further development producing a hurricane. Table A-3 below identifies the criteria for each stage of development.

Appendix Table A-3 - Classification of Hurricanes

Stage of Development	Criteria
Tropical Depression (development)	Maximum sustained surface wind speed is < 39 mph
Tropical Storm	Maximum sustained wind speed ranges 39 - <74 mph
Hurricane	Maximum sustained surface wind speed 74 mph+
Tropical Depression (dissipation)	Decaying stages of a cyclone in which maximum sustained surface wind speed has dropped below 39 mph

Hurricane winds blow in a large spiral around a relative calm center known as the "eye." The "eye", the storms core, is an area of low barometric pressure and is generally 20 to 30 miles wide. The storm may extend outward 100 - 400 miles in diameter. As a hurricane approaches, the skies will begin to darken and winds will grow in strength. As a hurricane nears land, it can bring torrential rains, high winds, storm surges, and severe flooding.

[22] National Weather Service – Facts about thunderstorms

As shown in Table A-4, the Saffir / Simpson Hurricane Scale is used to classify storms by numbered categories. Hurricanes are classified as Categories 1 through 5 based on central pressure, wind speed, storm surge height, and damage potential.

Appendix Table A-4 - Saffir/Simpson Hurricane Scale

Storm Category	Central Pressure	Sustained Winds	Storm Surge	Potential Damage
1	> 980 mbar	74 - 95 mph	4 – 5 ft	Minimal
2	965 – 979 mbar	96 - 110 mph	6 – 8 ft	Moderate
3	945 – 964 mbar	111 – 130 mph	9 – 12 ft	Extensive
4	920 – 944 mbar	131 – 155 mph	13 – 18 ft	Extreme
5	< 920 mbar	> 155 mph	> 18 ft	Catastrophic

A single hurricane can last for more than two weeks over open waters and can run a path across the entire length of the eastern seaboard. August and September are peak months during the hurricane season that lasts from June 1 through November 30.

11.3.2 Characteristics of Hurricanes and Tropical Storms

Hurricanes and Tropical Storms are categorized based on their wind speed. Both bring strong winds and are characterized by torrential rain that often results in widespread damage. Hurricanes can produce both extreme high winds and heavy rains. Tropical storms are most often associated with heavy rains that have the potential to produce severe flooding.

High winds from Hurricanes and Tropical Storms are capable of imposing large lateral (horizontal) and uplift (vertical) forces on buildings. Residential buildings can suffer extensive wind damage when they are improperly designed and constructed and when wind speeds exceed design levels. The effects of high winds on a building will depend on several factors:

- Wind speed (sustained and gusts) and duration of high winds
- Height of building above the ground
- Exposure or shielding of the building (by topography, vegetation, or other buildings) relative to wind direction
- Strength of the structural frame, connections, and envelope (walls and roof)
- Shape of building and building components
- Number, size, location, and strength of openings (windows, doors, vents)

- Presence and strength of shutters or opening protection
- Type, quantity, velocity of windborne debris

Proper design and construction of residential structures, particularly those close to water or near the coast, demand that every factor mentioned above be addressed. Failure to do so may result in building damage or destruction by wind.

11.4 EXTREME TEMPERATURE (HEAT)

11.4.1 Definition of Extreme Temperature (Heat)

Extreme summer heat is the combination of very high temperatures and exceptionally humid conditions. If such conditions persist for an extended period of time, it is called a heat wave (FEMA, 1997). Heat stress can be indexed by combining the effects of temperature and humidity, as shown in Table A-5. The index estimates the relationship between dry bulb temperatures (at different humidity) and the skin's resistance to heat and moisture transfer. The higher the temperature or humidity, the higher the apparent temperature.

Appendix TableA-5 - Heat Index and Disorders (Sources: FEMA, 1997; NWS, 1997)

Danger Category		Heat Disorders	Apparent Temperatures (°F)
IV	Extreme Danger	Heatstroke or sunstroke imminent.	>130
III	Danger	Sunstroke, heat cramps, or heat exhaustion likely; heat stroke possible with prolonged exposure and physical activity.	105-130
II	Extreme Caution	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and physical activity.	90-105
I	Caution	Fatigue possible with prolonged exposure and physical activity.	89-90

In the northeastern U.S. periods of warmer than normal temperatures typically occur several times a summer. Extreme heat waves may occur about once every five years or so where maximum daily temperatures exceed 100 degrees Fahrenheit for an extended period of time. The passing of a cold front usually moderates temperatures after a few days to a week.

11.4.2 Characteristics of Extreme Temperature (Heat)

The main impact of extreme heat is its effect on the human body. In a very hot environment, the most serious concern is heat stroke. In absence of immediate medical attention, heat stroke could be fatal. Heat stroke fatalities do occur every summer. Heat exhaustion and fainting (syncope) are less serious types of illnesses which are not fatal but interfere with a person's ability to work.

The major human risks associated with extreme heat can be summarized as follows.

Heatstroke: Considered a medical emergency, heatstroke is often fatal. It occurs when the body's responses to heat stress are insufficient to prevent a substantial rise in the body's core temperature. While no standard diagnosis exists, a medical heatstroke condition is usually diagnosed when the body's temperature exceeds 105°F due to environmental temperatures. Rapid cooling is necessary to prevent death, with an average fatality rate of 15 percent even with treatment.

Heat Exhaustion: While much less serious than heatstroke, heat exhaustion victims may complain of dizziness, weakness, or fatigue. Body temperatures may be normal or slightly, to moderately elevated. The prognosis is usually good with fluid treatment.

Heat Syncope: This refers to sudden loss of consciousness and is typically associated with people exercising who are not acclimated to warm temperatures. Causes little or no harm to the individual.

Heat Cramps: May occur in people unaccustomed to exercising in the heat and generally ceases to be a problem after acclimatization.

11.5 DROUGHT

11.5.1 Definition of Drought Hazard

A drought is an extended dry climate condition when there is not enough water to support urban, agricultural, human, or environmental water needs. It usually refers to a period of below-normal rainfall, but can also be caused by drying bores or lakes, or anything that reduces the amount of liquid water available. Drought is a recurring feature of nearly all the world's climatic regions.

Drought is the result of a decline in the expected precipitation over an extended period of time, typically one or more seasons in length. Meteorological drought is defined solely on the degree of dryness, expressed as a departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales. Hydrological drought is related to the effects of precipitation shortfalls on streamflows and reservoir, lake, and groundwater levels. Agricultural drought is defined principally in terms of soil moisture deficiencies relative to water demands of plant life, usually crops. Socioeconomic drought associates the supply and demand of economic goods or services with elements of meteorological, hydrologic, and agricultural drought. Socioeconomic drought occurs when the demand for water exceeds the supply as a result of weather-related supply shortfall. This may also be called a water management drought.

Appendix Figure A-4 - Lake Travis in Austin Texas, July, 2009 (Source: Texas Water Development Board)

11.5.2 Characteristics of Drought

Drought produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area experiencing physical drought. This complexity exists because water is integral to our ability to produce goods and provide services. Impacts are commonly referred to as direct or indirect. Reduced crop, rangeland, and forest productivity; increased fire hazard; reduced water levels; increased livestock and wildlife mortality rates; and damage to wildlife and fish habitat are a few examples of direct impacts. The consequences of these impacts illustrate indirect impacts. For example, a reduction in crop, rangeland, and forest productivity may result in reduced income for farmers and agribusiness, increased prices for food and timber, unemployment, reduced tax revenues because of reduced expenditures, increased crime, foreclosures on bank loans to farmers and businesses, migration, and disaster relief programs.

Drought is a normal part of virtually every climate on the planet, including areas of both high and low normal rainfall. The severity of drought can be aggravated by other climatic factors, such as prolonged high winds and low relative humidity (FEMA, 1997). A drought's severity depends on numerous factors, including duration, intensity, and geographic extent as well as regional water supply demands by humans and vegetation. Due to its multi-dimensional nature, drought is difficult to define in exact terms and also poses difficulties in terms of comprehensive risk assessments.

Drought differs from other natural hazards in three ways. First, the onset and end of a drought are difficult to determine due to the slow accumulation and lingering effects of an event. Second, the lack of an exact and universally accepted definition adds to the confusion of its existence and severity. Third, in contrast with other natural hazards, the impact of drought is less obvious and may be spread over a larger geographic area. These characteristics have hindered the preparation of drought contingency or mitigation plans by many governments.

Droughts may cause a shortage of water for human and industrial consumption and cause a decrease in hydroelectric power. Water quality may also decline while the number and severity of wildfires may increase. Severe droughts may result in the loss of agricultural crops and forest products, undernourished wildlife and livestock, lower land values, and higher unemployment.

11.6 WILDLAND FIRES

11.6.1 Definition of Wildland Fire Hazard

A wildfire, also known as a forest fire, vegetation fire, grass fire, brush fire, or hill fire, is an uncontrolled fire often occurring in wildland areas, which can also consume houses or agricultural resources. Common causes include lightning, human carelessness, and arson.

Wildfires are fueled by naturally occurring or non-native species of trees, brush, and grasses. Topography, fuel, and weather are the three principal factors that impact wildfire hazards and behavior.

Appendix Figure A-5 - Brush Fire (Source: FEMA)

11.6.2 Characteristics of Wildfires Interface

Wildfires often begin unnoticed, spread quickly, and are usually signaled by dense smoke that may fill the area for miles around. As mentioned, wildfires can be human-caused through acts such as arson or campfires, or can be caused by natural events such as lightning. Wildfires can be categorized into three types:

Wildland fires occur in very rural areas and are fueled primarily by natural vegetation.

Interface fires occur in areas where homes or other structures are endangered by the wildfires. The fires are fueled by both natural vegetation and man-made structures. These are often referred to as Wildland Urban Interface fires.

Firestorms occur during extreme weather (e.g., high temperatures, low humidity, and high winds) with such intensity that fire suppression is virtually impossible. These events typically burn until the conditions change or the fuel is exhausted.

The following three factors contribute significantly to wildfire behavior:

1. **Fuel:** The type of fuel and the fuel loading (measured in tons of vegetative matter per acre) have a direct impact on fire behavior. Fuel types vary from light fuels (grass) to moderate fuels (Southern Rough) to heavy fuels (slash). The type of fuel and the fuel load determines the potential intensity of the wildfire and how much effort must be expended to contain and control it.

2. **Weather:** The most variable factor affecting wildfire behavior is weather. Important weather variables are precipitation, humidity, and wind. Weather events ranging in scale from localized thunderstorms to large cold fronts can have major effects on wildfire occurrence and behavior. Extreme weather, such as extended drought and low humidity can lead to extreme wildfire activity.
3. **Topography:** Topography can have a powerful influence on wildfire behavior. The movement of air over the terrain tends to direct a fire's course.

11.7 WINTER STORMS

11.7.1 Definition of Winter Storm Hazards

A winter storm is a type of precipitation in which the dominant varieties of precipitation are forms that only occur at cold temperatures, such as snow or sleet, or a rainstorm where ground temperatures are cold enough to allow ice to form (i.e. freezing rain). In temperate continental climates, these storms are not restricted to the winter season, and may occur in the late autumn and early spring. Also, there are very rare occasions when they form in summer, although it would have to be an abnormally cold summer, such as the summer of 1816 in the Northeast U.S. In many locations in the Northern Hemisphere, the most powerful winter storms usually occur in March and, in regions where temperatures are cold enough, April.

Appendix Figure A-6 - Split Tree Caused by Ice Storm (Source: FEMA)

11.7.2 Characteristics of Winter Storms

Winter storms typically form along a front generally following the meandering path of the jet stream. These storms, called mid-latitude cyclones or extra-tropical cyclones, differ from hurricanes, in that they move from west to east as opposed to east to west. These weather patterns carry cold air from Canada and the Rockies into the southern U.S. The origins of the weather patterns that cause winter storms in Texas are affected by differences in temperature and pressure, moisture availability, and wind direction as well as weather systems in the Atlantic Ocean and Gulf of Mexico.

Winter storms vary in size and strength and include heavy snowstorms, blizzards, freezing rain, sleet, ice storms and blowing and drifting snow conditions. Extremely cold temperatures accompanied by strong winds can result in wind chills that cause bodily injury such as frostbite and death. Severe winter and ice storms can cause unusually heavy rain or snowfall, high winds, extreme cold, and ice storms throughout the continental United States.

NOAA describes the jet streams that carry storm systems across the United States as narrow bands of strong wind in the upper atmosphere that follow the boundaries between hot and cold air masses. These boundaries are most pronounced during the winter months, when the jet streams travel to their southernmost position over the United States and surrounding water.

In the last 11 winters, no region in the United States has escaped flooding during the winter months. The Southeastern and Gulf Coast States (regularly hit by autumn hurricanes) experience damaging floods in the winter months, too. No region is immune. Global warming threatens to disrupt weather patterns around the world and may increase the frequency of winter flooding.

Another weather phenomenon, El Niño, can have a significant effect on precipitation in the United States. Named by Peruvian fishermen who noticed the periodic appearance of warming surface temperatures in the Pacific Ocean around Christmas, El Niño is now understood to be the warm phase of a temperature oscillation in the Pacific Basin's water and atmosphere. The cool phase of the oscillation is nicknamed La Niña. During the warm phase, heat and moisture are released into the upper atmosphere, creating precipitation. El Niño alters the course of the jet stream - pushing it farther south than usual.

According to NOAA, El Niño winters tend to be wetter than normal in the Southeastern United States, as well, and contribute to flooding along the Gulf Coast. Storms that spin up in the Gulf of Mexico typically track northeast on the southern jet stream, bringing rain as well as ice and even snow to the Gulf States.

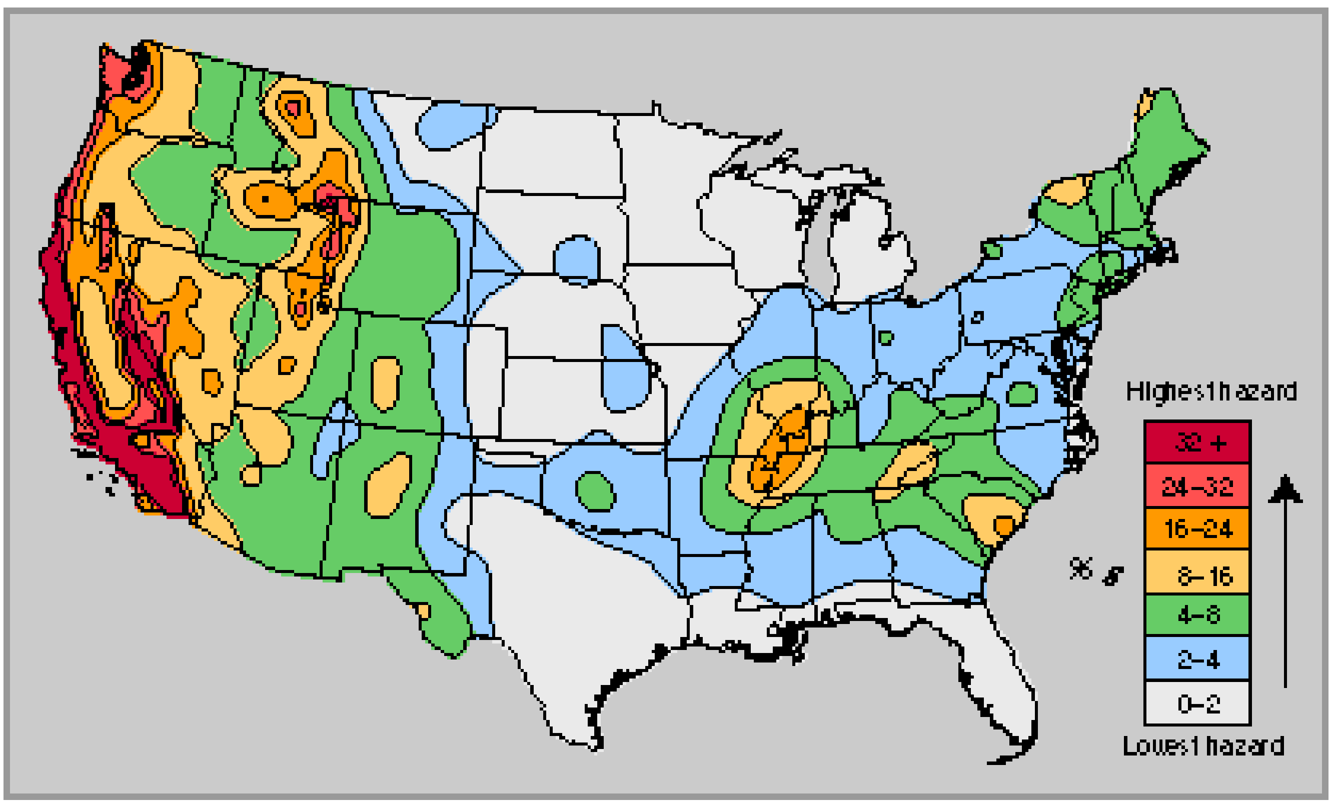
Winter storm occurrences tend to be very disruptive to transportation and commerce. Trees, cars, roads, and other surfaces develop a coating or glaze of ice, making even small accumulations of ice extremely hazardous to motorists and pedestrians. The most prevalent impacts of heavy accumulations of ice are slippery roads and walkways that lead to vehicle and pedestrian accidents; collapsed roofs from fallen trees and limbs and heavy ice and snow loads; and felled trees, telephone poles and lines, electrical wires, and communication towers. As a result of severe ice storms, telecommunications and power can be disrupted for days. Such storms can also cause exceptionally high rainfall that persists for days, resulting in heavy flooding.

11.8 EARTHQUAKES

11.8.1 Definition of Earthquake Hazard

An earthquake is "…a sudden motion or trembling caused by an abrupt release of accumulated strain in the tectonic plates that comprise the earth's crust." These rigid plates, known as tectonic plates, are some 50 to 60 miles in thickness and move slowly and continuously over the earth's interior. The plates meet along their edges, where they move away from or pass under each other at rates varying from less than a fraction of an inch up to five inches per year. While this sounds small, at a rate of two inches per year, a distance of 30 miles would be covered in approximately one million years (FEMA, 1997). Figure A-7 shows a USGS seismic probability map for the continental U.S.

Appendix Figure A-7 - United States Earthquake Zones (Source: USGS)



11.8.2 Characteristics of Earthquakes

The vibration or shaking of the ground during an earthquake is described by ground motion. Severity of ground motion generally increases with the amount of energy released and decreases with distance from the fault or epicenter of the earthquake. Ground motion causes waves in the earth's interior, also known as seismic waves, and along the earth's surface, known as surface waves. The following are the two kinds of seismic waves:

P (primary) waves are longitudinal or compressional waves similar in character to sound waves that cause back-and-forth oscillation along the direction of travel (vertical motion), with particle motion in the same direction as wave travel. They move through the earth at approximately 15,000 mph.

S (secondary) waves, also known as shear waves, are slower than P waves and cause structures to vibrate from side-to-side (horizontal motion) due to particle motion at right-angles to the direction of wave travel. Unreinforced buildings are more easily damaged by S waves.

Earthquakes are often relatively short duration, but there may be aftershocks and other effects (such as liquefaction) that prolong and exacerbate their effects. The potential for either of these effects depends on local conditions and other technical factors that are not discussed in this Plan.

There is some potential for seismic activity virtually anywhere on the earth. Locations that are close to tectonic faults, however, are much more likely to be impacted by earthquakes than other places. The United States Geologic Survey and other organizations develop maps to indicate the relatively probability of earthquakes in particular areas.

Appendix Figure A-8 - - Earthquake Damage (Source: FEMA)

11.9 LANDSLIDE (NON-SEISMIC)

11.9.1 Definition of Landslide Hazard

A landslide is a natural geologic process involving the movement of earth materials down a slope, including rock, earth, debris, or a combination of these, under the influence of gravity. However, there are a variety of triggers for landslides such as: a heavy rainfall event, earthquakes, or human activity. The rate of landslide movement ranges from rapid to very slow. A landslide can involve large or small volumes of material. Material can move in nearly intact blocks or be greatly deformed and rearranged. The slope may be nearly vertical or fairly gentle (Delano and Wilshusen, 2001).

11.9.2 Characteristics of landslides

Landslides are usually associated with mountainous areas but can also occur in areas of generally low relief. In low-relief areas, landslides occur due to steepening of slopes: as cut and fill failures (roadway and building excavations), river bluff failures, collapse of mine waste piles, and a wide variety of slope failures associated with quarries and open-pit mines (USGS, Landslide Types and Process, 2004).

Appendix Figure A-9 - Landslide in Residential Area (Source: USGS)

11.10 FLOODS

11.10.1 Definition of Flood Hazard

Flooding is the accumulation of water within a water body (e.g., stream, river, lake, or reservoir) and the overflow of excess water onto adjacent floodplains. As illustrated in Figure A-10, floodplains are usually lowlands adjacent to water bodies that are subject to recurring floods. Floods are natural events that are considered hazards only when people and property are affected. Nationwide, hundreds of floods occur each year, making them one of the most common hazards in the U.S. (FEMA, 1997). There are a number of categories of floods in the U.S., including the following:

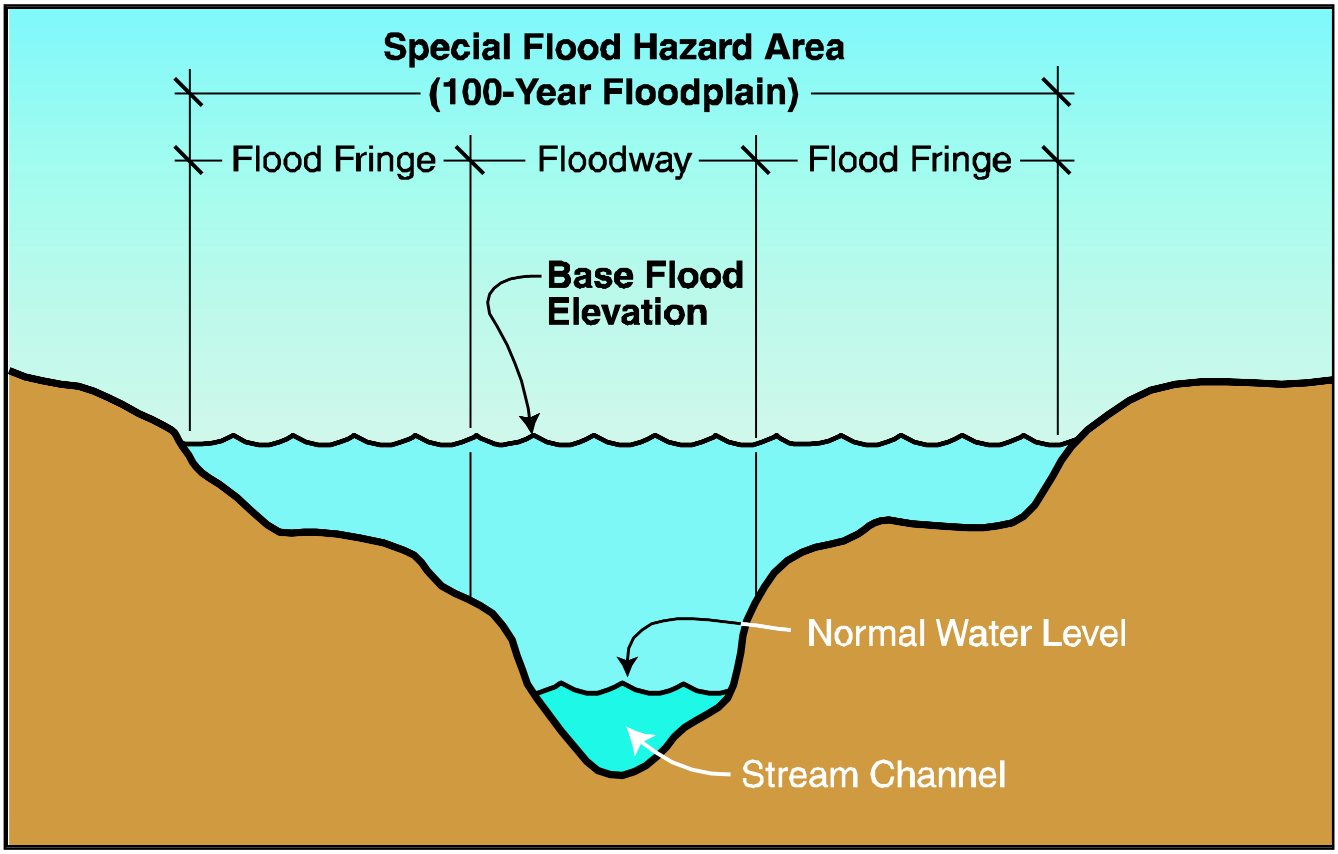
- Riverine flooding, (river channel, flash floods, alluvial fan floods, ice-jam floods, dam breaks)
- Local drainage or high groundwater levels
- Fluctuating lake levels
- Coastal flooding, including storm surges
- Debris flows
- Subsidence

11.10.2 Characteristics of Floods

While there is no sharp distinction between riverine floods, flash floods, alluvial fan floods, ice jam floods, and dam-break floods, these types of floods are widely recognized and may be helpful in considering the range of flood risk and appropriate responses.

The most common kind of flooding event is riverine flooding, also known as overbank flooding. Riverine floodplains range from narrow, confined channels in the steep valleys of mountainous and hilly regions, to wide, flat areas in plains and coastal regions. The amount of water in the floodplain is a function of the size and topography of the contributing watershed, the regional and local climate, and land use characteristics. In steep valleys, flooding is usually rapid and deep, but of short duration, while flooding in flat areas is typically slow, relatively shallow, and may last for long periods of time.

Appendix Figure Error! No text of specified style in document.**-10 - Floodplain Definition (Source: FEMA, August 2001)**



Flash floods involve a rapid rise in water level, high velocity, and large amounts of debris, which can lead to significant damage that includes the tearing out of trees, undermining of buildings and bridges, and scouring new channels. The intensity of flash flooding is a function of the intensity and duration of rainfall, steepness of the watershed, stream gradients, watershed vegetation, natural and artificial flood storage areas, and configuration of the streambed and floodplain. Dam failure and ice jams may also lead to flash flooding.

Alluvial fan floods occur in the deposits of rock and soil that have eroded from mountainsides and accumulated on valley floors in the pattern of a fan. Alluvial fan floods often cause greater damage than overbank flooding due to the high velocity of the flow, amount of debris, and broad area affected. Human activities may exacerbate flooding and erosion on alluvial fans via increased velocity along roadways acting as temporary drainage channels or changes to natural drainage channels from fill, grading, and structures.

Ice jam flood occur when an upstream part of a river thaws first (possibly because it flows away from the equator), and the ice gets carried downstream into the still-frozen part. Masses of ice can become lodged under bridges and other wiers, causing an ice dam, flooding areas upstream of the jam. After the ice dam breaks apart, the sudden surge of water that breaks through the dam can then flood areas downstream of the jam. While this usually occurs in spring, it can happen as winter sets in when the downstream part becomes frozen first. Dam-break floods may occur due to structural failures (e.g., progressive erosion), overtopping or breach from flooding, or earthquakes.

Local drainage floods may occur outside of recognized drainage channels or delineated floodplains for a variety of reasons, including concentrated local precipitation, a lack of infiltration, inadequate facilities for drainage and stormwater conveyance, and/or increased surface runoff. Such events often occur in flat areas, particularly during winter and spring where the ground is frozen. Drainage floods are found also in urbanized areas with large impermeable surfaces. High groundwater flooding is a seasonal occurrence in some areas, but may occur in other areas after prolonged periods of above-average precipitation.

11.11 STORM SURGE

11.11.1 Definition of Storm Surge Hazard

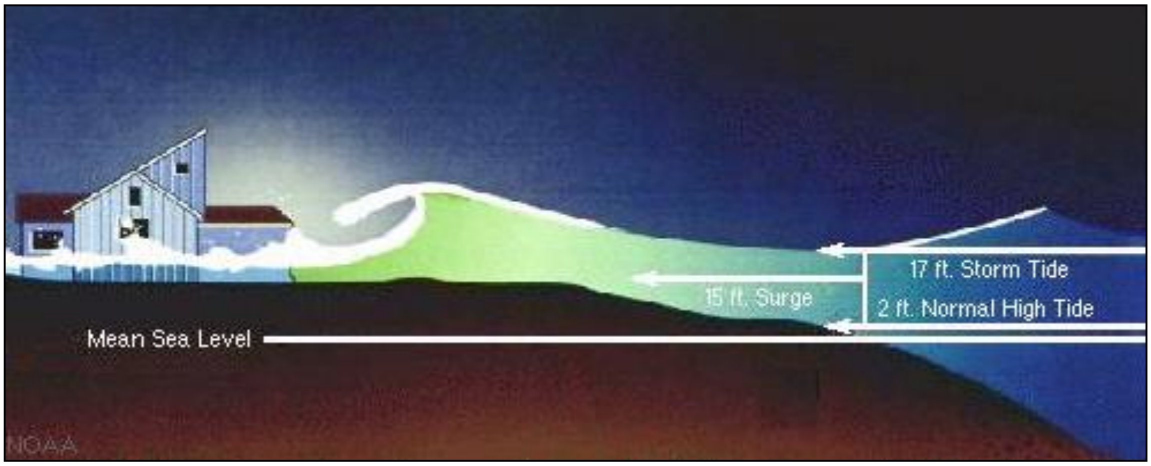
Storm surges occur when the water level of a tidally influenced body of water increases above the normal high tide. Storm surges occur with coastal storms caused by massive low-pressure systems with cyclonic flows that are typical of hurricanes.

Changes in the earth's surface also contribute to the effects of surges. Rising seas and erosion have led to the deterioration of the State's barrier islands and marsh, important shields against storm surge. Furthermore, erosion has caused the entire delta to sink, meaning homes, businesses and highways are becoming more susceptible to surges. New Orleans actually has pumps to keep rising seawaters from inundating the entire city, but they would hold little power in the face of a powerful hurricane.

11.11.2 Characteristics of Storm Surge

Storm surges are characterized by several factors that allow the displacement of water from oceans, bays or rivers to travel so far inland. Much of the coastlines along the Atlantic and Gulf Coast lie less than 10 feet above mean sea level. These coastal areas are also densely populated making the danger from storm tides a major concern to life and property. As shown in Figure A-11, the level of surge in a particular area is also determined by the slope of the continental shelf. A shallow slope off the coast will allow a greater surge to inundate coastal communities. Communities with a steeper continental shelf will not see as much surge inundation, although large breaking waves can still present major problems. Storm tides, waves, and currents in confined harbors have the potential to severely damage ships, marinas, and pleasure boats (Source: NOAA).

Appendix Figure A-11 - Storm Surge (Source: NOAA)

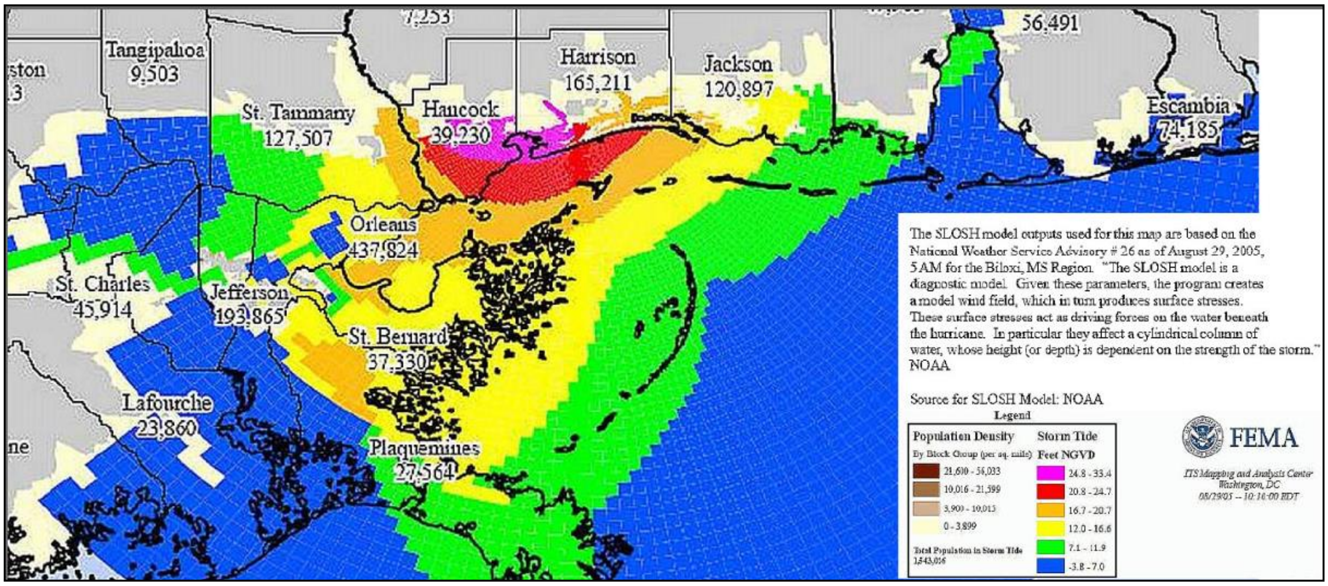


One tool used to evaluate the threat from storm surge is the Sea, Lake and Overland Surges from Hurricanes (SLOSH) Model. SLOSH is a computerized model run by the National Hurricane Center (NHC) to estimate storm surge heights and winds resulting from historical, hypothetical, or predicted hurricanes by taking the following into account:

- Pressure
- Size
- Forward speed
- Track
- Winds

Graphical output from the model displays color coded storm surge heights for a particular area in feet above the model's reference level, the National Geodetic Vertical Datum (NGVD), which is the elevation reference for most maps. Emergency managers often use the data produced from the SLOSH model to assist with determining which areas must be evacuated in advance of an approaching hurricane.

Appendix Figure A-12 - Hurricane Katrina SLOSH Model (Source: NOAA – National Hurricane Center)



Appendix B – Mitigation Planning Committee Meeting Minutes

Appendix C - Public Notice Documents and Meeting Minutes

12 Appendix C - Public Notice Documents and Meeting Minutes

13 Appendix D – Sources

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Appendix E – Acronyms

The following acronyms are used within the 2013 HMP:

APA – Approval Pending Adoption

BCA- Benefit Cost Analysis

BFE- Base Flood Elevation

CFR- Code of Federal Regulation

CRS- Community Rating System

DMA- Disaster Mitigation Act

EMCs- Emergency Management Coordinators

FEMA- Federal Emergency Management Agency

FHFs- Flood Hazard Factors

FIS- Flood Insurance Study

FIRM- Flood Insurance Rate Map

FMA- Flood Mitigation Assistance

GIS- Geographic Information System

GRR- General Reevaluation Report

HMA- Hazard Mitigation Assistance

HMGP- Hazard Mitigation Grant Program

HMP- Hazard Mitigation Plan

MPC- Mitigation Planning Committee

NCDC- National Climatic Data Center

NFIP- National Flood Insurance Program

NHC- National Hurricane Center

NOAA- National Oceanic and Atmospheric Administration

NWS- National Weather Service

PA- Public Assistance

PDM-C- Pre-Disaster Mitigation Grant Program

PDSI- Palmer Drought Severity Index

Pga- Peak Ground Acceleration

PWs- Project Worksheets

RFC- Repetitive Flood Claim

RFI- Request for Information

RL- Repetitive Loss

SFHA- Special Flood Hazard Area

SRL- Severe Repetitive Loss

STAPLEE- Social, Technical, Administrative, Political, Legal, Economic, and Environmental

TBCD – Trinity Bay Conservation District

TCEQ- Texas Commission on Environmental Quality

TDEM- Texas Division of Emergency Management

TWDB- Texas Water Development Board

TXDOT- Texas Department of Transportation

USACE- United States Army Corps of Engineers

USGS- United States Geological Survey

SHMO, State Hazard Mitigation Officer

14 Appendix F - Terms and Definitions

For the most part, terms used in the Plan have the meanings that are commonly associated with them:

Disaster. The occurrence of widespread or severe damage, injury, loss of life or property, or such severe economic or social disruption that supplemental disaster relief assistance is necessary for the affected political jurisdiction(s) to recover and to alleviate the damage, loss, hardship, or suffering caused thereby (DEM).

Federal Emergency Management Agency (FEMA). Coordinates the federal government's efforts to plan for, respond to, recover from, and mitigate the effects of natural and man-made hazards.

Flood Insurance Rate Map (FIRM). Prepared by the Federal Emergency Management Agency to show Special Flood Hazard Areas; this map is the basis for regulating development according to the Regulations for Flood Plain Management.

Floodplain. See "Special Flood Hazard Area (SFHA)" below.

Hazard. Defined as the natural or technological phenomenon, event, or physical condition that has the potential to cause property damage, infrastructure damage, other physical losses, and injuries and fatalities.

Mitigation. Defined as actions taken to reduce or eliminate the long-term risk to life and property from hazards. Mitigation actions are intended to reduce the need for emergency response – as opposed to improving the ability to respond.

National Flood Insurance Program (NFIP). Located within FEMA, is charged with preparing FIRMs, developing regulations to guide development, and providing insurance for flood damage.

Risk. Defined as the potential losses associated with a hazard. Ideally, risk is defined in terms of expected probability and frequency of the hazard occurring, people and property exposed, and potential consequences.

Special Flood Hazard Area (SFHA) or Floodplain. The area adjoining a river, stream, shoreline, or other body of water that is subject to partial or complete inundation. The SFHA is the area predicted to flood during the 1% annual chance flood, commonly called the "100-year" flood.

Planning Team – The core group responsible for making decisions, guiding the planning process, and agreeing upon the final contents of the plan. This is the core group of people responsible for developing and reviewing drafts of the plan, creating the mitigation strategy, and submitting the final plan for local adoption.

The planning area refers to the geographic area covered by the plan.

Stakeholders – Individuals or groups that affect or can be affected by a mitigation action or policy and include businesses, private organizations and citizens among others.

Disaster Resilience - Resilience is the ability to adapt to changing conditions and prepare for, withstand, and rapidly recover from disruption.

Action plan – lays the groundwork for implementation by describing how the mitigation plan will be incorporated into existing planning mechanisms and how the mitigation actions will be prioritized, implemented, and administered by each jurisdiction.

Mitigation action – specific action, project, activity, or process taken to reduce or eliminate long-term risk to people and property from hazards and their impacts.

Mitigation strategy is made up of three main required components: mitigation goals, mitigation actions, and an action plan for implementation

Mitigation goals are general guidelines that explain what the community wants to achieve with the plan (see Figure 6.1). They are usually broad policy-type statements that are long-term, and they represent visions for reducing or avoiding losses from the identified hazards.

Mitigation actions are specific projects and activities that help achieve the goals.

Hazus is a nationally applicable methodology for estimating potential losses from earthquakes, hurricane winds and floods.

A repetitive loss property*:* an NFIP insured structure that has had at least two paid flood losses of more than $1,000 each in any 10-year period since 1978.

Severe repetitive loss properties single or multifamily residential properties that are covered under an NFIP flood insurance policy and:

1. That have incurred flood-related damage for which 4 or more separate claims payments have been made, with the amount of each claim (including building and contents payments) exceeding $5,000, and with the cumulative amount of such claims payments exceeding $20,000; or

2. For which at least 2 separate claims payments (building payments only) have been made under such coverage, with cumulative amount of such claims exceeding the market value of the building.

3. In both instances, at least 2 of the claims must be within 10 years of each other, and claims made within 10 days of each other will be counted as 1 claim.

Historical analysis uses information on impacts and losses from previous hazard events to predict potential impacts and losses during a similar future event.

Community Assets anything that is important to the character and function of a community and can be described very generally in the following four categories:

People
Economy
Built environment
Natural environment

Natural Environment – Environmental assets and natural resources are important to community identity and quality of life and support the economy through agriculture, tourism and recreation, and a variety of other ecosystem services, such as clean air and water.

Built Environment – includes existing structures, infrastructure systems, critical facilities, and cultural resources.

Access and functional needs populations describes groups that may not comfortably or safely access the standard resources offered in emergencies.

Probability is the likelihood of the hazard occurring in the future

Previous occurrences. The plan must include the history of previous hazard events

Extent is the strength or magnitude of the hazard.

Location is the geographic areas within the planning area that are affected by the hazard

Natural hazard – source of harm or difficulty created by a meteorological, environmental, or geological event

Community assets – the people, structures, facilities, and systems that have value to the community

Vulnerability – characteristics of community assets that make them susceptible to damage from a given hazard

Impact – the consequences or effects of a hazard on the community and its assets

Risk – the potential for damage, loss, or other impacts created by the interaction of natural hazards with community assets

Risk assessment – product or process that collects information and assigns values to risks for the purpose of informing priorities, developing or comparing courses of action, and informing decision making.

Threat or human-caused incident – intentional actions of an adversary, such as a threatened or actual chemical or biological attack or cyber event.

Stakeholder – any person, group, or institution that can affect or be affected by a course of action.

The Plan Document is the written record of the planning process and must describe how the plan was prepared for each jurisdiction including the schedule and activities that made up the plan's development, as well as who was involved in the process.

Capability Assessment – Each community has a unique set of capabilities, including authorities, policies, programs, staff, funding, and other resources available to accomplish mitigation and reduce long-term vulnerability.

Administrative and technical capability refers to the community's staff and their skills and tools that can be used for mitigation planning and to implement specific mitigation actions.

Planning and regulatory capabilities are based on the implementation of ordinances, policies, local laws and State statutes, and plans and programs that relate to guiding and managing growth and development.

Financial capabilities are the resources that a jurisdiction has access to or is eligible to use to fund mitigation actions.

Education and Outreach – This type of capability refers to education and outreach programs and methods already in place that could be used to implement mitigation activities and communicate hazard-related information.

Mitigation. Sustained actions taken to reduce or eliminate long-term risk to life and property from hazards.

Prevention. Actions necessary to avoid, prevent, or stop an imminent threat or actual act of terrorism.

Protection. Actions necessary to secure the homeland against acts of terrorism and manmade or natural disasters.

Preparedness. Actions taken to plan, organize, equip, train, and exercise to build and sustain the capabilities necessary to prevent, protect against, mitigate the effects of, respond to, and recover from those threats that pose the greatest risk to the security of the Nation.

Response. Actions necessary to save lives, protect property and the environment, and meet basic human needs after an incident has occurred.

Recovery. Actions necessary to assist communities affected by an incident to recover effectively.

Probability of future events. Probability is the likelihood of the hazard occurring in the future

Natural hazard – source of harm or difficulty created by a meteorological, environmental, or geological event

Community assets – the people, structures, facilities, and systems that have value to the community

15 Appendix G Adoption Resolution

16 Appendix H FEMA Approval Letter

17 Appendix I – Data Collected for Incorporation

Section 5 of this Plan provides an overview of past hazard events and associated losses in TBCD.

The following list of hazards overviewed in Section 5 include:

- Dams/ Dam Failure
- Drought
- Earthquake/Seismic
- Extreme Heat
- Flood (Riverine Flooding and Shallow Flooding)
- Hurricanes and Tropical Storms
- Landslide/ Expansive Soil
- Storm Surge
- Thunderstorms/High Winds
- Tornadoes
- Wildland Fire
- Winter Storm

Flooding and wind pose the most significant risks to TBCD. Section 6 of the Plan outlines flood and wind hazards, past flood events, and summaries of the people and property that are at risk. The TBCD planning area has experienced a number of flood events, most resulting in localized damage. Section 6 also includes a detailed risk assessment of the National Flood Insurance Program (NFIP), Repetitive Loss, and Severe Repetitive Loss properties within the planning area. Chambers County is located in a region that experiences relatively frequent and devastating natural disasters. The impacts of natural hazards directly affect the safety and well-being of the residents of the planning area, highlighting the importance of developing ways to eliminate or reduce future damages from hazards.

The ultimate goal of the Trinity Bay Conservation Districts' 2013 Hazard Mitigation Plan is to promote the health, safety, and welfare of all residents and local interests. It is estimated that 14,814 buildings and many more parcels of undeveloped land in the planning area are located in flood-prone areas. (NFIP loss information is only available for the incorporated areas within TBCD's borders and unincorporated Chambers County, but not TBCD specifically.) The estimated number of flood prone buildings is derived from actual historical building claims plus an estimate of the number of buildings having experienced prior non-insured losses.

Hazard mitigation is often defined as actions taken to reduce the effects of natural hazards on a place and its population. Such hazards include a range of naturally-occurring events such as floods, earthquakes, and droughts as examples. The plan profiles 11 hazards that impact Chambers County and then further analyzes the risks associated with those hazards. A detailed risk assessment is completed for any hazard for which the jurisdiction has authority to mitigate, or hazards which impact its owned facilities.

44 CFR Part 201, Hazard Mitigation Planning, establishes criteria for State and local hazard mitigation planning authorized by Section 322 of the Stafford Act, as amended by Section 104 of the Disaster Mitigation Act. After November 1, 2004, local governments applying for mitigation funds through the States must have an approved local mitigation plan prior to the approval of local mitigation project grants. States are also required to have an approved Standard State mitigation plan in order to receive funds. Therefore, the development of State and local multi-hazard mitigation plans is key to maintaining eligibility for potential funding under FEMA mitigation grant programs.

Annual average high temperature	78.1 °F
Annual average low temperature	58.8 °F
Average temperature	68.4 °F
Average annual precipitation	54.1 in.

From the State of Texas Plan.

HOUSTON-GALVESTON AREA COUNCIL (H-GAC)

The H-GAC Regional Mitigation Action Plan covers the following counties:

Austin, Brazoria, **Chambers**, Galveston, Liberty, Montgomery, Waller and Walker.

These counties cover 6541square miles.

Vulnerability and Risk Assessment Data

The following represent **totals** in the H-GAC area:

People: 4,854,454

Residential Buildings: 2,426,098 with a value of $747,730,480

Commercial Buildings: 20,580 with a value of $90,609,145

Critical Facilities: 3,504

In 2000 the census counted 26,031 people living in Chambers County

2010 Census

Total housing units 13,291 100.0

Total households 11,952 100.0

Total population 35,096

62 years and over 4,421 12.6

Median age (years) 36.1 (X)

Vulnerability and Risk Assessment Data

The following represent **totals** in the H-GAC area:

People: 4,854,454

Residential Buildings: 2,426,098 with a value of $747,730,480

Commercial Buildings: 20,580 with a value of $90,609,145

Critical Facilities: 3,504

Infrastructure and Lifelines:

- Oil Pipelines: 7,715 kilometers
- Gas Pipelines: 10,005 kilometers
- Highways: 3,678 kilometers
- Railroads: 2,521 kilometers

Hazardous Materials :

- Sites: 404
- Materials: 2,975
-

(a) Riverine Flooding

(1) People at risk: 76,165

(2) Total potential annualized losses: $596,586,395

(3) Residential buildings: 23,280 single family; 182 multi family

(4) Commercial buildings: 2,285

(5) Critical facilities: 25

(6) Hazardous Materials: 164

(b) Coastal Flooding

(1) Surge – Category 1 Hurricane

i. People at risk: 119,756

ii. Single family residential buildings: 45,951 with a value of $6,561,352

iii. Multi-family residential buildings: 1,687 with a value of $1,496,278

iv. Commercial buildings: 505 with a value of $975,508

v. Hazardous Materials Facilities: 29

vi. Critical facilities: 7 with a value of $39,801

(2) Surge – Category 2 Hurricane

i. People at Risk: 156,083

ii. Single family residential buildings: 54,644 with a value of $8,374,951

iii. Multi-family residential buildings: 2,038 with a value of $1,717,232

iv. Commercial buildings: 621 with a value of $1,236,424

v. Critical facilities: 7 with a value of $50,617

vi. Hazardous materials facilities: 40

(3) Surge – Category 3 Hurricane

i. People at risk: 296,323

ii. Single family residential buildings: 103,915 with a value of $15,196,705

iii. Multi-family residential buildings: 2,788 with a value of $2,725,259

iv. Commercial buildings: 1100 with a value of $2,134,907

v. Hazardous materials facilities: 84

vi. Critical facilities: 23 with a value of $147,852

(4) Surge - Category 4 Hurricane

i. People at risk: 481,406

ii. Single family residential buildings: 163,100 with a value of $24,144,504

iii. Multi-family residential buildings: 3,739 with a value of $3,912,430

iv. Commercial buildings: 1673 with a value of $3,390,138

v. Hazardous materials facilities: 102

vi. Critical facilities: 26 with a value of $195,111

(5) Surge – Category 5 Hurricane

i. People at risk: 541,600

ii. Single family residential buildings: 186,220 with a value of $27,915,249

iii. Multi-family residential buildings: 4017 with a value of $4,308,453

iv. Commercial buildings: 1,151 with value of $2,327,501

v. Hazardous materials facilities: 139

vi. Critical facilities: 35 with value of $251,350

Repetitive Loss Information (Based on FEMA's Target Group of 10,000 nationwide):

Number of Target 10,000 properties: 416

Number of losses paid: 1,984

Cumulative losses paid: $59,272,533

Average annual insured loss: $2,633,040

Projected future damages avoided: $32,673,462

(a) Hurricane Winds

(1) Total potential annualized losses: $877,512,504

(2) Critical facilities: 955

(b) Tornadoes

(1) Potential annualized losses: $34,828,804

(c) Drought

(1) Potential annualized losses: $92,251,381 (mainly crop and farmland)

(d) Hail

(1) Potential annualized losses: $2,741,199

(e) Thunderstorms

(1) Potential annualized losses: $9,392,425

(f) Dam Failure

(1) People at risk: 15,147

(2) Potential residential buildings at risk: 12,166 value of $3,881,694,871

(3) Potential commercial buildings at risk: 88 with a value of $448,136,249

(g) Oil Pipeline Rupture

(1) People at risk: 504,281

(2) Potential residential buildings at risk: 235,809 with a value of $48,290,176

(3) Potential commercial buildings at risk: 2,912 with a value of $5,770,858

(h) Gas Pipeline Rupture

(1) People at risk: 438,610

(2) Potential residential buildings at risk: 236,498 with a value of $45,185,015

(3) Potential commercial buildings at risk: 2,459 with a value of $5,051,328

(i) Toxic Release

(1) People at risk: 123,171

(2) Potential residential buildings at risk: 47,265 with a value of $13,643,848,460

(3) Potential commercial buildings at risk: 478 with a value of $1,966,202,329

(4) Number of facilities: 400 , Number of chemicals: 2,970

	Quarter One			Quarter Two			Quarter Three			Quarter Four		
Task Month	1	2	3	4	5	6	7	8	9	10	11	12
Organize to prepare the plan, select MPC members and assign task responsibilities.	■	■										
Assess the Hazard		■	■	■								
Involve the Public			■	■	■	■	■	■	■			
Assess the Problem				■	■							
Set Goals					■	■						
Review Possible Alternatives					■	■	■					
Review and Revise Draft Plan					■	■	■	■	■			
Adopt the Plan									■			
Submit to the State and FEMA									■			
State and FEMA review										■	■	■
Implement, evaluate, and revise the plan												

Coordinate the proposed plan update effort with Project Manager and the leads. The proposed planning activity will result in a new Hazard Mitigation Plan. This is a standalone plan for TBCD

Collect and incorporate previous hazards information that may be available. Include map and description of known flood hazards and/or repetitive loss areas, and discuss past floods. Include a map and description of other natural hazards. This will focus on events that have occurred since the original plan development /adoption.

Documents will be prepared to brief the public on the plan update process. One public meeting will be held during the planning process and one meeting in conjunction with a Board Meeting when the plan is presented for adoption.

The plan will discuss the number and type of buildings subject to the hazards identified in the hazard assessment. It will also discuss: ·The impact of flooding on buildings, infrastructure, and public health and safety; The need and procedures for warning and evacuating residents and visitors; ·Critical facilities, such as hospitals, fire stations, and chemical storage companies; ·Areas that provide natural and beneficial functions, such as wetlands; ·Development trends and what the future brings for development and redevelopment in the floodplain, the watershed, and natural resource areas; and Impact of flooding on the community and its economy.

The update will include a review of mitigation and floodplain management program's goals to ensure they are still consistent and correct.

The plan will describe all potential mitigation activities that were considered and note why they are or are not recommended.

The plan will update will overview the results of all above mentioned analysis/data collection and will specify activities appropriate to the community's resources, flood hazard, and vulnerable properties. It will recommend who will do what, and how it will be financed.

Hold public meetings to review the Mitigation Plan update and incorporate relevant comments. Board approves and adopts the plan.

Submit the plan to State and FEMA for review and approval.

Several Month Review and Comment Time.

The plan will show's procedures for monitoring implementation, reviewing progress, and recommending revisions to the plan in an annual evaluation report.

Agenda For First MPC Meeting

1. Overview of Planning Process

2. Quarterly Reporting

3. Review Goals from Other Plans and Develop GCCDD Goal
4. Identification of Stakeholders
5. Hazard Profile Information
6. Request for Information
7. Request copies of plans/studies that could have impact on jurisdictional area
8. Outline Potential Mitigation Actions

Schedule and Next Steps

JW explained that the MPC would be responsible for drafting the Plan and would need to identify a stakeholder group to review drafts and provide input. To complete this, the team will need certain data and information and therefore a request for information (RFI) will be distributed to the team.

The goal is to have a first draft completed for a presentation to the Board and first public meeting on December 6th. The draft Plan will be placed on the GCCDD website and a Public Notice will be sent out to be published for two consecutive Sundays before the meeting. The MPC will plan to meet before that meeting. After the meeting, the MPC will present to the Board and the public a review of the plan and the process. Any comments received at that time will be incorporated. After that meeting, the MPC will meet a few more times to get the Plan to a final draft stage. At that point, the identified stakeholders will be notified that the draft if ready for their review and comment and a link will be provided for the stakeholders to download the plan for review and comment. This version of the draft plan also will replace the first draft on the GCCDD website and the public will be invited to a second meeting and have an opportunity to review the final draft. Approximately a month from the meeting, the plan will be finalized with all input provided incorporated into the plan and the plan will be sent to TDEM for review.

Review of Goals and from Other Plans and Develop DD7's Goal

The MPC reviewed goals from other plans and then arrived at their Goal which is as follows:

Trinity Bay Conservation Districts Mitigation Goal Statement

The mitigation goals of TBCD are:

- To protect public health, safety, and welfare
- To reduce losses due to hazards by identifying hazards, minimizing exposure of citizens and property to hazards, and increasing public awareness and involvement

- To facilitate the development review and approval process to accommodate growth in a practical way that recognizes existing storm water and floodplain problems while avoiding creating new problems or worsening existing problems
- In cooperation with other local organizations to develop and initiate hazard mitigation actions and projects which will serve to protect the lives and property of citizens in the planning area.
- To seek solutions to existing problems

JW explained that the MPC would be responsible for reviewing the original plan and updating the plan. The MPC will provide status on existing mitigation actions, add new action items, reaffirm hazards to be profiled and of those profiled hazards the jurisdiction has authority to mitigate, prepare risk assessments. The Update would need to identify a stakeholder group to review drafts and provide input. The Plan Update will follow a similar outline to the original plan:

Section 1 - Table of Contents

Section 2 - Executive Summary

Section 3 - Background

Section 4 - Approval and Adoption

Section 5 - Planning Process

Section 6 - Hazard Identification

Section 7 - Risk Assessment

Section 8 - Mitigation Goals, Objectives Strategies and Actions

Section 9 - Plan Monitoring and Maintenance

Appendices

There was discussion about providing the House legislation language that outlines the jurisdictions' area of authority since it crosses over County and State lines to manage TBCD waterways.

Hazard	History	Mitigation	Vulnerability	Data	Disaster	Total
Dams/ Dam Failure						

Hazard	History	Mitigation	Vulnerability	Data	Disaster	Total
Drought						
Earthquake/Seismic						
Extreme Heat						
Flood (Riverine and Shallow Flooding)						
Hurricanes/ Tropical Storms						
Landslide/ Expansive Soil						
Storm Surge						
Thunderstorms/High Winds						
Tornadoes						
Wildland Fire						
Winter Storm						

Identify and Mitigate NFIP Repetitive Loss Properties

Project/Action Description

As of August 2006, the JCWND planning area (the same as Jefferson County) had 728 NFIP repetitive loss properties. The figure includes Jefferson County and the Cities of Beaumont, Port Arthur and Port Neches. This project has two parts. First, a “sunny day” initiative to identify these properties, and then a parallel effort to determine the best methods for reducing flood losses and initiating them, coordinating the actions with other local and regional agencies.

Identify Additional Cost-Effective Mitigation Projects and Actions

Project/Action Description

This action is an ongoing initiative to identify JCWND assets or operations that may be at risk from natural hazards, and to develop projects and/or actions that will reduce these effects.

Ongoing Coordination and Involvement with Other Agencies to Maximize Mitigation Efforts and Use of Funds.

Project/Action Description

Continue involvement with other agencies to ensure that mitigation efforts across the multiple jurisdictions in the area (DD6, DD7, City of Beaumont, etc.) are adequately coordinating their mitigation actions and maximizing use of federal funds for flood control projects.

Team Member	Job Title	Organization	MPC Member Responsibility
Jerry Shadden	General Manger	Trinity Bay Conservation District	Data collection, data review, lead on actions, review each section and participate in the approval of information incorporated
Oras Ortego	Superintendent, FEMA Projects	Trinity Bay Conservation District	Data collection, data review, support on actions, review each section and participate in the approval of information incorporated
Jeff Ward	Mitigation Planning Consultant	JSWA	Data collection, data review, support on actions, review each section and participate in the approval of information incorporated

Kristen Thatcher	Mitigation Planning Consultant	JSWA	Data collection, data review, support on actions, review each section and participate in the approval of information incorporated

Group Member	Title	Organization
Mr. Kevin Dodson	President	Lamar University
Mr. Gilbert Ward	Flood Mitigation - Planning	Texas Water Development Board
Mr. Shaun Davis	Executive Director	Southeast Texas Regional Planning Commission
Mr. Carl Thibodeaux	Judge	Orange County
Mr. Jeff Branick	Judge	Jefferson County