South East Texas Regional Planning Commission

Regional Hazard Mitigation Action Plan

Prepared by

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In association with

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Acronyms

BCEGS	Building Code Effectiveness Grading Schedule
BEG	Bureau of Economic Geology
BFE	Base Flood Elevation
CAD	County Appraisal District
CAV	Community Assistance Visit
CEPRA	Coastal Erosion Planning and Response Act
CFR	Code of Federal Regulations
CRS	Community Rating System
DEM	Division of Emergency Management
DEM 21	Division of Emergency Management mitigation guidance document
DMA 2K	Disaster Mitigation Act of 2000
EAS	Emergency Alert System
EMS	Emergency Medical System
ESRI	Environmental Systems Research Institute
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
GIS	Geographic Information System
GLO	General Land Office
GNIS	Geographic Names Information System
HI	Heat Index
HMGP	Hazard Mitigation Grant Program

Acronyms

HMT	Hazard Mitigation Team
HSA	Hurricane Storm Atlas
KBDI	Keetch-Byram Drought Index
LIDAR	Light Detection and Ranging
MAP	Mitigation Action Plan
MSA	Metropolitan Statistical Area
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
PA	Public Assistance
PDM	Pre-Disaster Mitigation
PGA	Peak Gravitational Acceleration
PP-M	Property Protection Mitigation
SBA	Small Business Administration
SETRHMP	South East Texas Regional Hazard Mitigation Plan
SETRPC	South East Texas Regional Planning Commission
SLOSH	Sea, Lake, and Overland Storm Surge from Hurricanes
STAN	Southeast Texas Alert Network
TFS	Texas Forest Service
TSCP	Texas Shoreline Change Project
USGS	United States Geological Survey
VFD	Volunteer Fire Department

Executive Summary

Organization of the Plan

The South East Regional Hazard Mitigation Plan (SETRHMP) is a hybrid document that is neither a regional mitigation plan nor a collection of local plans, but rather, a combination of a regional plan with local plans. This document is organized such that the regional plan presents information common to all jurisdictions in the tri-county area, and the local plans provide information specific to each jurisdiction.

The South East Texas Regional Planning Commission (SETRPC) serves as the coordinating entity for the Regional Hazard Mitigation Team (RHMT) which is composed of representatives from jurisdictions participating in the regional plan and in seven local plans. Local hazard mitigation teams coordinated plan development for each of the seven local planning jurisdictions: Hardin County, Jefferson County, Orange County, and the cities of Beaumont, Port Arthur, Orange, and Vidor. The county plans include participating municipalities not otherwise presenting individual plans.

The RHMT was formed in May of 2002, with development of this document commencing in March of 2003. Plan development was funded through a federal hazard mitigation grant administered by the Governor's Division of Emergency Management and FEMA.

Demographics

The South East Texas Region encompasses three counties (Hardin, Jefferson, and Orange) located in the extreme southeast corner of Texas which comprise the Beaumont-Port Arthur Metropolitan Statistical Area. The population of the region is approximately 385,000 based on the 2000 census. Education, health, and social services represent the top employment sector, while petrochemicals is the major industrial sector.

The topography of the area is nearly flat with surface drainage being provided by a series of bayous that discharge to the Neches River, Sabine River, and to Sabine Lake.

Hazards Analysis, Identification, and Profile

Natural hazards referenced in the State of Texas Hazards Analysis were assessed to determine the potential for impacting the region. As a result of this review, eight types of hazards were identified as concerns for the region: coastal storms, floods, tornadoes, thunderstorms and lightning, hailstorms, wildfires, extreme summer weather, and drought. Other hazards, such as coastal erosion, may be of a particular concern to a local planning jurisdiction.

Vulnerability and Risk Assessment

The potential frequency and severity of the eight hazards of concern were examined to identify those types of hazards with the greatest potential to impact the region and the local jurisdictions. This analysis included identifying particular areas at greatest risk of being damaged during certain events. Based on the analysis, the most significant hazard of concern for the region is inland flooding. Historically, inland flooding causes the most fre-

quent and extensive damage to residences and businesses in the region. Coastal storms, including tropical storms and hurricanes, also pose a significant potential threat to the region. Along with inland flooding induced by heavy rains, hurricanes also spawn tornadoes, high winds, and storm surge, which are all sources of potential damage and threats to human life and safety.

Natural hazards not related to inland flooding or coastal storms were not considered to pose a significant risk for the region, although any of these hazards could be considered as significant on a local basis.

Partnerships and Public Involvement

Extensive public involvement with the planning process was accomplished through a series of public meetings, speaking engagements by Hazard Mitigation Team members, and responses to a questionnaire on natural hazards made available to the general public. Responses to the questionnaire along with comments received during public meetings indicated that the general public considered inland flooding to be the greatest natural hazard of concern for the region, followed by other impacts associated with coastal storms (see Appendix for a discussion on the questionnaire).

Due to decades of experience preparing for natural disasters such as hurricanes, tropical storms and reverent floods, the region has developed a rich history of forging private-public partnerships. The Sabine Neches Chiefs Association (SNCA), one of the oldest and most organized mutual aid associations in the country, was established in Jefferson and Orange Counties in 1949. In 2002, Hardin County was included to enable the SNCA to mirror the service area of the South East Texas Regional Planning Commission. The SNCA has established overhead teams that assist a jurisdiction when responding to a disaster. The overhead teams provide direct support to the Incident Commander ensuring effective consequent management for assess to resources, reimbursement of expenses, etc.

Not unlike most areas, jurisdictions within the South East Texas region have a wealth of equipment that may mitigate the effects of a disaster. However, without knowledge of the equipment available, jurisdictions cannot quickly access what is necessary. Entergy, the energy provider for the South East Texas Region, created a database listing specific equipment that is available to jurisdictions responding to a natural or manmade disaster, including contact information so that the equipment can be provided in an expeditious manner. Uniformity in equipment compatibility is also ensured through this database which circumvents another common problem in disaster response.

The Huntsman Corporation allows public service entities in mid- and south Jefferson County to utilize their cell phone repeaters which greatly expands the region's interoperability.

In the event of an evacuation due to a natural or manmade disaster, the public school districts use their buses and bus drivers to transport indigent residents to safety. Local home

health agencies assist in the distribution of, collection of data for, and education regarding the Special Needs Database in Beaumont. This Special Needs Database contains information, including emergency contact information, for individuals who, due to health, age, or disability, cannot access public or private evacuation resources in the event of a disaster. An example of one who might be included on the Special Needs Database is an elderly person who lives alone and is unable to drive. The Special Needs Database could help with special accommodations to evacuate this individual. Also, Market Basket, a locally-owned food store, provides assistance to local emergency responders by providing food, water, and other merchandise in times of a disaster.

Goals, Objectives, and Mitigation Actions

The region and local jurisdictions have adopted the mitigation goals and objectives recommended by the Federal Emergency Management Agency. Proposed mitigation actions for the five-year planning cycle are focused on lessening the potential impacts of inland flooding. Local jurisdictions have developed, or will be developing, specific projects targeting properties on the National Flood Insurance Program's Repetitive Loss List. Properties on this list have incurred repeated insured losses from flooding, and represent a highly vulnerable source of future losses. Potential damage to these properties may be mitigated through a variety of measures including acquisition/demolition, elevation of structures, removal of structures from the flood-prone areas, and structural flood control and infrastructure improvements. Alternative solutions for mitigating potential damage will be evaluated to determine the most cost effective solution for a particular situation. Federal grant funding will be sought to implement those projects with potential benefits exceeding expected costs.

Regional mitigation plans will concentrate on coordinating the efforts of local mitigation plans, and on developing and implementing public information and awareness efforts designed to lessen the impacts of potential natural hazards on property and on human health and safety.

Introduction

The South East Texas Regional Planning Commission (SETRPC) is serving as the lead agency in a collaborative effort with the local offices of emergency management for Hardin, Jefferson, and Orange Counties in developing a comprehensive regional plan for mitigating the potential impacts of natural hazards such as hurricanes, tornadoes, flooding, and wildfires. The requirements and legal basis for hazard mitigation planning are provided by the *Robert T. Stafford Disaster Relief and Emergency Assistance Act* (Stafford Act), as last amended in October 2000 by the *Disaster Mitigation Act of 2000* (DMA 2K), *Public Law 106-390*. Rules for implementing the statutory requirements have been issued under Title 44, Code of Federal Regulations, Parts 78, 201, and 206. The State of Texas Department of Public Safety Governor's Division of Emergency Management (DEM) has interpreted the federal regulations in the *State of Texas Mitigation Handbook* (DEM 21) which offers guidance for plan development. The Federal Emergency Management Agency (FEMA) has published a number of guidance documents which were utilized during the development of this plan.

As stated in the DEM 21, "the purpose of hazard mitigation is to implement and sustain actions that reduce vulnerability and risk from hazards, or reduce the severity of the effects of hazards on people and property." The South East Texas Regional Hazard Mitigation Plan (SETRHMP) addresses natural hazards of concern to the tri-county area and develops proposed mitigation actions for reducing potential impacts from these hazards. This plan has been specifically developed to meet state and federal requirements related to the DMA 2K.

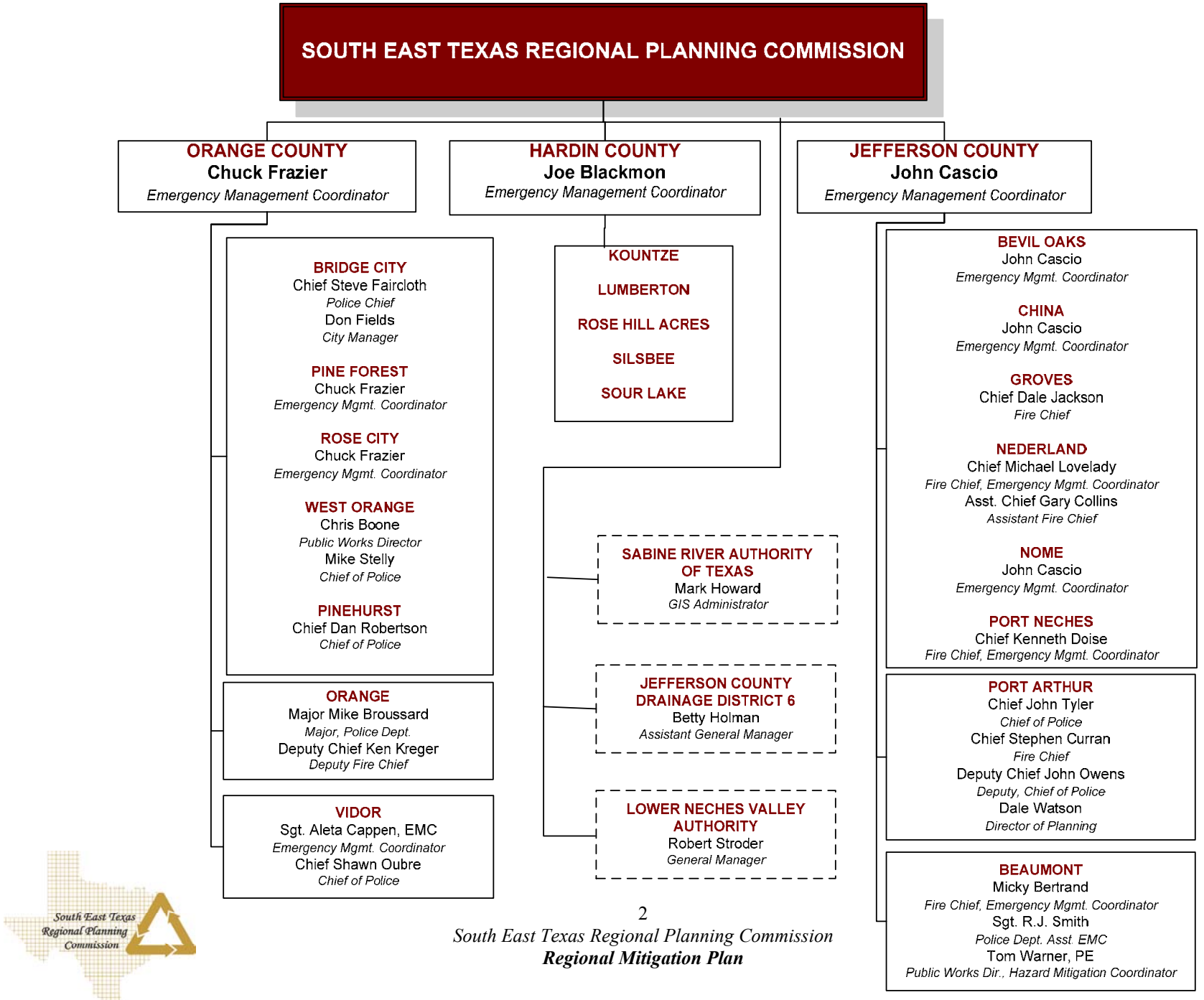
The SETRPC is a regional planning commission and political subdivision of the state of Texas organized and operating under the Texas Regional Planning Act of 1965, as amended, Chapter 391 of the Local Government Code. In the spring of 2003, SETRPC contracted with J.F. Thompson, Inc. of Houston, Texas, in association with Lamar University, to work with SETRPC and seven local jurisdictions in developing the regional hazards mitigation plan and local mitigation plans. Resources to develop this plan were provided through a Hazard Mitigation Grant Program (HMGP) federal grant awarded by the DEM and FEMA.

The SETRHMP includes the regional plan and individual plans for seven local jurisdictions. This document is organized so that the regional plan presents information common to all jurisdictions in the tri-county area, and the local plans provide information specific to each jurisdiction. Therefore, in progressing through this document, it may be necessary to refer to the regional and local plans at appropriate points as noted in the text.

Hazard Mitigation Team Organization

The SETRPC Hazard Mitigation Team (HMT) was formed on May 23, 2002. The organization of the HMT is represented in the Organizational Chart found on the following page.

Hazard Mitigation Team Organization



Area covered by Mitigation Action Plan (Annex P-29)

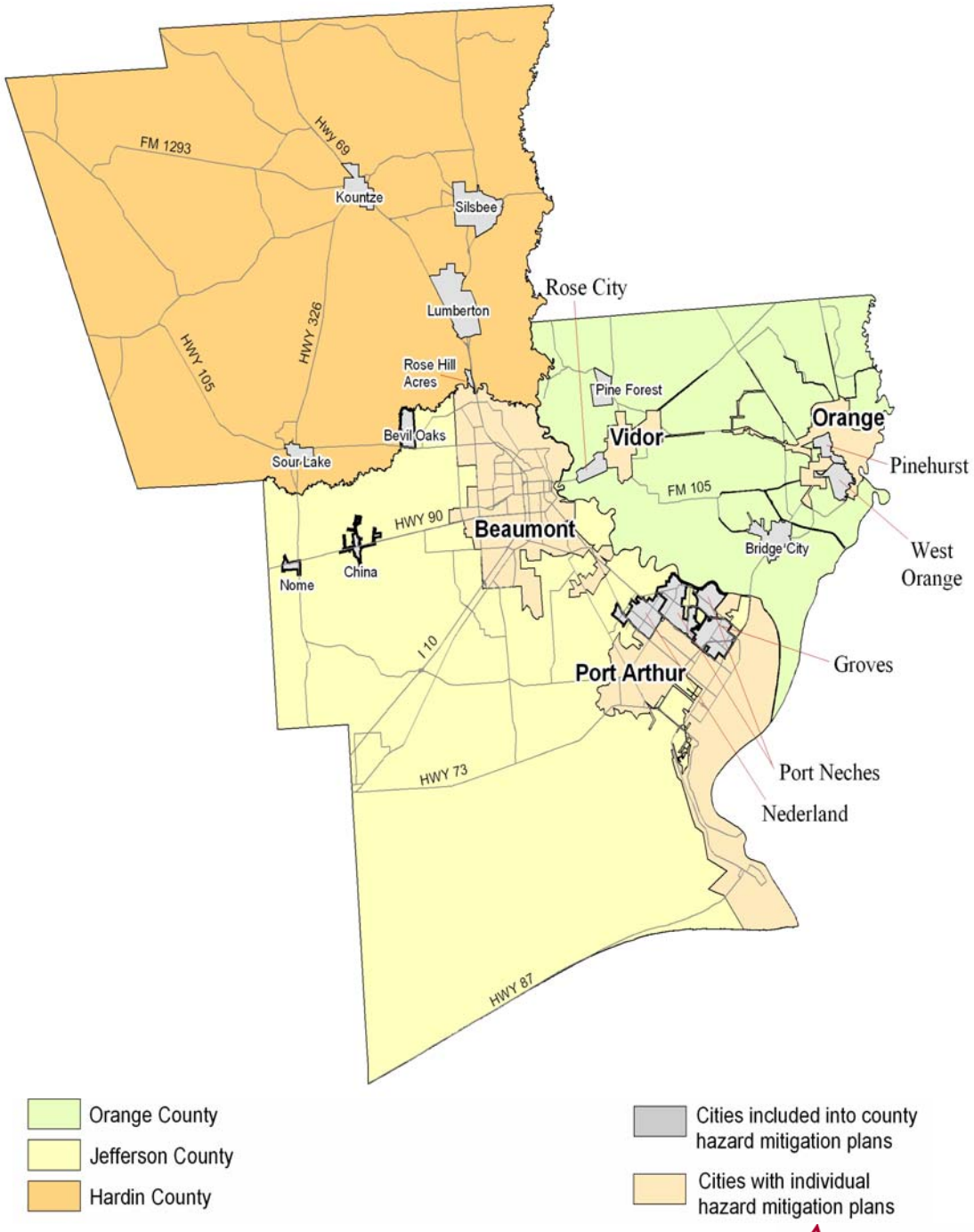
Jefferson, Orange, and Hardin Counties comprise the area that is covered in this plan. In addition to the comprehensive regional plan, local jurisdiction plans are included for the following:

1) Jefferson County
    2) City of Beaumont
    3) City of Port Arthur
4) Orange County
    5) City of Orange
    6) City of Vidor
7) Hardin County

In all, there are eight plans which cover the SETRPC area. The sector plans break down the overall area into smaller and more manageable segments. Each of the eight plans includes its own Hazards Analysis. Much of the information overlaps; therefore, where appropriate, the reader may be directed to reference either the regional or a jurisdictional plan for certain information.

Political subdivisions within the area (Annex P-30)

Jefferson, Orange, and Hardin Counties are located in southeast Texas along the border to Louisiana. Beaumont is the county seat of Jefferson County; Orange is the county seat of Orange County, and Kountze is the county seat of Hardin County. These three counties comprise the Beaumont – Port Arthur Metropolitan Statistical Area (MSA).



River basins, watersheds, and reservoirs (Annex P-31)

Regional River Basins

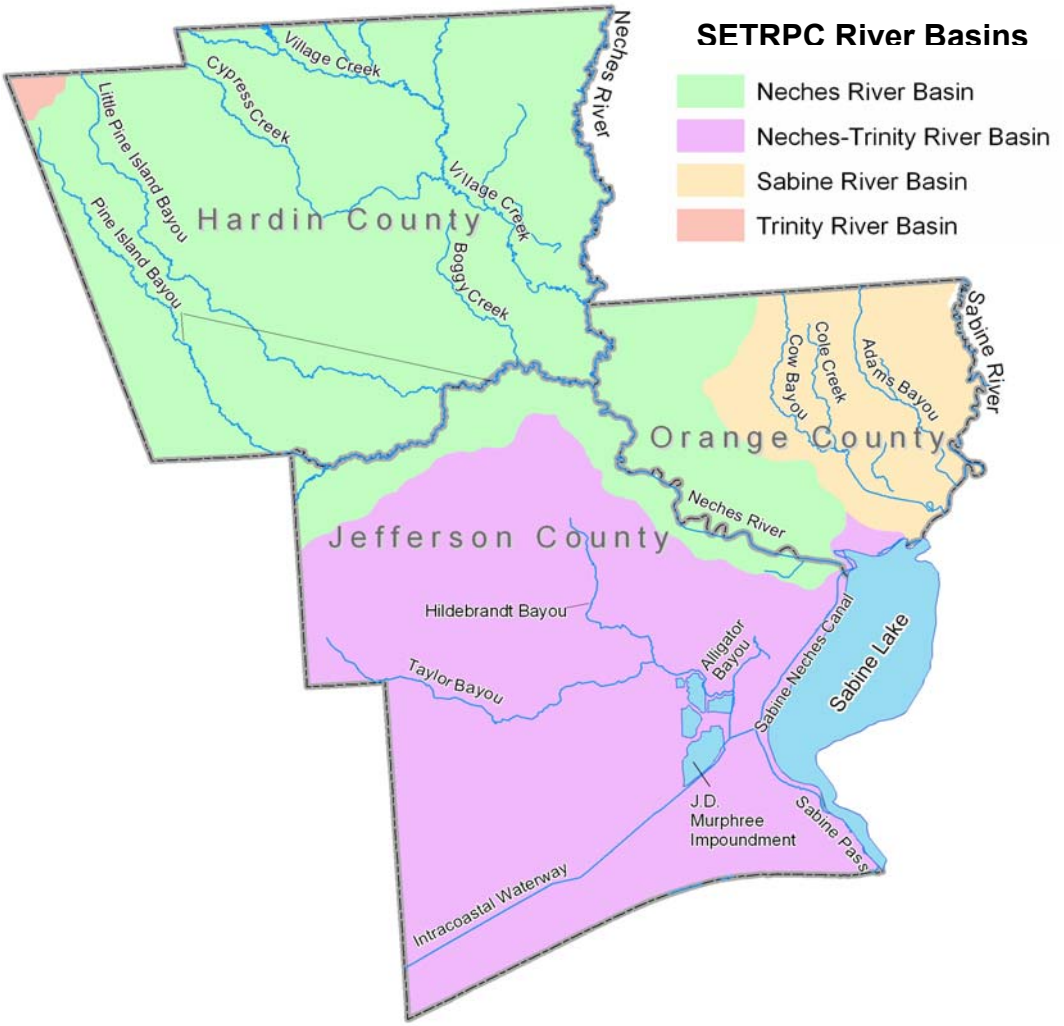
The area drained by a river and its tributaries is known as a **river basin**. The following four river basins are within the SETRPC region.

- Neches River Basin
- Neches-Trinity River Basin
- Sabine River Basin
- Trinity River Basin

These river basins are shown in the map below. **Refer to Annex P-31 of the city- and county-level plans for specific information regarding the river basins.**

Regional Rivers

Two main rivers draining the SETRPC region are the Neches and Sabine Rivers. **Specific information regarding these rivers can be found in Annex P-31 of the city- and county-level plans.**



Regional Watersheds

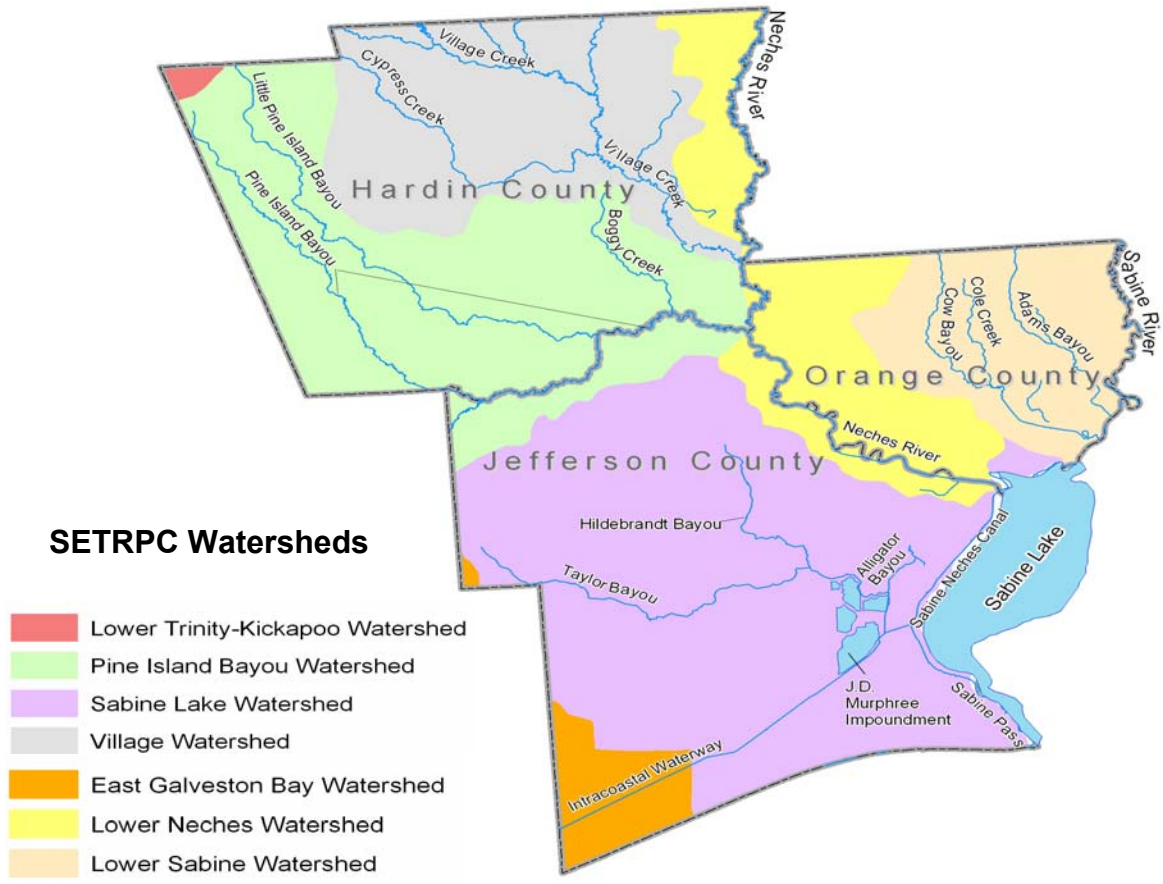
A **watershed** is a smaller (more specific) subset of a river basin that drains a smaller area. The following seven watersheds are within the SETRPC region:

- Lower-Trinity Kickapoo Watershed
- Pine Island Bayou Watershed
- Sabine Lake Watershed
- Village Creek Watershed
- East Galveston Bay Watershed
- Lower Neches Watershed
- Lower Sabine Watershed

These watersheds are shown in the map below. **Refer to Annex P-31 of the city- and county-level plans for specific information regarding the watersheds.**

Regional Reservoirs

The J.D. Murphree Impoundment reservoir is the main reservoir(s) located in the region. These reservoirs are shown in the map below. Sabine Lake is classified as a bay, not a reservoir. **Refer to Annex P-31 of the city- and county-level plans for specific information regarding the reservoirs.**

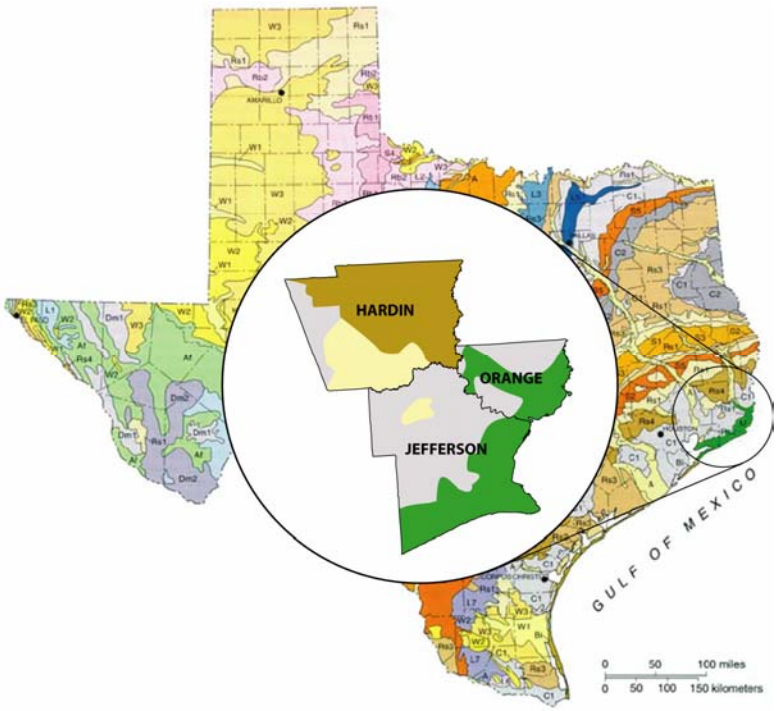


Geography, population, industries, and trends (Annex P-32)

Regional Geography

Jefferson, Hardin, and Orange Counties have a combined area of 2,388 square miles.[4] The counties are all located in what the Physiographic Map of Texas identifies as the "Coastal Prairie".[2] This is a vast region that runs along the coastline of the Gulf of Mexico, and stretches from the furthest southeast section of Texas (Orange County) to the southern tip of the state (Brownsville). The minimum elevation is 0 feet and the maximum elevation is 300 feet within the Coastal Prairie zone. The topography is nearly flat prairie and the geologic structure is nearly flat strata. The bedrock types are comprised of deltaic sands and muds. The map below displays the geologic makeup of the SETRPC region. **Refer to Annex P-32 of the city- and county-level plans for specific geographic information.**

Land Resource Map of Texas



*Data from Bureau of Economic Geology The University of Texas at Austin

- Aquifer recharge zone – mix of mainly course and lesser fine sand systems; low relief, sandy loam soil
- Major recharge sand – some gravel; high permeability, stable, vegetative slopes in rolling hills to flats
- Expansive clay and mud – locally silty, locally calcareous, flat to low, hilly prairie, commonly tiled
- Wetlands – fresh, brackish, and saltwater marsh and swamp, coastal and deltaic

Regional Population and Industries

The following statistics were obtained from 2000 U.S. Census data. The total population of the SETRPC region is 385,090. The population density of the region averages to 190 persons per square mile. The population of the labor force in the region is 169,293. The top industry within the region is in the category of educational, health, and social services with 33,373 laborers. A table listing the populations of the major counties in the SETRPC region is located on page 49 of this report. **Refer to Annex P-32 of the city- and county-level plans for specific population and industry information.**

Regional Employment Trends

The U.S. Bureau of Labor Statistics reported a June 2003 unemployment rate of 10.7% (20,400 workers) for the SETRPC area. The unemployment rate for the state of Texas as a whole for June 2003 was reported at 6.4 %, down from the May 6.8% figure;[14] thus, the SETRPC region had a 4.3% higher unemployment rate than the State average during this time period.

Communities designated for special consideration (Annex P-33)

The definition of "small and impoverished communities," as relevant to hazard mitigation planning, is provided in Chapter 44, Code of Federal Regulations, Part 201 (44 CFR § 201.2). The identification of "small and impoverished communities" for the purpose of mitigation planning is related to such a community receiving special consideration in meeting the requirements for a mitigation plan (44 CFR § 201.6(a)(3)).

There are no jurisdictions within the SETRPC region that have been identified as "small and impoverished communities."

Date of current Hazards Analysis and revision schedule (Annex P-34)

There is no known prior Hazards Analysis that has been conducted for this region. The Hazards Analysis included in this report begins on page 11 (Annex P-36).

Identify past emergencies and disasters. (Annex P-35)

Refer to Annex P-36 of the city- and county-level plans for hazard event tables that identify past natural hazard events. Local and state governments share the responsibility for protecting citizens from disasters, and for helping them to recover when a disaster strikes. In some cases, a disaster may be beyond the capabilities of the State and local government to respond.[63]

In 1988, the Stafford Act was ratified to support state and local governments when disasters overwhelm them. This law, as amended, established a process for communities requesting a Presidential Disaster Declaration, defined the type and scope of assistance available from the Federal government, and set the conditions for obtaining assistance. FEMA's "Guide to the Disaster Declaration Process and Federal Disaster Assistance"[64] provides a thorough explanation of this process.

According to FEMA, a Major Disaster Declaration usually follows these steps:

- Disaster occurs and local government responds aided by neighboring communities and volunteer agencies. If necessary, may turn to the State for assistance.
- The State may respond with resources from other state agencies including, if necessary, the Texas National Guard.
- Damage assessment that determines losses and recovery needs is performed by local, state, federal, and volunteer organizations.
- Governor requests a Presidential Disaster Declaration based on the damage assessment, and an agreement to commit state funds and resources to the long-term recovery.
- FEMA evaluates the request and recommends action to the White House based on the disaster, the local community, and the state's ability to recover.
- The President approves or denies the request and FEMA informs the governor of the decision. This decision process could take a few hours or several weeks depending on the nature of the disaster.

Disaster Aid Programs

There are two main types of disaster aid:

- Individual Assistance – damage to homes, businesses, or personal property losses
- Public Assistance – repair of infrastructure, public facilities, and debris removal

SETRPC Disasters

Disasters can be classified into two types: Presidential Disasters and Small Business Administration (SBA) disaster assistance events. Presidential Disaster Declarations are made when the severity and magnitude of a disaster event is beyond the capabilities of the state and the local governments, and federal assistance is necessary. SBA disasters refer to disasters that receive assistance from the U.S. SBA who can make federally subsidized loans to repair or replace homes, personal property, or businesses that sustained damages not covered by insurance. All Presidential Disasters receive SBA assistance; however, it is possible to receive SBA disaster assistance without the event deemed a Presidential Declared Disaster. There are two such events in the table below. The information in the table below was provided by the State of Texas DEM and displays disaster declarations for the SETRPC region from 1961-2002. Those events that occurred in more than one county, or all three counties, were recorded into this regional table. Events which occurred in only one county and/or city are listed in the respective jurisdiction plan.

COUNTY	YEAR	FEMA DISASTER #	DISASTER INCIDENT	PRESIDENTIAL DECLARATION	SBA DECLARATION
Jefferson, Orange	1963	OEP 159 DR	Hurricane Cindy	Yes	Yes
Jefferson, Orange	1973	OEP 393 DR	Flood	Yes	Yes
Hardin, Orange	1974	1043	Flood	No	Yes
Hardin, Jefferson	1975	1149	Flood	No	Yes
Hardin, Jefferson, Orange	1979	580 DR	Flood	Yes	Yes
Hardin, Jefferson, Orange	1989	828 DR	Flood	Yes	Yes
Hardin, Jefferson, Orange	1989	836 DR	Hurricane Chantal	Yes	Yes
Hardin, Jefferson, Orange	1994	1041 DR	Flood	Yes	Yes
Hardin, Jefferson, Orange	2001	1379 DR	Tropical Storm Allison	Yes	Yes
Hardin, Jefferson, Orange	2002	1439 DR	Severe Storms, Tornado	Yes	Yes

Hazards Identification and Risk Assessment (Annex P-36)

Introduction

The methods used to complete the hazards analysis of the SETRHMP utilize the guidelines provided in FEMA's "Understanding Your Risks" (FEMA 386-2) and the DEM 21. **Note that this regional plan examines the entire SETRPC area. Where appropriate, jurisdictional plans should be referenced for specific information. Prompts to reference jurisdictional plans will be provided (in bold) where appropriate.**

According to the DEM 21, hazards analysis involves "identifying all the hazards that potentially threaten a community and analyzing them individually to determine the degree of threat that is posed by each". This hazards analysis concentrates on natural hazards (floods, hurricanes, etc.) and will accomplish the following:

- Identification of hazards (what hazards may occur and when)
- Profiling of hazards (characteristics of each hazard)
- Prioritization of hazards (which hazards pose the greatest risk and require mitigation measures)

People and property in the SETRPC region are susceptible to a variety of natural hazards with the capability for causing loss of life and damages to property, infrastructure, and the environment. The purpose of this section is to identify, characterize, and prioritize those natural hazards that pose risk to the area. This process will ultimately determine the natural hazards of greatest concern to the region.

Natural Hazards – Severity and Frequency

When considering natural hazards, it is important to keep in mind two fundamental concepts: severity and frequency. Severity refers to the intensity of the event. For example, a Category 5 hurricane with winds greater than 155 miles per hour (mph) has a greater severity than a Category 1 hurricane with winds between 74-95 mph. Frequency refers to how often an event has occurred or may be expected to occur. Typically, a Category 1 hurricane is much more likely to happen than a Category 5 hurricane. In general, as the potential severity of a natural hazard event increases, the expected frequency decreases. A good example of this concept is located in the sidebar of page 16.

Hazards Analysis Outline

The identification and profile of each potential natural hazard event was the first step in this hazards analysis. Based on the information gathered during the hazards identification and profile process, the hazard was either recommended to be of concern to the area, or not to pose a significant threat. Those natural hazard events determined to be of concern were then further analyzed to determine the potential risk and vulnerability they may cause to the region. Finally, a hazard impact and risk summary worksheet was completed to prioritize all the natural hazard events of concern from highest to lowest priority for the region. An outline of the hazards analysis is provided in the sidebar of this page and is broken down in the following text.

Hazards Analysis Outline:

I. Hazards Identification and Profile

II. Vulnerability and Risk

III. Prioritized Hazards

Hazards Analysis

Natural Hazards

The following hazards are described in detail in the SETRPC Regional Report.

- Hurricanes
- Tropical storms
- Floods
- Thunderstorms and lightning
- Windstorms
- Tornadoes
- Hailstorms
- Coastal erosion
- Extreme summer weather
- Landslides
- Land subsidence
- Drought
- Wildfires
- Severe winter storms
- Earthquakes

I. Hazards Identification and Profile

Identifying Hazards

The hazards reviewed in this report were those recommended in the DEM 21 and the State of Texas Hazards Analysis. Each hazard was researched through web sites suggested by FEMA and local officials, and local newspapers for accounts of hazard events that occurred in the past. Reference books and journal articles were also consulted to provide the most accurate and comprehensive data possible and such are noted in the references section of this report. A complete list of the hazards reviewed for this analysis is shown in the sidebar at the left.

Hazard Event Data

For those hazards with recorded data, a table follows the text that lists the occurrences of the hazard and its characteristics. These tables are only found in the city- and county-level plans, not the regional document. **Refer to city- and county-level plans for specific hazard event tables.**

Profiling hazards

Profiling each hazard involved a detailed study to determine the hazard's essential characteristics. A hazard profile worksheet is located after the identification of each hazard. Developing a profile for each hazard, as specified by the DEM 21, focused on the following characteristics:

- Frequency of occurrence
- Severity of impact
- Areas affected
- Duration
- Seasonal pattern
- Warning Time
- Cascading potential/possible secondary hazard impacts
- Availability of warnings and warning systems

II. Vulnerability and Risk

Vulnerability

Things that can be affected by a natural hazard are known as "vulnerable". They are exposed to potentially threatening elements, such as strong winds and heavy rain. The DEM lists the following items as having the possibility of being vulnerable:

- People
- Critical Facilities (fire, police, communications facilities)
- Special Facilities (schools, nursing homes, jails)

- Housing
- Infrastructure, Lifeline (highways, bridges, navigable waterways, dams, levees)
- Hazardous Materials Facilities (oil and gas refineries, substations)
- Commercial Facilities

Specific statistical information on these vulnerable items within the SETRPC region is found in the Vulnerability and Risk section of this report. It is important to note that vulnerability focuses on the characteristics of the area, i.e., what *things* are susceptible to being damaged.

Risk

The likelihood of a natural hazard event occurring is known as its "risk". A natural hazard event can be frequent, but be of such low severity that it does not pose a significant risk. For example, thunderstorms occur on a regular basis within the SETRPC area. Some of them may have such a low severity that they do not cause any negative impacts. When the severity of a natural hazard event is extremely low, the frequency of the event can be insignificant. In other words, the damage caused by the event is so minor (or non-existent) that it does not matter how often that event occurs. By comparison, a natural hazard event can be extremely severe and have significantly damaging impacts; however, it may have a low frequency of occurring, therefore making the overall risk low. For instance, earthquakes have a very low probability of occurring within the SETRPC region. In fact, there is only one recorded earthquake for the region which occurred in Orange County in 1952, and is believed to be the aftershock from a meteor's impact. Since the frequency of occurrence of this event is so low, the risk to the area is equally low. It is important to note that risk focuses on the *hazard event* and the likelihood of its occurrence.

III. Prioritized Hazards

Hazards are prioritized based upon the information compiled in the Hazards Identification and Profile section and the Vulnerability and Risk section. The priority level considers frequency, warning time, potential severity of impact, and risk level. Priorities are ranked qualitatively as High, Medium, and Low.

The next section will introduce the hazards by giving their descriptions, their potential impacts, and a profile of the hazards regarding the SETRPC region.

I. Hazards Identification and Profile – HURRICANES

Hurricanes are intense tropical weather systems with maximum sustained winds of 74 mph or higher.

Description of Hurricanes

Hurricanes are intense tropical weather systems with maximum sustained winds of 74 mph or higher.[10] Hurricane winds circulate in a large spiral around a relatively calm center - the eye of the storm, which can be 20 to 30 miles wide.[15] They develop over warm water and are caused by the atmospheric instability created by the collision of warm air with cooler air.[10] Hurricanes that strike the Texas coast are born in the tropical and subtropical Atlantic Ocean off the west coast of Africa, in the Caribbean Sea, and in the Gulf of Mexico. Most occur in August, September, and October, but the six-month period from June 1 to November 30 is considered the Gulf of Mexico hurricane season.[16]

A hurricane can last for more than two weeks over water, and can extend outward up to 400 miles.[10] The length of time that a hurricane lasts depends upon two things: the forward motion of the storm and the availability of a warm water source for energy. The initial forward speed is usually less than 15 mph, but as the hurricane moves further from the equator, its forward speed begins to increase. However, it is seldom that a hurricane's forward speed is ever faster than 15 to 20 mph.[15] The forward speed adds to the strength of the storm. Once the hurricane moves onto land, it becomes starved for energy (water) and eventually loses its strength.

Potential Impacts from Hurricanes

When a hurricane approaches land, it may bring with it torrential rain, high wind, storm surge, coastal flooding, inland flooding, and tornadoes. Each of these impacts is discussed in detail in the respective sections of this Hazards Analysis.

The torrential rains that may accompany the hurricane can produce sudden flooding as the storm moves onshore and further inland. As previously mentioned, the hurricane is fueled by the warm water of the ocean. Once the storm moves onto land and is cut off from the warm ocean, it begins to lose strength, starves for water and heat energy, and eventually winds down and tears apart. However, even after the storm begins to break up, the floods that can be brought on by the storm remnants can drop significant amounts of rain resulting in the possibility of extensive damage and loss of life.

A storm surge is the onshore rush of sea water caused by high winds associated with a land-falling hurricane or storm.

As the hurricane approaches landfall and moves across the coastline, it brings huge waves and above-normal tides. These huge waves and above normal tides produce a **storm surge** which is defined as the onshore rush of sea water caused by the high winds associated with a land-falling hurricane or storm and the low pressure of the storm. Simply put, storm surge is the water from the ocean that is pushed towards the shore and onto land by the force of strong winds and pressure that occur during a hurricane. This surge, together with a normal tide, is acted upon by wind waves to create a powerful wave that is capable of destroying all that is in its path.[16] The picture on the following page illustrates how a storm surge is formed. It is important to note that storm surges are a product of hurricanes and other coastal storms. They do not occur independently.

Though the winds accompanying a hurricane cause major damage, drowning has, by far, been the greatest reason for deaths caused by a hurricane.[15] The more intense the storm, the greater the height of the water. In addition, the higher the storm surge, the greater the damage to the coastline. The storm surge may flood low-lying areas along the coast with salt water, and can destroy crops and much of the natural vegetation. Storm surge values are highly dependent on the slope of the continental shelf in the landfall region. The southeast Texas coast has a gentle slope and many of the floods along this coast have been caused by storm surges and flash floods. Hurricane Audrey on June 27, 1957 spawned storm surges that brought storm water about 25 miles inland from the sea.

Hurricanes are measured on the Saffir-Simpson Hurricane Scale[66] (see chart on the following page) which assigns a 1-5 rating (1 being the lowest) based on the hurricane's intensity (wind speed). This rating is used to estimate the potential impacts expected along the coast from a hurricane landfall.

Category	Wind Speed	Effects
One	Winds 74-95 mph	No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Also, some coastal road flooding and minor pier damage
Two	Winds 96-110 mph	Some roofing material, door, and window damage to buildings. Considerable damage to vegetation, mobile homes, and piers. Coastal and low-lying escape routes flood 2-4 hours before arrival of center. Small craft in unprotected anchorages break moorings.
Three	Winds 111-130 mph	Some structural damage to small residences and utility buildings with a minor amount of curtainwall failures. Mobile homes are destroyed. Flooding near the coast destroys smaller structures with larger structures damaged by floating debris. Terrain continuously lower than 5 feet ASL may be flooded inland 8 miles or more.

Four	Winds 131-155 mph	More extensive curtainwall failures with some complete roof structure failure on small residences. Major erosion of beach. Major damage to lower floors of structures near the shore. Terrain continuously lower than 10 feet ASL may be flooded requiring massive evacuation of residential areas inland as far as 6 miles.
Five	Winds greater than 155 mph	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Major damage to lower floors of all structures located less than 15 feet ASL and within 500 yards of the shoreline. Massive evacuation of residential areas on low ground within 5 to 10 miles of the shoreline may be required.

SETRPC Coastal Storm Risk
(Probability per year)

Tropical Storms and all Hurricanes = 31-32%

Hurricanes = 18%

Extreme Hurricanes (136 mph wind or higher) = 4-7%

***Note the decrease in frequency with the increase in severity.**

Profile of Hurricanes in the SETRPC Region

As massive moving storm systems, hurricanes can affect entire states or entire coastlines. Areas far inland can also experience direct impacts from hurricanes. Although considered very destructive, hurricanes are not frequent events in southeast Texas. Based on the State of Texas Hazards Analysis, the SETRPC region has approximately an 18% probability of a hurricane in any given year and only a 4 –7% chance of a hurricane with winds more than 136 mph. However, when the possibility of tropical storms and hurricanes are added together, there is a 31-32% probability of occurrence.[15] (Tropical storms will be discussed further beginning on page 18 of this report). Though the probability of a hurricane in the SETRPC region is relatively low, the damage caused by the storm can be enormous; thus, hurricanes are a natural hazard of concern to the region. **Refer to city- and county-level plans for specific hurricane history.**

Hazard Profile Worksheet

The chart on the following page was created by the DEM to compile and organize what is known about natural hazards. The worksheet addresses severity, frequency, seasonal patterns, source document notations used for identifying potentially affected areas, probable duration, warning time, cascading potential (secondary hazards), and existing warning systems. The profile helps to organize the characteristics for hurricanes in the SETRPC region.

Hurricanes

POTENTIAL SEVERITY OF IMPACT:

Substantial	• Multiple deaths • Complete shutdown of facilities for 30 days or more. • More than 50 percent of property destroyed or with major damage.
Major	• Injuries and/or illnesses result in permanent disability. • Complete shutdown of critical facilities for at least 2 weeks. • More than 25 percent of property destroyed or with major damage.
Minor	• Injuries and/or illnesses do not result in permanent disability. • Complete shutdown of critical facilities for more than 1 week. • More than 10 percent of property destroyed or with major damage.
Limited	• Injuries and/or illnesses are treatable with first aid. • Minor quality of life lost. • Shutdown of critical facilities and services for 24 hours or less. • Less than 10 percent of property destroyed or with major damage.

FREQUENCY OF OCCURRENCE:

Highly likely: Event probable in next year.

Likely: Event probable in next 3 years.

Occasional: Event possible in next 5 years.

Unlikely: Event possible in next 10 years.

SEASONAL PATTERN:

June, July, August, September, October, November

SOURCE DOCUMENTS, STUDIES, MAPS, ETC, THAT IDENTIFY AREAS POTENTIALLY AFFECTED:

Lake Sabine Study Area—Hurricane Storm Atlas, National Weather Service Reports: 1970-1979, http://www.aoml.noaa.gov/hrd/tcfaq/tcfaqhed.html, http://www.aoml.noaa.gov/hrd/tcfaq/d1.html, http://www.ncdc.noaa.gov, www.nhc.noaa.gov/, http://www.hurricanes.noaa.gov, http://ocean-beach.com/weather_nore_hurr_vs_nore.htm

***PROBABLE DURATION*: 6 to 8 Hours**

WARNING TIME (Potential Speed of Onset):

Minimal (or no) warning.

3 to 6 hours warning.

6 to 12 hours warning.

More than 12 hours warning.

CASCADING POTENTIAL:

Flooding, storm surge, coastal erosion, tornadoes, high wind, salt water inundation

EXISTING WARNING SYSTEMS:

Doppler radar, satellite images, EAS, STAN, SKYWARN

I. Hazards Identification and Profile – TROPICAL STORMS

Tropical storms are defined as low pressure systems over tropical or subtropical waters with wind speeds between 39-73 mph.

Description of Tropical Storms

Tropical storms are defined as low pressure systems over tropical or subtropical waters with wind speeds between 39-73 mph. When hurricanes lose strength, they downgrade into tropical storms; thus, tropical storms can be defined as a weak form of hurricanes.

Potential Impacts from Tropical Storms

Because tropical storms are a downgraded form of hurricanes, they are also a precursor to torrential rain, high wind, storm surge, coastal flooding, inland flooding, and tornadoes.

Profile of Tropical Storms in the SETRPC Region

The SETRPC region has approximately a 31-32% probability of receiving a tropical storm or hurricane in any given year. **Refer to city- and county-level plans for specific tropical storm history.**

Hazard Profile Worksheet

The chart on the following page was created by the DEM to compile and organize what is known about natural hazards. The worksheet addresses severity, frequency, seasonal patterns, source document notations used for identifying potentially affected areas, probable duration, warning time, cascading potential (secondary hazards), and existing warning systems. The profile helps to organize the characteristics for tropical storms in the SETRPC region.

Tropical storms

POTENTIAL SEVERITY OF IMPACT:

Substantial	• Multiple deaths • Complete shutdown of facilities for 30 days or more. • More than 50 percent of property destroyed or with major damage.
Major	• Injuries and/or illnesses result in permanent disability. • Complete shutdown of critical facilities for at least 2 weeks. • More than 25 percent of property destroyed or with major damage.
Minor	• Injuries and/or illnesses do not result in permanent disability. • Complete shutdown of critical facilities for more than 1 week. • More than 10 percent of property destroyed or with major damage.
Limited	• Injuries and/or illnesses are treatable with first aid. • Minor quality of life lost. • Shutdown of critical facilities and services for 24 hours or less. • Less than 10 percent of property destroyed or with major damage.

FREQUENCY OF OCCURRENCE:

Highly likely: Event probable in next year.

Likely: Event probable in next 3 years.

Occasional: Event possible in next 5 years.

Unlikely: Event possible in next 10 years.

SEASONAL PATTERN:

June, July, August, September, October, November

SOURCE DOCUMENTS, STUDIES, MAPS, ETC, THAT IDENTIFY AREAS POTENTIALLY AFFECTED:

http://www.ncdc.noaa.gov, Lake Sabine Study Area-Hurricane Storm Atlas, National Weather Service Reports: 1970-1979

***PROBABLE DURATION*:** **12 to 15 Hours**

WARNING TIME (Potential Speed of Onset):

Minimal (or no) warning.
3 to 6 hours warning.
6 to 12 hours warning.
More than 12 hours warning.

CASCADING POTENTIAL:

Storm surge, coastal erosion, flooding, high wind, salt water inundation, tornadoes

EXISTING WARNING SYSTEMS:

Doppler radar, satellite images, EAS, STAN, SKYWARN, other warning systems

I. Hazards Identification and Profile – FLOODS

Description of Floods

Floods can either be slow to develop or occur suddenly with devastating power as in flash floods. Floods are natural and recurrent events and only become a hazard when people compete for the use of floodplains.[15] The natural purpose of a floodplain is to carry away surplus water during a time of flood. Failure to recognize this purpose can lead to disorganized development in floodplains and consequent increases in flood hazards.

Flash floods occur when torrential rain is deposited on a relatively small drainage area. Runoff from these intense rainfalls results in high flood water that can destroy infrastructure and property. Flash floods quickly reach their peak and diminish almost as rapidly. **Riverine floods** are caused by rainfall over a large area and differ from flash floods in their extent and duration. They take place in river systems whose tributaries usually drain large geographic areas and encompass many independent river basins. The systems are primarily influenced by variations in the intensity, amount, and distribution of precipitation. **Urban floods** refer to floods that take place in urban areas. Urbanization increases runoff by two to six times over what would occur in natural terrain because structures and pavement are not permeable and do not allow water to be absorbed by the ground.[7] Urban flood waters can fill streets, freeway underpasses, and parking lots, and can sweep away cars. **Small stream floods** occur when small rural or urban streams reach or exceed their banks.

Potential Impacts from Floods

Floods create about 90% of the disaster damage to Texas.

Floods can lead to erosion, destruction of property (land), infrastructure, and structures such as housing and commercial facilities. Floods create about 90% of the disaster damage to Texas.[15]

Profile of Floods in the SETRPC Region

Most of the floods that occur in the SETRPC region have been tidal floods (floods due to storm surges), and flash floods.

Most of the floods that occur in the SETRPC region have been caused by storm surges and flash floods which are, in turn, caused by hurricanes, tropical storms, thunderstorms, and rainfall events that have occurred in neighboring areas or counties. Southeast Texas is vulnerable to flooding due to its proximity to the Gulf of Mexico and the Pacific Ocean. The even terrain of the SETRPC area is another factor that works in favor of flash floods causing flooding in low lying areas, streets, and houses.

Flood-prone areas are delineated on the basis of whether the area is located in a 100-year floodplain zone (1% chance of flooding in any given year) or a 500-year floodplain zone (0.2% chance of flooding in any given year). The Environmental Systems and Research Institute (ESRI) and FEMA web sites show portions of the SETRPC region to be within the 100- and 500-year floodplain zones. Floods are a hazard of concern to the region. **Refer to city- and county-level plans for specific flood history.**

Hazard Profile Worksheet

The chart on the following page was created by the DEM to compile and organize what is known about natural hazards. The worksheet addresses severity, frequency, seasonal patterns, source document notations used for identifying potentially affected areas, probable

duration, warning time, cascading potential (secondary hazards), and existing warning systems. The profile helps to organize the characteristics for floods in the SETRPC region.

Floods

POTENTIAL SEVERITY OF IMPACT:

Substantial	• Multiple deaths • Complete shutdown of facilities for 30 days or more. • More than 50 percent of property destroyed or with major damage.
Major	• Injuries and/or illnesses result in permanent disability. • Complete shutdown of critical facilities for at least 2 weeks. • More than 25 percent of property destroyed or with major damage.
Minor	• Injuries and/or illnesses do not result in permanent disability. • Complete shutdown of critical facilities for more than 1 week. • More than 10 percent of property destroyed or with major damage.
Limited	• Injuries and/or illnesses are treatable with first aid. • Minor quality of life lost. • Shutdown of critical facilities and services for 24 hours or less. • Less than 10 percent of property destroyed or with major damage.

FREQUENCY OF OCCURRENCE:

Highly likely: Event probable in next year.

Likely: Event probable in next 3 years.

Occasional: Event possible in next 5 years.

Unlikely: Event possible in next 10 years.

SEASONAL PATTERN:

August, September, October, November, December, January

SOURCE DOCUMENTS, STUDIES, MAPS, ETC, THAT IDENTIFY AREAS POTENTIALLY AFFECTED:

http://www.ncdc.noaa.gov, Lake Sabine Study Area—Hurricane Storm Atlas, National Weather Service Reports 1970-1979, http://www.esri.com, http://www.aom1.noaa.gov/hrd/tcfaq/tx_jefferson.gif

***PROBABLE DURATION*: 2 to 6 Days – Highly dependent upon the event.**

***WARNING TIME (Potential Speed of Onset):* Highly dependent on the event. While some floods can be predicted in advance, many occur with little or no warning time.**

Minimal (or no) warning.

3 to 6 hours warning.

6 to 12 hours warning.

More than 12 hours warning.

CASCADING POTENTIAL:

Saltwater inundation, coastal erosion, thunderstorms and lightning, hailstorms, hurricanes, tornadoes

EXISTING WARNING SYSTEMS:

Doppler radar, satellite warning systems, EAS, STAN, SKYWARN

I. Hazards Identification and Profile – THUNDERSTORMS/LIGHTNING

Thunderstorms occur year-round in the SETRPC region, although their frequency is highest during the spring and summer months.

Description of Thunderstorms and Lightning

A thunderstorm is a severe local storm produced when a relatively shallow layer of warm moist air is overrun by a deep layer of dry cool air.[15] Thunderstorms occur year-round in the SETRPC region, although their frequency is highest during the spring and summer months. The influx of moist air cooled by the waters of the Gulf of Mexico and warmed by the passage over the heated coastal plain in daytime is key in the development of mostly scattered and unorganized groups of thunderstorms. Lightning is a secondary effect of electrification within a thunderstorm cloud system. It is a gigantic electrical spark having an immense amount of power and lasting only a fraction of a second.

Potential Impacts from Thunderstorms and Lightning

Thunderstorms may cause flash floods (refer to page 20) resulting in damage to life and property. A fairly common sight after a thunderstorm is flooded streets and knee-deep water in low-lying houses.[34] At times, a thunderstorm can occur without being detected, so a thunderstorm warning may not necessarily be given by the National Weather Service.[14] Thunderstorms "may contain over a million tons of water and enormous amounts of energy that are often released in the forms of high winds, excessive rain, lightning, hail, and tornadoes".[15]

Lightning has resulted in loss of life and property in the SETRPC region.

Profile of Thunderstorms and Lightning in the SETRPC Region

Most of the incidences of thunderstorms in the SETRPC region have been those of high-speed thunderstorm winds and microbursts which are rapid downdrafts of wind from a single cell thunderstorm that produces a sudden outflow of horizontal winds at the surface. Because of thunderstorm and lightning's frequency of occurrence and seasonal pattern, it can create vulnerability and risk to all of the SETRPC region's people and property. Lightning has resulted in loss of life and property in the SETRPC region and kills more people in the U.S. each year than tornadoes or hurricanes.[37] Damage from lightning results from any of the four effects of the lightning strike:

- electrocution of humans and animals
- vaporization of materials in the path of the lightning streak
- fire as a result of the extremely high temperatures of the strike
- and a sudden power surge that plays havoc with electrical and electronic equipment.[15]

Due to the nature of these hazards, thunderstorms and lightning are of concern to the area. **Refer to city- and county-level plans for specific thunderstorm and lightning history.**

Hazard Profile Worksheet

The chart on the following page was created by the DEM to compile and organize what is known about natural hazards. The worksheet addresses severity, frequency, seasonal patterns, source document notations used for identifying potentially affected areas, probable duration, warning time, cascading potential (secondary hazards), and existing warning systems. The profile helps to organize the characteristics for thunderstorms and lightning in the SETRPC region.

Thunderstorms and Lightning

POTENTIAL SEVERITY OF IMPACT:

Substantial	• Multiple deaths • Complete shutdown of facilities for 30 days or more. • More than 50 percent of property destroyed or with major damage.
Major	• Injuries and/or illnesses result in permanent disability. • Complete shutdown of critical facilities for at least 2 weeks. • More than 25 percent of property destroyed or with major damage.
Minor	• Injuries and/or illnesses do not result in permanent disability. • Complete shutdown of critical facilities for more than 1 week. • More than 10 percent of property destroyed or with major damage.
Limited	• Injuries and/or illnesses are treatable with first aid. • Minor quality of life lost. • Shutdown of critical facilities and services for 24 hours or less. • Less than 10 percent of property destroyed or with major damage.

FREQUENCY OF OCCURRENCE:

Highly likely: Event probable in next year.

Likely: Event probable in next 3 years.

Occasional: Event possible in next 5 years.

Unlikely: Event possible in next 10 years.

SEASONAL PATTERN:

March, April, May, June, July, August, September, October, November

SOURCE DOCUMENTS, STUDIES, MAPS, ETC, THAT IDENTIFY AREAS POTENTIALLY AFFECTED:

http://www.ncdc.noaa.gov, http://www.tsgc.utexas.edu/stars/tstorms.html, http://www.srh.weather.gov, http://www.crh.noaa.gov, http://www.lightningsafety.noaa.gov/

***PROBABLE DURATION*:** **3 To 4 Hours / 1-2 Seconds**

WARNING TIME (Potential Speed of Onset):

Minimal (or no) warning. (Lightning)

3 to 6 hours warning. (Thunderstorms, though some occur with little or no warning.)

6 to 12 hours warning.

More than 12 hours of warning.

CASCADING POTENTIAL:

Flooding, high wind, hailstorms, tornadoes

EXISTING WARNING SYSTEMS:

Doppler radar, satellite images, EAS, STAN, SKYWARN

The SETRPC region is located in Zone III of the "Wind Zones of the United States" which is described as having experienced significant tornado activity and includes coastal areas that are susceptible to hurricanes.

Description of Windstorms

Windstorms are usually associated with tornadoes, tropical storms, thunderstorms, or hurricanes; however, they can occur independently of these events. Additional information for wind-related damage is provided in the sections of this report under the previously mentioned hazards.

Potential Impacts from Windstorms

Because windstorms are typically associated with the hazard events mentioned above (tornadoes, tropical storms, thunderstorms, or hurricanes), the potential impacts from those events apply to windstorms as well.

Profile of Windstorms in the SETRPC Region

The SETRPC region is located in Zone III according to FEMA's "Wind Zones in the United States" map below.[62] Zone III is described as having experienced significant tornado activity and includes coastal areas that are susceptible to hurricanes.

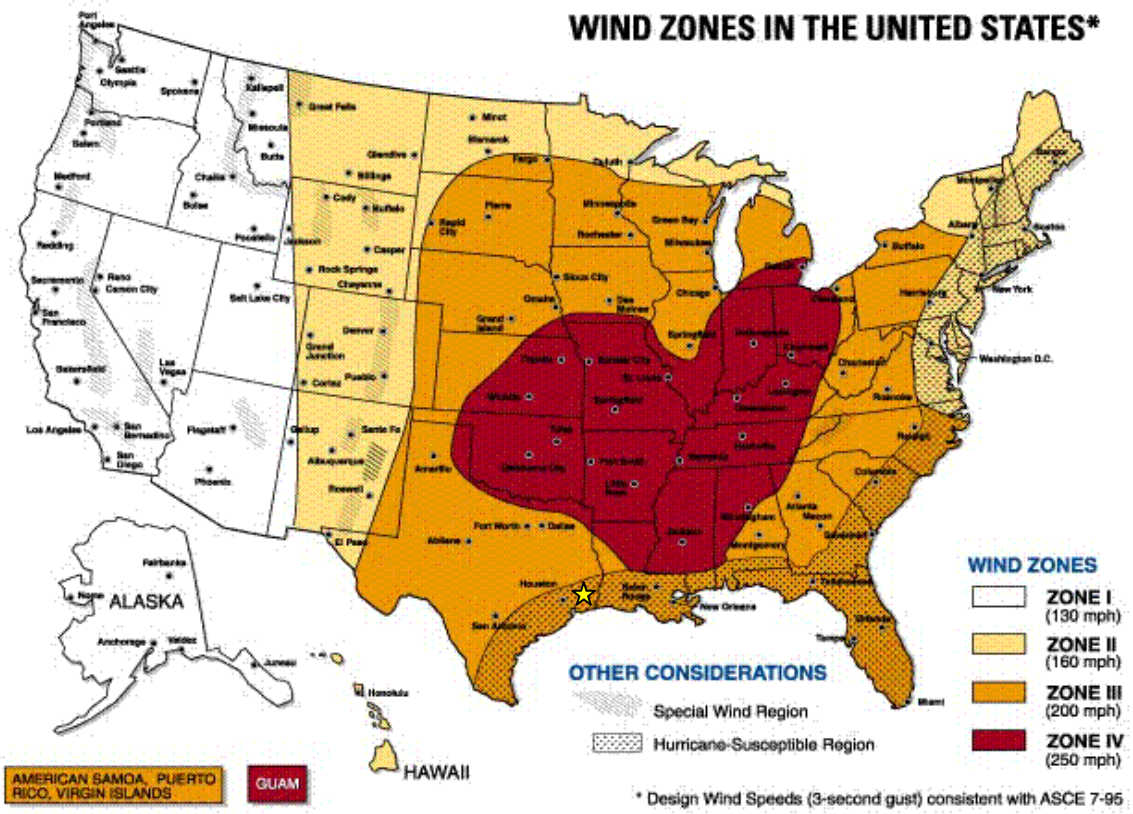


Figure I.2 Wind zones in the United States

Hazard Profile Worksheet

The chart below was created by the DEM to compile and organize what is known about natural hazards. The worksheet addresses severity, frequency, seasonal patterns, source document notations used for identifying potentially affected areas, probable duration, warning time, cascading potential (secondary hazards), and existing warning systems. The profile helps to organize the characteristics for windstorms in the SETRPC region.

Windstorms

POTENTIAL SEVERITY OF IMPACT:

Substantial	• Multiple deaths • Complete shutdown of facilities for 30 days or more. • More than 50 percent of property destroyed or with major damage.
Major	• Injuries and/or illnesses result in permanent disability. • Complete shutdown of critical facilities for at least 2 weeks. • More than 25 percent of property destroyed or with major damage.
Minor	• Injuries and/or illnesses do not result in permanent disability. • Complete shutdown of critical facilities for more than 1 week. • More than 10 percent of property destroyed or with major damage.
Limited	• Injuries and/or illnesses are treatable with first aid. • Minor quality of life lost. • Shutdown of critical facilities and services for 24 hours or less. • Less than 10 percent of property destroyed or with major damage.

FREQUENCY OF OCCURRENCE:

Highly likely: Event probable in next year.

Likely: Event probable in next 3 years.

Occasional: Event possible in next 5 years**.**

Unlikely: Event possible in next 10 years.

SEASONAL PATTERN:

Most likely during the hurricane season from June-November, but are possible any time during the year

SOURCE DOCUMENTS, STUDIES, MAPS, ETC, THAT IDENTIFY AREAS POTENTIALLY AFFECTED:

http://www.fema.gov/graphics/library/wmap.gif

***PROBABLE DURATION*: Minutes to hours**

WARNING TIME (Potential Speed of Onset):

Minimal (or no) warning.

3 to 6 hours warning.

6 to 12 hours warning.

More than 12 hours warning.

CASCADING POTENTIAL:

Tornadoes, hurricanes, hailstorms, wind erosion

EXISTING WARNING SYSTEMS:

Doppler radar

Texas is recognized as leading the nation in the number of tornado incidences per year.

Description of Tornadoes

Tornadoes are "a violent destructive whirling wind accompanied by a funnel-shaped cloud that progresses in a relatively narrow path over the land".[15] Texas encompasses a large area which may account for why it is recognized as leading the nation in the number of tornado incidences per year. By virtue of location between the Gulf of Mexico on its southeastern flank and the Rocky Mountains on its western periphery, Texas is a prime area for the formation of tornadoes, particularly in the spring, early summer, and autumn. Tornadoes occur more often from mid-July through mid-September (the active hurricane season), which has a close bearing on the formation of tornadoes, particularly in coastal areas.

Tornadoes are the most erratic and most violent of storms and, although tornadoes usually affect relatively small areas, they strike faster and with more ferocity than any other storm. Tornadoes go hand in hand with tropical storms and hurricanes as they make landfall and follow the rightward or forward path of a storm. The majority of tornadoes occur during the afternoon and early evening hours, with the greatest frequency of occurrence confined to the period from about 3:00 PM to 7:00 PM. Some tornadoes strike later in the evening and few occur after midnight. The most common type of tornado to be observed in Texas is the funnel-shaped broad at the top where the tornado is attached to the base of a thunderstorm but tapers to a relatively small diameter at the end that touches the ground.

Potential Impacts from Tornadoes

Waterspouts, which are tornadoes moving across a body of water, are also not an unusual occurrence. The most common type of waterspout observed in the coastal area is the one which builds downward from a towering cumuliform cloud. Many waterspouts have been observed off the coast of the Gulf of Mexico. Waterspouts are only a threat when they come into contact with people or property which is rare.

Tornado intensity is measured and reported using the Fujita Scale[67] shown on the following page. This scale assigns a category number (F0 through F5) based on the wind speed of the tornado and defines the potential damage or impacts to be expected.

SCALE	WIND ESTIMATE (MPH)	TYPICAL DAMAGE
F0	< 73	**Light damage.** Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	73-112	**Moderate damage.** Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	113-157	**Considerable damage.** Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
F3	158-206	**Severe damage.** Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
F4	207-260	**Devastating damage.** Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
F5	261-318	**Incredible damage.** Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yds); trees debarked; incredible phenomena will occur.

Profile of Tornadoes in the SETRPC Region

Based upon the reported history of tornadoes, there is an average of 2 tornadoes per year that occur within the SETRPC region. Because the area is susceptible to tornadoes, it is a hazard of concern to the region. **Refer to city- and county-level plans for specific tornado history.**

Hazard Profile Worksheet

The chart on the following page was created by the DEM to compile and organize what is known about natural hazards. The worksheet addresses severity, frequency, seasonal patterns, source document notations used for identifying potentially affected areas, probable duration, warning time, cascading potential (secondary hazards), and existing warning systems. The profile helps to organize the characteristics for tornadoes in the SETRPC region.

Tornadoes

POTENTIAL SEVERITY OF IMPACT:

Substantial	• Multiple deaths • Complete shutdown of facilities for 30 days or more. • More than 50 percent of property destroyed or with major damage.
Major	• Injuries and/or illnesses result in permanent disability. • Complete shutdown of critical facilities for at least 2 weeks. • More than 25 percent of property destroyed or with major damage.
Minor	• Injuries and/or illnesses do not result in permanent disability. • Complete shutdown of critical facilities for more than 1 week. • More than 10 percent of property destroyed or with major damage.
Limited (Based upon tornado events that have occurred in the region in the past.)	• Injuries and/or illnesses are treatable with first aid. • Minor quality of life lost. • Shutdown of critical facilities and services for 24 hours or less. • Less than 10 percent of property destroyed or with major damage.

FREQUENCY OF OCCURRENCE:

Highly likely: Event probable in next year.

Likely: Event probable in next 3 years.

Occasional: Event possible in next 5 years.

Unlikely: Event possible in next 10 years.

SEASONAL PATTERN:

March, April, May, June, October, November

SOURCE DOCUMENTS, STUDIES, MAPS, ETC, THAT IDENTIFY AREAS POTENTIALLY AFFECTED:

http://www.ncdc.noaa.gov, Lake Sabine Study Area—Hurricane Storm Atlas, National Weather Service Reports 1970-1979, Beaumont Enterprise Issue Dated 09-06-1980, http://www.tornadoproject.com/, http://www.spc.noaa.gov/faq/tornado/

***PROBABLE DURATION*: 10 to 20 Minutes – Highly dependant on the event**

WARNING TIME (Potential Speed of Onset):

Minimal (or no) warning.

3 to 6 hours warning.

6 to 12 hours warning.

More than 12 hours warning.

CASCADING POTENTIAL:

Thunderstorms and lightning, hailstorms, hurricanes, floods

EXISTING WARNING SYSTEMS:

Doppler radar, storm chasers/spotters, SKYWARN, STAN, EAS

Hailstorms occur regularly in the SETRPC area as evidenced by the storm event tables in the jurisdictional hazard mitigation plans.

Description of Hailstorms

A thunderstorm may develop into a hailstorm on fulfillment of two basic conditions: 1) strong updraft velocities to support hailstorms during their growth phase and 2) accumulation of liquid moisture in a super cooled state in the upper reaches of a storm. The low-pressure storm cell that is present in the middle levels of the atmosphere embedded in a strong circulation pattern of high-level westerly winds propels cold polar or arctic air into Texas and helps import mid- and high-level moisture from the Pacific Ocean and the Gulf of Mexico causing snow or a hailstorm.[16] Thus, the formation of hail takes place in the upper reaches of a thunderstorm.

Hail size varies from small particle to grapefruit size hail. Particles may be spherical, conical, or have an irregular shape; the shape is dictated by the intensity of the storm cell. The rising and lowering of the freezing moisture particle within the storm cell increases the size of the hailstone until it is emitted or thrown out of the cloud. Hail is generally white and translucent, and is made up of liquid or snow particles coated with layers of ice.[15]

Potential Impacts from Hailstorms

Although it is unlikely for hail to produce serious injuries or deaths among the people of the area, hail becomes a problem when the magnitude is large and causes damage to crops and property. Hail may cause injury to people and damage property, particularly standing crops.

Profile of Hailstorms in the SETRPC Region

Hailstorms occur regularly in the SETRPC area as evidenced by the storm event tables in the jurisdictional hazard mitigation plans. All of the people and property of the SETRPC region are vulnerable to hailstorms. Since hailstorms routinely damage crops and property, it is included as a natural hazard of concern to the region. **Refer to city- and county-level plans for specific hailstorm history.**

Hazard Profile Worksheet

The chart on the following page was created by the DEM to compile and organize what is known about natural hazards. The worksheet addresses severity, frequency, seasonal patterns, source document notations used for identifying potentially affected areas, probable duration, warning time, cascading potential (secondary hazards), and existing warning systems. The profile helps to organize the characteristics for hail in the SETRPC region.

Hailstorms

POTENTIAL SEVERITY OF IMPACT:

Substantial	• Multiple deaths • Complete shutdown of facilities for 30 days or more. • More than 50 percent of property destroyed or with major damage.
Major	• Injuries and/or illnesses result in permanent disability. • Complete shutdown of critical facilities for at least 2 weeks. • More than 25 percent of property destroyed or with major damage.
Minor	• Injuries and/or illnesses do not result in permanent disability. • Complete shutdown of critical facilities for more than 1 week. • More than 10 percent of property destroyed or with major damage.
Limited	• Injuries and/or illnesses are treatable with first aid. • Minor quality of life lost. • Shutdown of critical facilities and services for 24 hours or less. • Less than 10 percent of property destroyed or with major damage.

FREQUENCY OF OCCURRENCE:

Highly likely: Event probable in next year.

Likely: Event probable in next 3 years.

Occasional: Event possible in next 5 years.

Unlikely: Event possible in next 10 years.

SEASONAL PATTERN:

April, May, June, July, August, September

SOURCE DOCUMENTS, STUDIES, MAPS, ETC, THAT IDENTIFY AREAS POTENTIALLY AFFECTED:

http://www.ncdc.noaa.gov, http://www.tsgc.utexas.edu/stars/tstorms.html, http://www.srh.weather.gov, http://www.crh.noaa.gov, http://www.lightningsafety.noaa.gov/

***PROBABLE DURATION*: Minutes to hours**

WARNING TIME (Potential Speed of Onset):

Minimal (or no) warning.

3 to 6 hours warning.

6 to 12 hours warning.

More than 12 hours warning.

CASCADING POTENTIAL:

Thunderstorms and lightning, floods, high wind, tornadoes

EXISTING WARNING SYSTEMS:

Doppler radar, SKYWARN, STAN, EAS

Description of Coastal Erosion

Coastal erosion is a natural hazard threatening the southeast Texas coast which is undergoing long-term shoreline retreat. The processes contributing to the erosion include climate, tides, relative sea-level change, tropical storms, and the amount and rate of sediment dispersal.[15] Texas beaches are experiencing rates of coastal erosion that are among the highest in the continental U.S.[15]

Potential Impacts from Coastal Erosion

In 1999, the CEPRA authorized the GLO to carry out a coastal-erosion response program.

Many homes, highways, and commercial establishments along the coast are threatened by ongoing coastal erosion. Unfortunately, there is no obvious solution to the problem. However, in an attempt to address this problem, the Texas Legislature passed the Coastal Erosion Planning and Response Act (CEPRA) in 1999. This act authorized the Texas General Land Office (GLO) to carry out a coastal erosion response program. In support of the program, GLO coastal researchers are working with the Bureau of Economic Geology (BEG) in identifying and studying areas of erosion along the Gulf of Mexico and coastal bay shorelines of Texas. They are currently quantifying data gathered from research and creating a comprehensive, digital database of historical shoreline positions and average annual rates of shoreline change.[62] This effort is known as the Texas Shoreline Change Project (TSCP). The goal of the TSCP is to "establish a state-of-the-art shoreline monitoring and shoreline-change analysis program that will help guide coastal erosion and storm hazard mitigation projects along bay and gulf shorelines".[70] The rate of shoreline change is determined by comparing shoreline positions from aerial photography dating back to the 1930s to 2002 light detection and ranging (LIDAR) surveys.

Profile of Coastal Erosion in the SETRPC Region

The shoreline retreat has received increased attention after Tropical Storms Josephine in 1996 and Frances in 1998 caused episodic erosion and the destruction and endangerment of houses and infrastructure. Coastal erosion is a natural process; however, the problem can be compounded when structures such as jetties are built in the ocean and disrupt natural sand dispersal. For the reasons mentioned, the SETRPC region needs to consider coastal erosion as a hazard of concern, given that the area has a stretch of coastline along Jefferson County.

Hazard Profile Worksheet

The chart on the following page was created by the DEM to compile and organize what is known about natural hazards. The worksheet addresses severity, frequency, seasonal patterns, source document notations used for identifying potentially affected areas, probable duration, warning time, cascading potential (secondary hazards), and existing warning systems. The profile helps to organize the characteristics for coastal erosion in the SETRPC region.

Coastal Erosion

POTENTIAL SEVERITY OF IMPACT:

Substantial	• Multiple deaths • Complete shutdown of facilities for 30 days or more. • More than 50 percent of property destroyed or with major damage.
Major	• Injuries and/or illnesses result in permanent disability. • Complete shutdown of critical facilities for at least 2 weeks. • More than 25 percent of property destroyed or with major damage.
Minor	• Injuries and/or illnesses do not result in permanent disability. • Complete shutdown of critical facilities for more than 1 week. • More than 10 percent of property destroyed or with major damage.
Limited	• Injuries and/or illnesses are treatable with first aid. • Minor quality of life lost. • Shutdown of critical facilities and services for 24 hours or less. • Less than 10 percent of property destroyed or with major damage.

FREQUENCY OF OCCURRENCE:
Ongoing – Coastal erosion is a natural process, however it can be accelerated when hurricanes and tropical storms are a problem.

SEASONAL PATTERN:
June, July, August, September, October, November, December – Ongoing (naturally), highest during hurricane season

SOURCE DOCUMENTS, STUDIES, MAPS, ETC, THAT IDENTIFY AREAS POTENTIALLY AFFECTED:
http://www.beg.utexas.edu/coastal/sand.htm, http://www.glo.state.tx.us/coastal/erosion/pdf/report03-01-implementation.pdf, http://www.glo.state.tx.us/coastal/erosion/projects/cycle01.html, http://www.glo.state.tx.us/coastal/erosion/projects/cycle02.html#1072, http://gulf.rice.edu/coastal/report.html

***PROBABLE DURATION*: N/A**

WARNING TIME (Potential Speed of Onset):
Ongoing

CASCADING POTENTIAL:
Inland flooding, saltwater inundation

EXISTING WARNING SYSTEMS:
TSCP, SKYWARN, EAS (relative to approaching tropical storms or hurricanes)

Description of Extreme Summer Weather

With Texas' geographical location close to the Tropic of Cancer, summers are usually hot. As the searing rays of the sun become more vertical with the approach of the summer solstice, the land slowly but steadily warms under their influence. In the absence of cool fronts, warm and muggy air that swarmed into the state from the Gulf of Mexico at semi-periodic intervals in winter and spring becomes a climatic fixture in summer.[16]

Potential Impacts from Extreme Summer Weather

When the high humidity of the southeast Texas area is factored in with the warm temperatures, the heat index can become dangerously high. The **Heat Index** (HI) is the temperature the body feels when heat and humidity are combined. The chart below shows the HI that corresponds to the actual air temperature and relative humidity. (This chart is based upon shady, light wind conditions. Exposure to direct sunlight can increase the HI by up to 15°F.) Along with possible heat disorders, extreme summer weather can also lead to drought, fire, and agricultural losses.

Temperature (F) versus Relative Humidity (%)									
°F	90%	80%	70%	60%	50%	40%	30%	20%	10%
65	65.6	64.7	63.8	62.8	61.9	60.9	60.	59.1	58.1
70	71.6	70.7	69.8	68.8	67.9	66.9	66.	65.1	64.1
75	79.7	76.7	75.8	74.8	73.9	72.9	72.	71.1	70.1
80	88.2	85.9	84.2	82.8	81.6	80.4	79.	77.4	76.1
85	101.4	97.	93.3	90.3	87.7	85.5	83.5	81.6	79.6
90	119.3	112	105.8	100.5	96.1	92.3	89.2	86.5	84.2
95	141.8	131.1	121.7	113.6	106.7	100.9	96.1	92.2	89.2
100	168.7	154.	140.9	129.5	119.6	111.2	104.2	98.7	94.4
105	200	180.7	163.4	148.1	134.7	123.2	113.6	105.8	100.
110	235.	211.2	189.1	169.4	151.9	136.8	124.1	113.7	105.8
115	275.3	245.4	218	193.3	171.3	152.1	135.8	122.3	111.9
120	319.1	283.1	250.	219.9	192.9	169.1	148.7	131.6	118.2

Heat Index	Possible Heat Disorder:
80°F - 90°F	Fatigue possible with prolonged exposure and physical activity.
90°F - 105°F	Sunstroke, heat cramps and heat exhaustion possible.
105°F - 130°F	Sunstroke, heat cramps, and heat exhaustion likely, and heat stroke possible.
130°F or greater	**Heat stroke highly likely with continued exposure.**

Profile of Extreme Summer Weather in the SETRPC Region

The SETRPC region has high humidity levels which combine with the heat to produce a heat index above 100 degrees for many days during the summer.[15] As a result; extreme summer weather is a hazard of concern for the region. **Refer to city- and county-level plans for specific extreme summer weather history.**

Hazard Profile Worksheet

The chart on the following page was created by the DEM to compile and organize what is known about natural hazards. The worksheet addresses severity, frequency, seasonal patterns, source document notations used for identifying potentially affected areas, probable duration, warning time, cascading potential (secondary hazards), and existing warning systems. The profile helps to organize the characteristics for extreme summer weather in the SETRPC region.

Extreme Summer Weather

POTENTIAL SEVERITY OF IMPACT:

Substantial	• Multiple deaths • Complete shutdown of facilities for 30 days or more. • More than 50 percent of property destroyed or with major damage.
Major	• Injuries and/or illnesses result in permanent disability. • Complete shutdown of critical facilities for at least 2 weeks. • More than 25 percent of property destroyed or with major damage.
Minor	• Injuries and/or illnesses do not result in permanent disability. • Complete shutdown of critical facilities for more than 1 week. • More than 10 percent of property destroyed or with major damage.
Limited	• Injuries and/or illnesses are treatable with first aid. • Minor quality of life lost. • Shutdown of critical facilities and services for 24 hours or less. • Less than 10 percent of property destroyed or with major damage.

FREQUENCY OF OCCURRENCE:

Highly likely: Event probable in next year.

Likely: Event probable in next 3 years.

Occasional: Event possible in next 5 years.

Unlikely: Event possible in next 10 years.

SEASONAL PATTERN:

June – September (Summer)

SOURCE DOCUMENTS, STUDIES, MAPS, ETC, THAT IDENTIFY AREAS POTENTIALLY AFFECTED:

Governor's Division of Emergency Management, "*The State Of Texas Hazard Analysis*", Department of Public Safety, Austin, Texas, (2000) September

Bomar, George W., "*Texas Weather*", University of Texas Press, Austin, (1995

***PROBABLE DURATION*: Days – Weeks – Months**

WARNING TIME (Potential Speed of Onset):

Minimal (or no) warning.

3 to 6 hours warning.

6 to 12 hours warning.

More than 12 hours warning.

CASCADING POTENTIAL:

Fire, Drought

EXISTING WARNING SYSTEMS:

Doppler radar, National Weather Service

Description of Landslides

Southeast Texas is not particularly prone to earthquakes, volcanic eruptions, or extreme rain incidents, which are the major causes of landslides. Also, the geology and topography of the area does not offer much in terms of hillside slopes or embankments, which is where landslides and mudslides take place.

Potential Impacts from Landslides

As mentioned above, landslides can yield earthquakes, volcanic eruptions, and other equally dangerous impacts.

Profile of Landslides in the SETRPC Region

The SETRPC region is located in the low incidence zone in the United States Geological Survey's (USGS) "Landslide Overview Map of the Conterminous United States."[44] Hence, landslide is not considered to be a concern to the area.

Hazard Profile Worksheet

The chart on the following page was created by the DEM to compile and organize what is known about natural hazards. The worksheet addresses severity, frequency, seasonal patterns, source document notations used for identifying potentially affected areas, probable duration, warning time, cascading potential (secondary hazards), and existing warning systems. The profile helps to organize the characteristics for landslides in the SETRPC region.

Landslides

POTENTIAL SEVERITY OF IMPACT:

Substantial	• Multiple deaths • Complete shutdown of facilities for 30 days or more. • More than 50 percent of property destroyed or with major damage.
Major	• Injuries and/or illnesses result in permanent disability. • Complete shutdown of critical facilities for at least 2 weeks. • More than 25 percent of property destroyed or with major damage.
Minor	• Injuries and/or illnesses do not result in permanent disability. • Complete shutdown of critical facilities for more than 1 week. • More than 10 percent of property destroyed or with major damage.
Limited **(N/A)**	• Injuries and/or illnesses are treatable with first aid. • Minor quality of life lost. • Shutdown of critical facilities and services for 24 hours or less. • Less than 10 percent of property destroyed or with major damage.

FREQUENCY OF OCCURRENCE:

Highly likely: Event probable in next year.

Likely: Event probable in next 3 years.

Occasional: Event possible in next 5 years.

Unlikely: Event possible in next 10 years.

Highly unlikely: Event not likely to occur

SEASONAL PATTERN:

August - January

SOURCE DOCUMENTS, STUDIES, MAPS, ETC, THAT IDENTIFY AREAS POTENTIALLY AFFECTED:

http://landslides.usgs.gov/html_files/landslides/nationalmap/national.html

***PROBABLE DURATION*: N/A**

WARNING TIME (Potential Speed of Onset):

Minimal (or no) warning.
3 to 6 hours warning.
6 to 12 hours warning.
More than 12 hours warning.

CASCADING POTENTIAL:

N/A

EXISTING WARNING SYSTEMS:

N/A

Description of Land Subsidence

Land subsidence is a gradual settling or sudden sinking of the earth's surface due to subsurface movement of earth materials. The principal causes of subsidence are:

- Aquifer-system compaction
- Drainage of organic soils
- Underground mining
- Hydrocompaction
- Natural compaction
- Sinkholes
- Thawing permafrost[43]

The compaction of unconsolidated aquifer systems that can accompany excessive groundwater pumping is by far the single largest cause of subsidence.

Potential Impacts from Land Subsidence

Land subsidence may cause many problems including 1) changes in elevation and slope of streams, canals, and drains; 2) damage to bridges, roads, railroads, storm drains, sanitary sewers, canals, and levees; 3) damage to private and public buildings; and 4) failure of well casings from forces generated by compaction of fine-grained materials in aquifer systems.[68]

Profile of Land Subsidence in the SETRPC Region

Land subsidence is not considered to be a hazard of concern for the region.

Hazard Profile Worksheet

The chart on the following page was created by the DEM to compile and organize what is known about natural hazards. The worksheet addresses severity, frequency, seasonal patterns, source document notations used for identifying potentially affected areas, probable duration, warning time, cascading potential (secondary hazards), and existing warning systems. The profile helps to organize the characteristics for land subsidence in the SETRPC region.

Land Subsidence

POTENTIAL SEVERITY OF IMPACT:

Substantial	• Multiple deaths • Complete shutdown of facilities for 30 days or more. • More than 50 percent of property destroyed or with major damage.
Major	• Injuries and/or illnesses result in permanent disability. • Complete shutdown of critical facilities for at least 2 weeks. • More than 25 percent of property destroyed or with major damage.
Minor	• Injuries and/or illnesses do not result in permanent disability. • Complete shutdown of critical facilities for more than 1 week. • More than 10 percent of property destroyed or with major damage.
Limited **(N/A)**	• Injuries and/or illnesses are treatable with first aid. • Minor quality of life lost. • Shutdown of critical facilities and services for 24 hours or less. • Less than 10 percent of property destroyed or with major damage.

FREQUENCY OF OCCURRENCE:

Highly likely: Event probable in next year.

Likely: Event probable in next 3 years.

Occasional: Event possible in next 5 years.

Highly Unlikely: Event not likely to occur.

SEASONAL PATTERN:

Ongoing process

SOURCE DOCUMENTS, STUDIES, MAPS, ETC, THAT IDENTIFY AREAS POTENTIALLY AFFECTED:

http://geohazards.cr.usgs.gov/dq/graphics/usmap.gif

***PROBABLE DURATION*: Ongoing process**

WARNING TIME (Potential Speed of Onset):

Minimal (or no) warning.
3 to 6 hours warning.
6 to 12 hours warning.
More than 12 hours warning.

CASCADING POTENTIAL:

N/A

EXISTING WARNING SYSTEMS:

N/A

Description of Drought

A drought is described as a period of time without any rainfall that lasts about a year, or a period of climatic dryness that is severe enough to take away the soil moisture and water supplies below the requirements necessary to sustain normal plant, animal, and human life.[15] Droughts can cover large areas ranging from just one county to many counties.

Drought in Texas can be divided into agricultural and hydrologic.[15] Agricultural droughts are a dry period long enough to have significant impacts on crop yields. Hydrological droughts are dry periods long enough to have significant impacts on the flow in rivers, streams, and springs.[15]

Potential Impacts of Drought

A prolonged drought can have a serious economic impact on a community. Increased demand for water and electricity may result in shortages of resources. Moreover, food shortages may occur if agricultural production is damaged or destroyed by a loss of crops or livestock. Droughts may also lead to increased fires.

Profile of Drought in the SETRPC Region

Since 1892, the SETRPC area has experienced 11 drought events.[15] The average duration of the droughts was only about 60 days.[15] Drought has been known to create problems with infrastructure and property within the SETRPC region, namely broken water manes and cracked slabs. Although the effects of drought have not been substantial, it is considered to be a hazard of concern for the SETRPC region. **Refer to city- and county-level plans for specific drought history.**

Hazard Profile Worksheet

The chart on the following page was created by the DEM to compile and organize what is known about natural hazards. The worksheet addresses severity, frequency, seasonal patterns, source document notations used for identifying potentially affected areas, probable duration, warning time, cascading potential (secondary hazards), and existing warning systems. The profile helps to organize the characteristics for drought in the SETRPC region.

Drought

POTENTIAL SEVERITY OF IMPACT:

Substantial	• Multiple deaths • Complete shutdown of facilities for 30 days or more. • More than 50 percent of property destroyed or with major damage.
Major	• Injuries and/or illnesses result in permanent disability. • Complete shutdown of critical facilities for at least 2 weeks. • More than 25 percent of property destroyed or with major damage.
Minor	• Injuries and/or illnesses do not result in permanent disability. • Complete shutdown of critical facilities for more than 1 week. • More than 10 percent of property destroyed or with major damage.
Limited	• Injuries and/or illnesses are treatable with first aid. • Minor quality of life lost. • Shutdown of critical facilities and services for 24 hours or less. • Less than 10 percent of property destroyed or with major damage.

FREQUENCY OF OCCURRENCE:

Highly likely: Event probable in next year.

Likely: Event probable in next 3 years.

Occasional: Event possible in next 5 years.

Unlikely: Event possible in next 10 years.

SEASONAL PATTERN:

Most likely in the dry summer months from June – September, but possible year-round

SOURCE DOCUMENTS, STUDIES, MAPS, ETC, THAT IDENTIFY AREAS POTENTIALLY AFFECTED:

Governor's Division of Emergency Management, "*The State Of Texas Hazard Analysis*", Department of Public Safety, Austin, Texas, (2000) September,
http://webgis.tamu.edu/tfs/kbdi_daily/kbdicounty.png

***PROBABLE DURATION*: Days - Weeks**

WARNING TIME (Potential Speed of Onset):

Minimal (or no) warning.
3 to 6 hours warning.
6 to 12 hours warning.
More than 12 hours warning.

CASCADING POTENTIAL:

Wildfire

EXISTING WARNING SYSTEMS:

Keetch-Byram Drought Index, National Weather Service

Description of Wildfires

The environment conducive for the occurrence of wildfires is usually created by dry conditions with low humidity which is compounded by the fact that there is significant building in the zone usually referred to as the urban wildlife interface. It is in this zone of natural landscape that more and more structures are added which, in effect, become additional fuel to one of the many fires, usually man-caused, that occur seasonally in interface forest and range lands.[57] The greatest fire danger sources are forest brush and grass fires.[15] The major factors that influence fire behavior can be grouped under the general headings of fuels, weather, and topography.[57] These factors have a bearing in the cycle of burning. The intensity of the fires and the rate at which they spread are governed by factors like the relative humidity, wind speed, and the temperature.[57]

Potential Impacts from Wildfires

The higher the KBDI value for a given location, the greater the chances of a wildfire/forest fire occurring in that region.

Property (land), structures, and infrastructure can be impacted by wildfire. The Keetch-Byram Drought Index (KBDI) is used to gauge the relative probability/susceptibility of an area to fires. The higher the KBDI value for a given location, the greater the chances of a wildfire/forest fire occurring in that region. The KBDI value for a region has seasonal and climatic variations.[55] The KBDI is basically a mathematical system for relating current and recent weather conditions to potential or expected fire behavior. This system was originally developed for the southeastern U.S. and is based primarily on recent rainfall patterns.[55] The KBDI is the drought index system most widely used by fire managers in the south. It is also one of the only drought index systems specifically developed to equate the effects of drought with potential fire activities.[56] The result of this system is a drought index number ranging from 0 to 800 that describes the deficit moisture. A rating of zero defines the point where there is no moisture deficiency and 800 is the maximum drought possible.[58] The KBDI index chart is shown below.

KBDI Index
0 – 200: Soil and fuel moisture are high. Most fuels will not readily ignite or burn. However, with sufficient sunlight and wind, cured grasses and some light surface fuels will burn in spots and patches.
200 – 400: Fires more readily burn and will carry across an area with no gaps. Heavier fuels will still not readily ignite and burn. Also, expect smoldering and the resulting smoke to carry into and possibly through the night.
400 – 600: Fire intensity begins to significantly increase. Fires will readily burn in all directions exposing mineral soils in some locations. Larger fuels may burn or smolder for several days creating possible smoke and control problems.
600 – 800: Fires will burn to mineral soil. Stumps will burn to the end of underground roots and spotting will be a major problem. Fires will burn thorough the night and heavier fuels will actively burn and contribute to fire intensity.

Profile of Wildfires in the SETRPC Region

The SETRPC region is prone to dry conditions conducive to wildfire and has experienced numerous wildfires in the past; thus, it is a hazard of concern for the region. **Refer to city- and county-level plans for specific wildfire history.**

Hazard Profile Worksheet

The chart below was created by the DEM to compile and organize what is known about natural hazards. The worksheet addresses severity, frequency, seasonal patterns, source document notations used for identifying potentially affected areas, probable duration, warning time, cascading potential (secondary hazards), and existing warning systems. The profile helps to organize the characteristics for wildfire in the SETRPC region.

Wildfires

POTENTIAL SEVERITY OF IMPACT:

Substantial	• Multiple deaths • Complete shutdown of facilities for 30 days or more. • More than 50 percent of property destroyed or with major damage.
Major	• Injuries and/or illnesses result in permanent disability. • Complete shutdown of critical facilities for at least 2 weeks. • More than 25 percent of property destroyed or with major damage.
Minor	• Injuries and/or illnesses do not result in permanent disability. • Complete shutdown of critical facilities for more than 1 week. • More than 10 percent of property destroyed or with major damage.
Limited	• Injuries and/or illnesses are treatable with first aid. • Minor quality of life lost. • Shutdown of critical facilities and services for 24 hours or less. • Less than 10 percent of property destroyed or with major damage.

FREQUENCY OF OCCURRENCE:

Highly likely: Event probable in next year.

Likely: Event probable in next 3 years.

Occasional: Event possible in next 5 years.

Unlikely: Event possible in next 10 years.

SEASONAL PATTERN:

Possible year-round, but are most likely in the dry summer months from June - September

SOURCE DOCUMENTS, STUDIES, MAPS, ETC, THAT IDENTIFY AREAS POTENTIALLY AFFECTED:

http://txforestservice.tamu.edu/fire/default.asp, http://www.tamu.edu/ticc//fire_risk_assessment.htm, http://txforestservice.tamu.edu/shared/article.asp?documentid=851

***PROBABLE DURATION*: Minutes to days**

WARNING TIME (Potential Speed of Onset):

Minimal (or no) warning.

3 to 6 hours warning.

6 to 12 hours warning.

More than 12 hours warning.

CASCADING POTENTIAL:

N/A

EXISTING WARNING SYSTEMS:

Keetch-Byram Drought Index, National Weather Service, Texas Forest Service

Description of Severe Winter Storms

Severe winter weather in Texas is most often characterized by snowstorms, blizzards, cold waves, and ice storms.[15] Freezing rain occurs when rain developing in a relatively warm (above freezing) layer of air passes through a layer of air under freezing temperatures (between 25 and 32 degrees Fahrenheit). The rain is "supercooled" as it passes through the cooler layer closer to the ground surface. When the highly cooled liquid drops touch anything on the ground that is below freezing temperature, they freeze on contact. In general, winter weather can occur in Texas from late November to mid-March. Most of the snowfall, blizzards, and cold wave fronts are experienced in the Panhandle and Southern Plains regions.

Potential Impacts from Severe Winter Storms

Severe winter storms can disrupt transportation routes, electric and phone service, and telecommunications.

Profile of Severe Winter Storms in the SETRPC Region

The SETRPC region has received less than an inch of snowfall (on average) from 1961-1990. The SETRPC region rarely experiences winter storms; thus, this hazard does not pose significant risk requiring further development. **Refer to city- and county-level plans for specific severe winter storm history.**

Hazard Profile Worksheet

The chart on the following page was created by the DEM to compile and organize what is known about natural hazards. The worksheet addresses severity, frequency, seasonal patterns, source document notations used for identifying potentially affected areas, probable duration, warning time, cascading potential (secondary hazards), and existing warning systems. The profile helps to organize the characteristics for severe winter storms in the SETRPC region.

Severe Winter Storms

POTENTIAL SEVERITY OF IMPACT:

Substantial	• Multiple deaths • Complete shutdown of facilities for 30 days or more. • More than 50 percent of property destroyed or with major damage.
Major	• Injuries and/or illnesses result in permanent disability. • Complete shutdown of critical facilities for at least 2 weeks. • More than 25 percent of property destroyed or with major damage.
Minor	• Injuries and/or illnesses do not result in permanent disability. • Complete shutdown of critical facilities for more than 1 week. • More than 10 percent of property destroyed or with major damage.
Limited	• Injuries and/or illnesses are treatable with first aid. • Minor quality of life lost. • Shutdown of critical facilities and services for 24 hours or less. • Less than 10 percent of property destroyed or with major damage.

FREQUENCY OF OCCURRENCE:

Highly likely: Event probable in next year.

Likely: Event probable in next 3 years.

Occasional: Event possible in next 5 years.

Unlikely: Event possible in next 10 years.

SEASONAL PATTERN:

November - March

SOURCE DOCUMENTS, STUDIES, MAPS, ETC, THAT IDENTIFY AREAS POTENTIALLY AFFECTED:

http://www.web2.iadfw.net/danb1/climate.htm

***PROBABLE DURATION*: Days – Weeks**

WARNING TIME (Potential Speed of Onset):

Minimal (or no) warning.

3 to 6 hours warning.

6 to 12 hours warning.

More than 12 hours warning.

CASCADING POTENTIAL:

N/A

EXISTING WARNING SYSTEMS:

Doppler radar, National Weather Service

Description of Earthquakes

Earthquakes are exceedingly rare in southeast Texas; "however, the hazard level is not zero anywhere in Texas".[15] The earthquakes that are possible in southeast Texas might be caused by movement within salt domes found near the earth's surface. Within these domes, the salt tends to move upward because it is less dense than the surrounding sediments, and small earthquakes occur when the accumulated strain within overlying sediment is released among faults. Another possibility is that the seismicity (movement) results as the earth's crust adjusts to the loading from ongoing sedimentation in the Gulf of Mexico.

Potential Impacts from Earthquakes

Earthquakes can disrupt gas, electric, and phone service and sometimes trigger landslides, avalanches, flash floods, fires, and destructive ocean waves (tsunamis).

Profile of Earthquakes in the SETRPC Region

Peak gravitational acceleration (PGA) is the deciding factor in labeling an area as being prone to earthquakes. PGA is a measure of the strength of ground movements. The SETRPC region does not lie over a major fault zone and has a PGA rating of 0 - 2.0, which implies it has a relatively low seismic risk. Thus, earthquakes do not pose a significant risk to the region.

Hazard Profile Worksheet

The chart on the following page was created by the DEM to compile and organize what is known about natural hazards. The worksheet addresses severity, frequency, seasonal patterns, source document notations used for identifying potentially affected areas, probable duration, warning time, cascading potential (secondary hazards), and existing warning systems. The profile helps to organize the characteristics for earthquake in the SETRPC region.

Earthquakes

POTENTIAL SEVERITY OF IMPACT:

Substantial	• Multiple deaths • Complete shutdown of facilities for 30 days or more. • More than 50 percent of property destroyed or with major damage.
Major	• Injuries and/or illnesses result in permanent disability. • Complete shutdown of critical facilities for at least 2 weeks. • More than 25 percent of property destroyed or with major damage.
Minor	• Injuries and/or illnesses do not result in permanent disability. • Complete shutdown of critical facilities for more than 1 week. • More than 10 percent of property destroyed or with major damage.
Limited **(N/A)**	• Injuries and/or illnesses are treatable with first aid. • Minor quality of life lost. • Shutdown of critical facilities and services for 24 hours or less. • Less than 10 percent of property destroyed or with major damage.

FREQUENCY OF OCCURRENCE:

Highly likely: Event probable in next year.

Likely: Event probable in next 3 years.

Occasional: Event possible in next 5 years**.**

Unlikely: Event possible in next 10 years.

Highly Unlikely: Event not likely to occur

SEASONAL PATTERN:

Not seasonal

SOURCE DOCUMENTS, STUDIES, MAPS, ETC, THAT IDENTIFY AREAS POTENTIALLY AFFECTED:

http://www.fema.gov/hazards/earthquakes/, http://geohazards.cr.usgs.gov/eq/graphics/usmap.gif

Frohlich Cliff, Davis Scott D., "*Texas Earthquakes*", University of Texas Press, Austin, 2002: 173-174, 244

***PROBABLE DURATION*: Minutes**

WARNING TIME (Potential Speed of Onset):

Minimal (or no) warning.

3 to 6 hours warning.

6 to 12 hours warning.

More than 12 hours warning.

CASCADING POTENTIAL:

May trigger landslides, avalanches, flash floods, fires, and huge, destructive ocean waves (tsunamis)

EXISTING WARNING SYSTEMS:

N/A

II. Vulnerability and Risk

Introduction

The purpose of this section is to assess the natural hazards that have been determined to be of concern to the region, and to identify what items are made vulnerable as a result of the impacts from the hazards. To review, the DEM lists the following items as having the possibility of being vulnerable:

- People
- Critical Facilities (fire, police, communications facilities)
- Special Facilities (schools, nursing homes, jails)
- Housing
- Infrastructure, Lifeline (highways, bridges, navigable waterways, dams, levees)
- Hazardous Materials Facilities (oil and gas refineries, substations)
- Commercial Facilities

SETRPC Natural Hazards of Concern

1) Coastal storms
- **Hurricanes**
- **Tropical storms**

2) Floods
3) Tornadoes
4) Thunderstorms and lightning
5) Hailstorms
6) Wildfires
7) Extreme summer weather
8) Drought

SETRPC Natural Hazards of Concern

In the Hazards Identification and Profile section, all hazards suggested by the DEM and State of Texas Hazards Analysis were identified and profiled for the SETRPC area and reviewed based upon each hazard's:

- Frequency of occurrence
- Severity of impact
- Areas affected that identify areas at risk
- Duration
- Seasonal pattern
- Warning Time
- Cascading potential/possible secondary hazard impacts
- Availability of warnings and warning systems

As a result of the review of the 15 natural hazards, the following eight are identified as being of concern to the SETRPC area:

1) Coastal storms
   - Hurricanes
   - Tropical storms
2) Floods/Inland Flooding (flash, riverine, urban, and small stream floods)
3) Thunderstorms and lightning
4) Hailstorms
5) Tornadoes
6) Wildfires
7) Extreme summer weather
8) Drought

Of the eight hazards identified to be of concern to the SETRPC region, three are more likely to occur in predictable areas of the region within defined areas of risk. The remaining five do not have defined areas of risk and can generally occur anywhere or eve-

rywhere within the region. The table below identifies those hazards with and without defined risk areas.

Hazards with defined areas of risk	Hazards without defined areas of risk
Coastal storms	Thunderstorms and lightning
Floods	Hailstorms
Wildfires	Tornadoes
	Extreme summer weather
	Drought

The vulnerability of structures in the southeast Texas region to damage caused by flooding may be evidenced by the number of properties located in the region that are included on FEMA's Repetitive Loss List. Repetitive Loss (RL) properties are those NFIP-insured structures that have incurred flood damages resulting in two or more claims of at least $1,000 paid by the NFIP within any ten-year period since 1978. As a function of the development of this Plan, the FEMA RL lists for all participating jurisdictions were reviewed and 721 properties were verified by local officials.

FEMA has developed a national RL strategy to identify those RL properties that are a priority for mitigation (reducing the potential for future damage and disruption of life). The FEMA-compiled "Top 10,000" list of priority RL properties includes 94 verified properties located within the southeast Texas region. The criteria for a property to be included on the "Top 10,000" list is different from the criteria used to place a property on the regular RL list. The criteria for inclusion is four or more paid flood damage claims of more than $1,000 each; or two paid claims within any ten-year period that, when added together, equal or exceed the current value of the insured property; or, three or more paid claims that, when added together, equal or exceed the current value of the insured property.

Additional information on RL properties may be located in the Vulnerability and Risk section in each of the county-level and city-level reports.

Characteristics of Potentially Vulnerable Items within the SETRPC Region

To estimate the potential vulnerability from the hazards of concern, statistical information was collected for each of the vulnerable items (listed at the top of page 48) within the region. Information on populations, locations and types of facilities, locations of housing, and locations and types of infrastructure was collected so that impacts from hazards could be estimated, and potential vulnerability of these items could be identified. The information is categorized into the following four groups:

1) People (P-36.01)

To determine the number of people potentially affected by hazards of concern, the populations and population densities of each county and the region were obtained from the 2000 U.S. census, as shown below.

Area	Overall Population	Population density per square mile
Jefferson County	252,051	279
Orange County	84,966	238
Hardin County	48,073	54
SETRPC Region	**385,090**	**Average: 190**

2) Housing Units (P-36.02)

Total numbers for housing units and their densities were also obtained from the 2000 U.S. census for each county and the region. This data is useful in determining what areas have a higher vulnerability or are denser than others and, consequently, could potentially receive a greater amount of damage. The number of housing units at the county and city levels and their corresponding densities are provided in the table on the following page.

Area	Housing Units	Density per square mile
Jefferson County	102,080	113
Orange County	34,781	98
Hardin County	19,836	22
SETRPC Region	**156,697**	**Average: 78**

3) Facilities: Critical, Special, Hazmat, and Commercial (P-36.03, 04, 06, 07)

Facility locations and descriptions were obtained to identify the facilities that had the potential of being damaged by certain hazard events. The DEM 21 categorizes facilities into four types:

- Critical – fire, rescue, police, communications
- Special – schools, nursing homes, health care, prisons, jails
- Hazmat – facilities that make, use, store, or transport hazardous materials such as corrosives, explosives, flammable or radioactive materials, toxins
- Commercial – businesses, industrial sites, retail centers, factories

Facilities were identified and located by utilizing both the USGS Geographic Names Information System (GNIS) and the Hurricane Storm Atlas (HSA), which was a study conducted by the Hazard Reduction and Recovery Center at Texas

A&M University for the DEM that included the SETRPC region. These two sources are explained in greater detail on pages 52 and 53. Maps of the facilities that are at-risk to flooding and storm surge were developed, and are located in the city- and county-level plans.

4) Infrastructure and Lifeline (P-36.05)

Infrastructure and lifeline locations were obtained from the SETRPC Geographic Information System (GIS) Department. The information is useful in determining what types of infrastructure (roads, railroads, pipelines, levees) are vulnerable to the impacts from the hazards of concern. Examples of infrastructure and lifeline are:

- Pipelines, railroads, highways, levees, bridges, and waterways
- Utilities and mass transit systems that provide services within the area

Methodology Used to Identify Vulnerability from Hazards of Concern

To review, things that can be affected by a natural hazard are known as "vulnerable". To determine the vulnerability of the region from each hazard of concern, a methodology was applied to each event that consisted of the following three steps:

1. Select the Probable Event

The probable, or most likely, event for each hazard within the region was selected based upon the history of the hazard within that area, or by using accepted standards for identifying hazard risk areas, for example, the floodplain.

2. Analyze the Potential Impact

Once the probable event was selected, estimates were made concerning what items had the potential to be at-risk from each hazard. Estimating the potential impact from hazards with defined areas of risk was achieved. For example, to estimate which facilities had the possibility of being at-risk due to a 100-year flood, facilities within the 100-year floodplain (the defined area of risk) were located and identified. For hazards that did not have defined areas of risk, the entire region was considered to be at-risk.

3. Results

After the probable event and the potential area of impact of the event were estimated, vulnerable items were able to be specifically identified for certain hazards. For the hazards that did not have defined risk areas, observations were made regarding which areas have the highest densities in population and housing, thus making these areas more vulnerable than areas with smaller concentrations of vulnerable items.

The remainder of this Vulnerability and Risk section focuses on the hazards of concern to the region, and how the methodology to identify vulnerability was applied.

Coastal storms that can affect the SETRPC region include hurricanes and tropical storms. A coastal storm with wind speeds of 74 miles per hour (mph) or higher is a hurricane, and a coastal storm with wind speeds of 73 mph or lower is a tropical storm. Storm surge is a hazard impact uniquely associated with coastal storms. To review, a storm surge is the onshore rush of sea water caused by the high winds associated with a land-falling hurricane or storm. This onshore rush of salt water produces coastal flooding. The greater the magnitude of the coastal storm, the higher the flood water. Storm surge was the hazard impact selected for the coastal storm analysis because 1) it is likely to cause the most extensive amount of damage, and 2) it has defined areas of risk. Other hazard impacts typically associated with coastal storms include inland flooding, tornadoes, and hail. These hazards are analyzed individually in their respective sections (to follow) in this report. The two analyses below were performed to estimate the impacts of storm surge in the SETRPC area.

1) **At-Risk Property and Facilities – Due to the Most Likely Storm Surge Event (Category 2)**
2) **At-Risk Property – Due to the Worst Case Storm Surge Event (Category 5)**

The objectives of these analyses were to 1) determine a dollar value for property at-risk from both the most likely and worst case storm surge event, and 2) identify facilities at-risk of flooding from the most likely storm surge. The following text describes the storm surge event selected for each analysis, the sources of information used, the potential impact to the SETRPC region, and the results of the estimated damage.

The Probable Event

Historical records from NOAA were consulted to determine the number and strength of hurricanes that made landfall in or near the SETRPC region. The information showed that from 1900-1996, the north Texas coastline, which includes the SETRPC region, received:

- 7 Category One hurricanes
- 3 Category Two hurricanes
- 3 Category Three hurricanes
- 4 Category Four hurricanes
- 0 Category Five hurricanes

Based upon this history, the *average* (most likely) hurricane to make landfall along the north region of the Texas coastline (which the SETRPC region lies within) is approximately a Category 2; therefore, the most likely storm surge event analysis is based upon a Category 2 event. It is important to note that the hurricane used as the simulated event for the analysis was also assumed to make landfall 60 miles west of Sabine Pass, and to be traveling in a straight line (perpendicular) to the coastline. Both at-risk property and facilities were analyzed for the most likely storm surge event.

The Worst Case Event

The worst case storm surge event is created from a Category 5 hurricane; thus, the worst case storm surge analysis is based upon a Category 5 event. According to NOAA, since 1900, no Category 5 hurricanes have made landfall in the SETRPC area; however, it is possible for the region to experience a storm of this magnitude. Only at-risk property was analyzed for the worst case storm surge event.

Property and Facility Sources of Information

The property information used in the analyses came from digital county appraisal district (CAD) databases obtained from Jefferson and Orange counties. These databases contain the property location, property type (residential, commercial, industrial, etc.), and dollar value of property within each county. Currently, Jefferson and Orange CADs are both working to complete their digital county appraisal records; therefore, the appraisal records that were obtained at the time of this study were not complete. Refer to each report for estimates of the amount of completed appraisal records used for the analysis. Hardin County was unable to provide a CAD database and census information was used instead, as explained in the Hardin County report.

Information for the facilities at-risk from the most-likely storm surge event was gathered from two sources: the United States Geological Survey's (USGS) Geographic Names Information System (GNIS) and the Hurricane Storm Atlas (HSA). The USGS GNIS is a database containing information about almost two million physical and cultural geographic features in the United States, including facilities. The HSA is a hurricane study performed by Texas A&M University for the State of Texas Division of Emergency Management (DEM) that incorporated the SETRPC region and identified its facilities.

Storm Surge Source of Information

The HSA also provided storm surge flood depths for the area. The storm surge was calculated using the Sea, Lake and Overland Storm Surge from Hurricanes (SLOSH) model software, which is developed and maintained by the NOAA National Hurricane Center. SLOSH considers the pressure, size, forward speed, track, and winds of a hurricane when generating storm surge depth. For the HSA study, the SLOSH software was used to estimate storm surge depths over a predefined area for hypothetical hurricanes.

The storm surge depth data has some built-in inaccuracies. The SLOSH model considers a large area along the Gulf Coast and into the Gulf of Mexico for its predictions. This large study area is subdivided into square areas in which SLOSH reports the *average* flooding. Due to the size of each subdivision, the model may display a large area as flooded at a certain depth when, in reality, only a portion of that area may be flooded to that depth, and some of that area may not be flooded at all. In addition, when mapped, these large subdivisions of the SLOSH study area created a jagged-edged surge outline rather than smooth contours one would expect to see.

The Potential Impact

All property and facilities that are within the risk areas for the most likely and worst case storm surge events are considered at-risk for the purposes of this analysis. It is important to note that the elevation of the property (from the CAD) and the elevation of the facilities (from the USGS GNIS and HSA) are unavailable in the digital format required for this analysis. The lack of facility and property elevation eliminates the ability to determine the exact depth of flooding for each structure, or if a structure may be elevated above the estimated storm surge depth.

The first step in assessing the potential impact from storm surge was to map the cities and counties within the SETRPC region and the area flooded by storm surge within it. Next, the CAD properties (census information for Hardin County) and the facilities were mapped. The properties and facilities within the storm surge flooded areas were identified. The improvements (structures, etc. on the property) were then totaled to obtain a dollar value of at-risk properties. (Note: A geographic information system (GIS) was used to perform this study. A GIS allows the user to query or analyze a database and receive the results in the form of a map, table, or report.)

Results

Summary tables for the most likely and worst case storm surge events have been prepared for Jefferson and Orange counties and the cities of Beaumont, Port Arthur, Orange, and Vidor. These tables present the CAD property information by 1) the dollar amount and percentage of the total property within the city or county, and 2) the dollar amount and percentage within the at-risk area from the storm surge for the city or county. All property that was within the risk area was considered at-risk because, elevation for the CAD property was unavailable. The property analyses utilized the CAD records and grouped them into the following categories:

- Residential – single family homes, apartments, duplexes, mobile homes
- Commercial – stores, hotels, office buildings
- Industrial – industrial/manufacturing property
- Agricultural – farms, ranches
- Non-Profit – churches, etc.
- Government – state/county/city property
- Education – school districts, training facilities
- Utilities – water/wastewater, electricity

Loss estimates for Hardin County were developed from the census information and are explained further in the Hardin County report.

At-risk facility tables were generated to identify facilities that are at-risk from the most-likely storm surge event. It is important to note that the facilities used came from the USGS and the HSA, not the CAD records. These facilities may not be included in the CAD records because, as previously mentioned, the CAD records were not 100% complete at the time of this analysis. The at-risk facilities tables also identify the elevation and the flood depth. The elevation refers to the natural-ground elevation at the facility.

The flood depth refers to the estimated depth of flooding above natural ground as a result of storm surge.

Maps were developed to display the defined risk area for each hurricane category.

Refer to the city- and county-level reports in the Vulnerability and Risk section for at-risk facility and CAD tables, and risk area maps.

Inland flooding includes all types of flooding associated with extreme rainfall events (i.e., flash, riverine, urban, and small stream floods). The severity of flooding is dependant upon the intensity and duration of rainfall. The analysis below was performed to estimate the impacts of inland flooding for the counties of Jefferson, Orange, and Hardin and the cities of Port Arthur, Orange, Vidor, and Beaumont.

At-Risk Property and Facilities – Due to Inland Flooding

The objectives of this analysis were to 1) estimate a dollar value for at-risk property, and 2) identify facilities at-risk from inland flooding. The following text describes the probable flooding event selected for the analysis, the sources of information used, the potential impact to the region, and the results of the estimated damage.

The Probable Event

The **100-year flood event** (1% probability of occurrence in any given year) is used by the Federal Emergency Management Agency (FEMA) as a standard for delineating special flood hazard areas.

The **100-year floodplain** (defined risk area) is the area deemed by FEMA to be likely to flood as a result of a 100-year flood event, and is the defined risk area for this analysis.

Property and Facility Sources of Information

The same property and facility information used in the coastal storm analysis was used for the inland flooding analysis. Refer to the top of page 53 in this section.

Floodplain Source of Information

The 100-year floodplain utilized in this analysis is the digital FEMA Q3 flood data. Q3 flood data is the only digital FEMA floodplain information available. The Q3 is designed to provide guidance and a *general proximity* of the location of Special Flood Hazard Areas. Although the Q3 floodplain data displays the floodplain, it does not identify the base flood elevation (BFE) which is the elevation of the flood water that is expected from a 100-year flood. This is important to note because, if a property or facility is in the 100-year floodplain but above the BFE, it is not expected to be damaged during a 100-year flood event. The FIRM panel numbers used for this analysis may differ from the most current FIRMs available in paper format. Refer to the Appendix of this report for a further explanation of the Q3 flood data limitations, and a table of the Q3 FIRM panels and the most current FIRM panels available.

The Potential Impact

All property and facilities that are within the boundaries of the 100-year floodplain are considered at-risk of inland flooding for the purposes of this analysis. It is important to note that the elevation of the property (from the CAD), and the elevation of the facilities (from the USGS GNIS and HSA) are unavailable in the digital format required for this analysis. In addition, the elevation of the BFE is also unavailable, as noted above. The

lack of BFE coupled with the lack of facility and property elevation eliminates the ability to determine the exact depth of flooding for each structure.

The first step in assessing the potential impact of inland flooding was to map cities and counties within the SETRPC region and their respective 100-year floodplains. Next, the CAD properties (census information for Hardin County) and the facilities were mapped. The properties and facilities within the floodplain were identified. The improvements (structures on the property) were then totaled to obtain a dollar value of at-risk properties. (Note: A geographic information system (GIS) was used to perform this study. A GIS allows the user to query or analyze a database and receive the results in the form of a map, table, or report.)

Results

Summary tables have been prepared for Jefferson and Orange counties and the cities of Beaumont, Port Arthur, Orange, and Vidor. These tables present the CAD property information by 1) the dollar amount and percentage of the total property within the city or county, and 2) the dollar amount and percentage within the 100-year floodplain for each city or county. The property analysis utilized the CAD records and grouped them into the following categories:

- Residential – single family homes, apartments, duplexes, mobile homes
- Commercial – stores, hotels, office buildings
- Industrial – industrial/manufacturing property
- Agricultural – farms, ranches
- Non-Profit – churches, etc.
- Government – state/county/city property
- Education – school districts, training facilities
- Utilities – water/wastewater, electricity

At-risk facility tables were generated to identify facilities that are at-risk from inland flooding. It is important to note that the facilities used came from the USGS and the HSA, not the CAD records. These facilities may not be included in the CAD records because, as previously mentioned, the CAD records were not complete at the time of this analysis.

Maps were developed to display the defined risk area (floodplain) for each jurisdiction. Included on the map are the 100- and 500-year floodplains (500-year = 0.2% probability of occurrence in any given year).

Refer to the city- and county-level reports in the Vulnerability and Risk section for at-risk facility and CAD tables and risk area maps.

The Probable Event

In order to estimate the potential vulnerability posed to the region by this hazard, the typical (average) tornado event for the region was estimated. To make this determination, the storm event tables in the jurisdictional reports were consulted. The table below summarizes the tornado history for the SETRPC region.

Area	Total # of tornadoes (since 1950)	Average # of tornadoes	Average Magnitude*
Jefferson County	97	2 (per year)	F1
Orange County	25	1 (every 2 years)	F1
Hardin County	19	1 (every 2 years)	F1
SETRPC Region	**141**	**2 (per year)**	**F1**

**Refer to the Fujita Scale in the Hazards Identification and Profile Section.*

The Potential Impact

Although there are conditions that make tornadoes more likely to occur, tornadoes are sporadic and do not have defined areas of risk (like floodplains) that can be used to measure specific areas with more vulnerability than others. Therefore, the entire SETRPC region is susceptible to tornadoes.

It is important to note that tornadoes are the most erratic and most violent of storms and, although tornadoes usually affect relatively small areas, they strike faster and with more ferocity than any other storm.

Results

It can be noted by analyzing the vulnerable items on pages 49 and 50, the areas with higher population densities and housing unit densities are more vulnerable than those areas with lower densities. Tornadoes have caused damage to the region in the past. For instance, the tornado that occurred on November 7, 1957 in Jefferson County caused $2,500,000 in property damage, injured 59 people, and killed two people. When more people and structures are located in an area, the vulnerability from hazards increases because there are more vulnerable items (people, housing, etc.) that have the potential to be damaged.

The Probable Event

To estimate the potential vulnerability posed to the region by thunderstorms and lightning, the typical (average) number of events per year were estimated for each county and the region as a whole. To make this calculation, the storm event tables in the jurisdictional reports were consulted. The table below summarizes the thunderstorm and lightning history for the SETRPC region.

Area	Total # of thunderstorm/lightning events (since 1955)	Average # of thunderstorm/lightning events per year
Jefferson County	171	4
Orange County	82	2
Hardin County	67	2
SETRPC Region	**320**	**7**

The Potential Impact

Although there are conditions that make thunderstorms and lightning more likely to occur, they are sporadic and do not have defined areas of risk. Therefore, the entire SETRPC region is susceptible to thunderstorms and lightning.

The severity of thunderstorms and lightning within the region is important to consider when analyzing the impacts of these hazards. It is rare that loss of life occurs as a result of either hazard; property is most often the greatest concern when dealing with impacts from these events.

Results

It can be noted by analyzing the vulnerable items on pages 49 and 50, the areas with higher population densities and housing unit densities are more vulnerable than those areas with lower densities. Thunderstorms and lightning have caused damage to the region in the past. For instance, the thunderstorm that occurred on August 14, 1998 in Beaumont in Jefferson County caused $75,000 in property damage, injured one person, and killed another person. When more people and structures are located in an area, the vulnerability from hazards increases because there are more vulnerable items (people, housing, etc.) that have the potential to be damaged.

The Probable Event

To estimate the potential vulnerability posed to the region by hailstorms, the typical (average) yearly number of events for each county and the region was estimated. To make this estimation, the storm event tables in the jurisdictional reports were consulted. The table below summarizes the hailstorm history for the SETRPC region.

Area	Total # of hailstorm events (since 1955)	Average # of hailstorm events per year
Jefferson County	81	2
Orange County	31	1
Hardin County	39	1
SETRPC Region	**151**	**3**

The Potential Impact

Although there are conditions that make hailstorms more likely to occur, they are sporadic and do not have defined areas of risk that can be used to measure specific areas with more vulnerability than others. Therefore, the entire SETRPC region is susceptible to hailstorms.

Results

It can be noted by analyzing the vulnerable items on page 48 the areas with higher population densities and housing unit densities are more vulnerable than those areas with lower densities. When more people and structures are located in an area, the vulnerability from hazards increases because there are more vulnerable items (people, housing, etc.) that have the potential to be damaged. Like thunderstorms and lightning, property is most often the greatest concern when dealing with impacts from hailstorms. In addition, hailstorms often create substantial damage to crops. Croplands within the region are particularly vulnerable to impacts from hail.

The Probable Event

The Texas Forest Service (TFS) contains a history of wildfires within the SETRPC region from 1992 - 2001. Based on this information, the following wildfire events were reported:

Area	Total # of wildfire events (1992 - 2001)	Average # of wildfire events per year
Jefferson County	18	2
Orange County	124	14
Hardin County	458	50
Regional	**600**	**66**

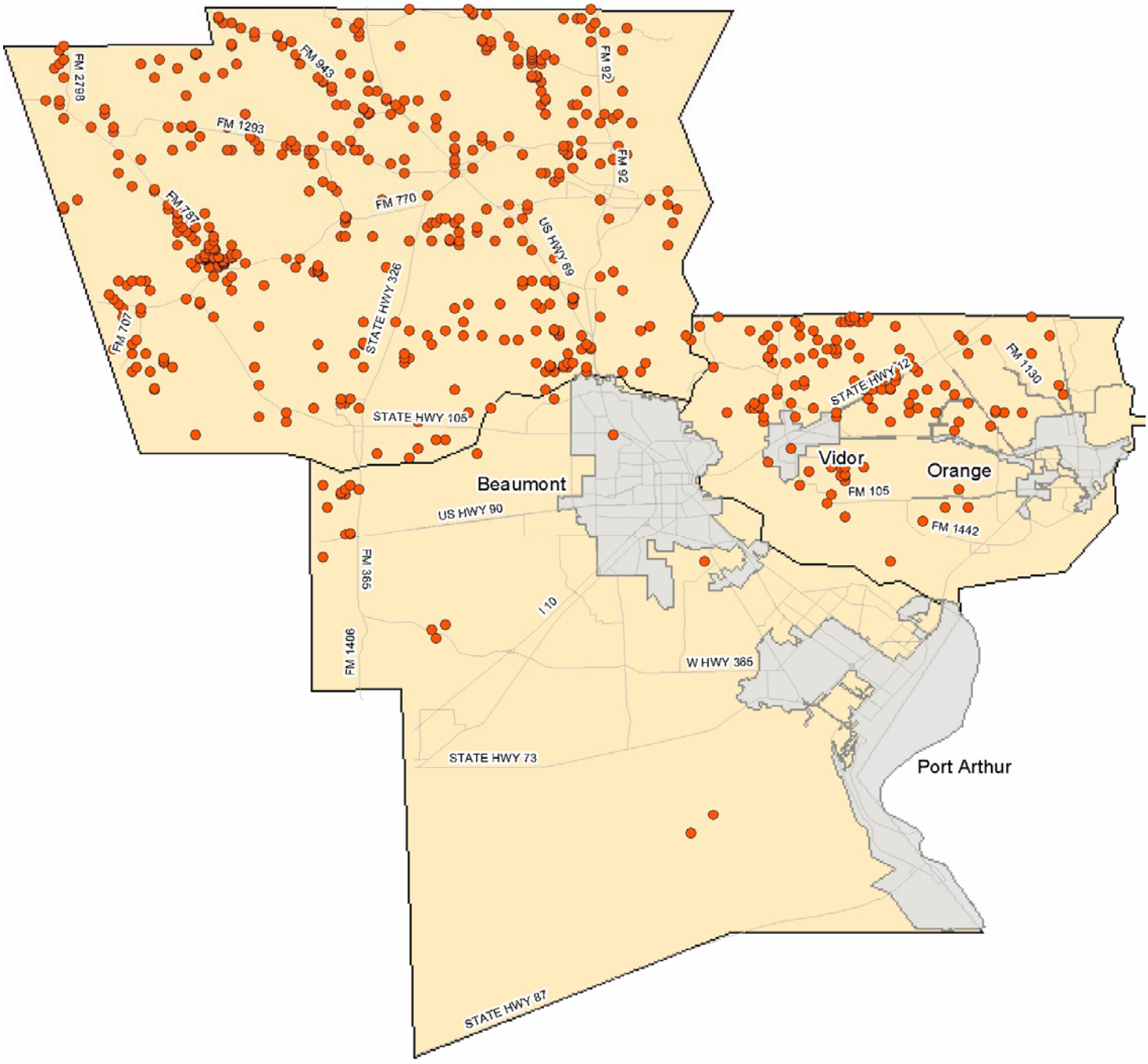
A map depicting the incidences of wildfires in the SETRPC area is included on the following page. It is important to note that all of the wildfires depicted in the map as well as those listed in the county-level reports are those reported to the Texas Forestry Service during the time period from 1992 - 2001. All wildfires that TFS units were involved in suppressing are included in this information. However, the TFS records do not include, for instance, a response by a volunteer fire department (VFD) where the TFS was never called. Thus, the information will not include any house fires or EMS runs and will probably not include a significant number (half or more) of the smaller (2-3 acres or less) woods or pasture fires. The TFS responds to wildfires on all private and non-federal lands. It also assists federal agencies (as requested) and reports the response in its database. However, the appropriate federal agency (National Park Service, USFS, etc.) will be the primary responder and may or may not request assistance from the TFS.

The Potential Impact

Wildfire will cause the most damage when it meets the urban-wildlife interface (the zone of natural landscape where structures begin); however, property (land) damage from wildfires also occurs when these hazards burn wooded areas. There is potential for substantial impacts to property and loss of life from wildfire within the SETRPC region. In the past, wildfires have proved to be destructive to property within the region. It is important that precautions, such as burn bans, are taken during dry and hot periods.

Results

As previously mentioned, the major factors that influence fire behavior can be grouped under the general headings of fuels, weather, and topography.[22] These factors have a bearing in the cycle of burning. The intensity of the fires and the rate at which they spread are governed by factors like the relative humidity, wind speed, and the temperature.[57] Wildfires are highly dependent on these variables; thus, their probability changes as often as the weather. Drought indexes (such as the KBDI Index mentioned in the drought section) are important to monitor to gauge the potential danger. Wildfire is relatively frequent within the region.



SETRPC Wildfires from 1992 - 2001[73]

• Wildfires

0 10 20 Miles

The Probable Event

Drought conditions within the SETRPC region have a short duration.[15] However, in the past, the region has endured periods without significant rain accompanied with high temperatures that have produced minor problems concerning infrastructure and property.

The Potential Impact

All of the area in the region is vulnerable to the effects of drought. The region has suffered drought-like conditions in the past that led to water mane breaks and cracked slabs for structures. As a result, housing and infrastructure appear to be the two most vulnerable items to the effects of drought within the region. As previously mentioned, drought can also lead to agricultural losses and the increase of fires.

Results

Although drought does not appear to pose a significant risk to life within the SETPRC region, it has been shown in the past to cause problems with property, specifically housing and infrastructure. Precautions should be taken to reduce the damage that may occur to slabs and water manes. In addition, area wildfire managers should be aware of the increased risk of fire.

The Probable Event

The National Weather Service recorded the temperature history from 1961-1990 for the SETRPC region (weather station located in Port Arthur). According to this recorded history, during this 30-year time period, the normal daily maximum temperatures during the summer months were as follows:

- June - 89.4º
- July - 91.9º
- August - 91.7º
- September - 87.3º

When these temperatures are combined with the high humidity levels typical in the southeast Texas area, people and property may be at-risk.

The Potential Impact

Along with possible heat disorders, extreme summer weather can also lead to drought, fire, and agricultural losses. Refer to the Heat Index (HI) chart on page 33 for possible heat disorders.

Results

High temperatures and humidity are normal and expected for region. They will be of greatest concern in the summer months. It is recommended that people take the necessary precautions during these months to limit their exposure to the dangerous conditions outdoors. In addition, precautions should also be made by fire managers to enforce burn bans to reduce the risk of wildfire in the area.

SETRPC Hazard Impact and Risk Summary

The natural hazards that are of concern to the SETRPC region can be prioritized based upon cross-reference of the information compiled in the Hazards Identification and Profile and Vulnerability and Risk sections. To assign a priority to the hazards, the following items were considered:

- Frequency of Occurrence
- Warning Time
- Potential Severity of Impact
- Risk Level

This analysis prioritizes the natural hazards qualitatively as High, Medium, and Low. The Hazard Impact and Risk Summary table on the following page prioritizes the hazards of concern to the SETRPC area.

III. Prioritized Hazards – Hazard Impact and Risk Summary

Hazard	*Frequency of Occurrence*	*Warning Time*	*Potential Severity** *Substantial, Major, Minor, Limited*	*Risk Level* *Very High, High, Limited, Minimal*	*Priority* *High, Medium, Low*
Coastal Storms **Hurricanes** **Tropical Storms**	Occasional: Event possible next five years	More than 12 hours	Major	Minimal	High
Floods	Highly Likely: Event probable in next year	Highly dependent on the event (none to hours)	Minor	High	High
Wildfires	Highly Likely: Event probable in next year	Minimal or None	Limited	High	High
Tornadoes	Highly Likely: Event probable in next year	Minimal or None	Limited	High	Medium
Thunderstorms and Lightning	Highly Likely: Event probable in next year	3 to 6 hours (thunderstorm) Minimal or None (lightning)	Limited	Very High	Low
Hailstorms	Highly Likely: Event probable in next year	Minimal or None	Limited	High	Low
Drought	Occasional: Event possible next five years	More than 12 hours	Limited	Minimal	Low
Extreme Summer Weather	Highly Likely: Event probable in next year	More than 12 hours	Limited	High	Low

Refer to the Regional Report Hazard Profile Worksheets for an explanation on Potential Severity categories.

Membership and functions of HMT (Annex P-37)

Multi-disciplined, long range mitigation planning requires a coordinated team of personnel with administrative, financial, and technical knowledge and expertise in a variety of functional areas that may be needed to achieve mitigation objectives. The regional Hazard Mitigation Team (HMT) is composed of individuals with this knowledge and expertise. The HMT, under the leadership and coordination of the Hazard Mitigation Coordinator (HMC), is collectively responsible for development, distribution, and maintenance of the local Hazard Analysis, Mitigation Action Plan, and this annex. Team members provide assistance for hazard mitigation activities as required by the HMC. Team members were selected for functional areas that are applicable to the region and which may have required local expertise. The participating jurisdictions and team members are represented in the Organizational Chart found in the Introduction section of this report.

The HMT met on the following various occasions to discuss the progress of the MAP.

Date	Location
April 24, 2002	South East Texas Regional Planning Commission (SETRPC)
May 28, 2002	SETRPC
July 26, 2002	SETRPC
November 5, 2002	SETRPC
January 3, 2003	SETRPC
January 10, 2003	SETRPC
January 16, 2003	SETRPC
February 6, 2003	SETRPC
March 13, 2003	Nederland City Hall
May 6, 2003	SETRPC
May 22, 2003	Port Arthur Fire Station Number 1
June 25, 2003	SETRPC
July 17, 2003	SETRPC
July 24, 2003	SETRPC
August 21, 2003	SETRPC
December 18, 2003	Vidor Police Department
March 2, 2004	Southeast Regional Airport **<public meeting>**
March 4, 2004	Orange City Council Chambers **<public meeting>**
April 1, 2004	SETRPC

Public/private partnerships (Annex P-38)

N/A

Involvement with neighboring jurisdictions (Annex P-39)

N/A

Public involvement with Mitigation Action Plan (Annex P-40)

Involvement of the public in the Mitigation Action planning process was of critical importance to the regional planners. Therefore, the FEMA Household Questionnaire was utilized to obtain data regarding the public's involvement with and knowledge of disasters and mitigation actions. The questionnaire was modified slightly to address the needs of the southeast Texas region, and was then placed on the regional (SETRPC), county, and city web sites. The timing of placement coincided with hurricane season (June through October) when there was heightened public concern and interest in disasters. In addition, emergency management planners conducted more speaking engagements to the public during this time. During these engagements, questionnaires were distributed to the public for their input. Also, Lamar University distributed the questionnaire to college students who could obtain extra credit points for completion. Because older Americans are often the most isolated segment of the population, the South East Texas Area Agency on Aging coordinated the questionnaires' distribution to Meals on Wheels clients typically considered as "shut-ins." The help of the public was also enlisted to input electronically the information completed by hand on the questionnaire. In addition, two public meetings were held on the progress of the MAP – one on March 2, 2004 at the Southeast Regional Airport and one on March 4, 2004 at the Orange City Council Chambers.

Public awareness and involvement with efforts (Annex P-41)

In filling out the FEMA Household Questionnaire, the public became more aware of the hazards potentially affecting their area and the available mitigation actions. Questions on the survey discussed what kinds of measures the public would be willing to take, have taken, or would not take to protect themselves and their property in the event of a disaster. The answers to these questions contributed to the proposed mitigation actions later specified by the region and the individual jurisdictions.

Effectiveness of previous mitigation measures, policies, plans, etc (Annex P-42)

This section deals with previously implemented mitigation measures and current mitigation-related policies, plans, practices, and programs.

Hazard Mitigation Grant Program (HMGP) projects (Annex P-42.01)

Refer to city- and county-level plans for Annex P-42.01.

Public Assistance (PA) program projects (Annex P-42.02)

1998 - #1245 Tropical Storm Francis
2001 - #1379 Tropical Storm Allison

Corps of Engineers studies, plans, and projects (Annex P-42.03)

Corps of Engineers studies, plans, and projects were performed for Hardin County, Orange County, Jefferson County, and the City of Port Arthur. **Please refer to those jurisdictional plans for more information.**

Texas Water Development Board funded items (Annex P-42.04)

Texas Water Development Board funded items were performed for Hardin County, Jefferson County, City of Orange, and the City of Port Arthur. **Please refer to those jurisdictional plans for more information.**

Project Impact, PDM, and PP-M funded items (Annex P-42.05)

Refer to city- and county-level plans for Annex P-42.05.

Current master drainage and storm water management plans (Annex P-42.06)

Refer to city- and county-level plans for Annex P-42.06.

Current comprehensive and capital improvement plans (Annex P-42.07)

Refer to city- and county-level plans for Annex P-42.07.

Current building and fire codes (Annex P-42.08)

Refer to city- and county-level plans for Annex P-42.08.

Current floodplain management ordinances/orders (Annex P-42.09)

Refer to city- and county-level plans for Annex P-42.09.

FEMA CAV reports, FIS, CRS, etc. (Annex P-42.10)

Refer to city- and county-level plans for Annex P-42.10.

BCEGS reports (Annex P-42.11)

Refer to city- and county-level plans for Annex P-42.11.

Natural hazards cannot be eliminated; although with effective mitigation, their effects can be reduced. FEMA encourages local governments to take action in order to protect themselves from the devastating impacts of a natural hazard and to maintain their communities' sustainable growth . Mitigation actions provide a way for communities to protect themselves from the sometimes devastating effects of a natural hazard. FEMA defines mitigation as "any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards." The State of Texas established the following mitigation goals as part of its state mitigation plan, and these goals should be the foundation of any community's mitigation plan:

- Reduce/eliminate hazardous conditions which inflict injuries or cause loss of life
- Reduce/eliminate hazardous conditions which cause property damage
- Reduce/eliminate hazardous conditions which degrade important natural resources

The SETRPC communities involved in creating a hazard mitigation action plan are responsible for developing goals, objectives, and mitigation actions in order to comply with the federal and state guidelines for the plan. Regional and jurisdictional mitigation goals are consistent with the state's goals and do not contradict other community goals. In relation, the goals expressed in the regional plan include the goals of the jurisdictional plans (as appropriate), as well as those strategies that will benefit the region as a whole. According to the State of Texas Mitigation Handbook, the procedures below are in order to align the regional plan with the community plans.

- Goals to reduce hazard vulnerability and risk should always be coordinated with the regional plan and capital improvements program

- The regional plan reflects what the communities would like to see happen in the future; it guides other local measures such as capital improvements, zoning and subdivision ordinances.

- The regional plan can incorporate the mitigation strategies identified in the communities' mitigation action plans to limit new development in hazard prone areas and encourage practices that are consistent with disaster resistant communities' goals.

The SETRPC Region

In 2003, the SETRPC developed a Household Natural Hazards Preparedness Questionnaire and made it available through the Homeland Security and Emergency Management Planning Division section of the region's website: www.setrpc.org/hsempd/survey/ (see the Appendix section of this report for a brief overview). The responses to this questionnaire helped local officials determine what hazards are of most concern to the citizens of this tri-county area. According to the Hazards Analysis and Vulnerability and Risk sections of this Mitigation Action Plan, the hazards of concern are those with ranked priority based on fre-

quency, warning time, potential severity, and risk level (see Hazard Impact and Risk Summary section).

Goals and Objectives of the SETRPC Region

The hazard mitigation goals and objectives below were established for the regional MAP and are applicable to the jurisdictions represented in the individual plans. Using FEMA's State and Local Mitigation Planning How-To Guide, *Developing the Mitigation Plan: Identifying Mitigation Actions and Implementation* Strategies (386-3), examples of goals and objectives were presented to the SETRPC region. The members of the Regional Hazard Mitigation Team, along with jurisdictional hazard mitigation teams, adopted the following goals and objectives.

1. Protect existing properties.
Objectives:
1.1 Use the most effective approaches to protect buildings from flooding, including acquisition or relocation where warranted.
1.2 Enact and enforce regulatory measures that ensure new development will not increase flood threats to existing properties.
1.3 Use appropriate actions to mitigate against the danger and damage posted by other hazards.

2. Protect health and safety.
Objectives:
2.1 Advise everyone of safety/health precautions to take against flooding and other hazards.
2.2 Improve traffic circulation during floods and at other times.
2.3 Improve water quality and habitat.

3. Improve the quality of life in the community.
Objectives:
3.1 Preserve and improve the downtown core of businesses and services.
3.2 Ensure that current owners can maintain and improve their properties.
3.3 Use acquisition programs to expand open space and recreational opportunities.
3.4 Maintain attractive public open spaces.

4. Reduce the impact of natural disasters on people and property.
Objectives:
4.1 Promote studies and projects that support natural resource protection.
4.2 Develop and implement programs that remove or relocate residential structures from highly vulnerable areas.
4.3 Enforce measures that regulate new development in high hazard areas.

5. Improve communication and coordination with other relevant organizations.
Objectives:

5.1 Improve inter-jurisdictional coordination within region.
5.2 Establish and maintain lasting partnerships and mutual aid agreements.
5.3 Encourage jurisdictional capability to perform hazard risk assessments and track mitigation activities.
5.4 Improve quantity and quality of information on hazard identification and vulnerable assets and populations.

Mitigation Actions for the SETRPC Region

Based on the regional Hazard Impact and Risk Summary found in the Prioritized Hazards section of this report, the results of the SETRPC Household Natural Hazards Preparedness Questionnaire (see Appendix), and the mitigation actions proposed within the local MAPs, a regional mitigation strategy was developed for the five-year planning cycle. Given the limited resources available to this region and a limited expectation that any significant amount of federal mitigation funding will become available within the five-year planning horizon, the region and participating jurisdictions have elected to focus their mitigation planning efforts on flood-related hazards. Inland flooding resulting from hurricanes, tropical storms, thunderstorms, and other heavy rainfall events is considered to be the primary natural hazard for this area of the state.

The Code of Federal Regulations, 44 CFR §206.434, discusses the types of hazard mitigation projects that may be eligible for federal financial participation through FEMA. Without reiterating these regulations, eligible projects include the following activities:

- Planning
- Structural hazard control or protection
- Other hazard protection construction activities
- Property acquisition or relocation
- Development of local mitigation standards
- Development of comprehensive mitigation programs including implementation
- Development of improvement of warning systems

Benefit-Cost Ratio

The regional and local MAPs conform to this list of eligible activities. The federal regulations also require that projects be cost effective. This requirement is fulfilled through calculation of a Benefit-Cost Ratio (BCR). Simply put, the estimated benefits to be derived from implementing a project must equal to or exceed the cost of implementation (i.e., the BCR must be ≥ 1.0). Although the limited resources available for development of the SETRHMAP did not permit the calculation of a BCR for each and every project included in this document, a qualitative assessment of the relative value of each project was performed by HMTs within each jurisdiction. As proposed projects are refined for grant application purposes by the region and individual communities, a BCR will be developed for each project with funding priority being assigned to those projects offering the higher

BCRs. Quantitative BCRs were calculated for repetitive loss acquisition projects as is discussed in the following narrative.

Repetitive Loss

The regional mitigation strategy focuses on acquisition and/or relocation of properties that have experienced repetitive losses from flooding events. Repetitive loss (RL) lists as of 3/31/2003 were provided from FEMA and were distributed to each jurisdiction for verification of the status and location of each property. Each jurisdiction verified that the properties were correctly identified with the responsible political jurisdiction and that the properties still existed. In certain instances, properties had already been acquired and demolished through buyout programs. For those properties that were verified, the responsible jurisdiction identified the current value of the land and improvements for local tax records.

A BCR was calculated for each verified RL property. The methodology employed to calculated the BCR is based on the formula presented in FEMA's "Full Data Riverine BCA Module", Appendix 1, and appears as follow:

$$NPV = B\left[\frac{1-(1+i)^{-T}}{i}\right] - INV$$

Where:

NPV	is the expected Net Present Value of the hazard mitigation project;
B	is the expected annual net Benefit of the hazard mitigation project for year t;
i	is the annual discount rate;
T	is the length of the planning horizon (useful life or Time of the hazard mitigation project); and
INV	is the initial investment (the cost of the project)

For the purpose of the RL analysis, the following values were assigned to T and i:

$T = 100$ years $\qquad i = 7\%$

The cost of the project (INV) was calculated as follows:

1. The purchase price for the property is the sum of the land value obtained from the tax records and the structure value, which was taken as the greater of the tax-assessed value or the building value as listed in the FEMA RL list.
2. $13,500 was added to the estimated purchase price for brokerage and consultation fees, demolition, and the present value of future maintenance expense. One percent of the purchase price was then added to cover estimated closing costs.

The expected annual benefit (B) to be derived from implementation of the project was calculated as follows:

1. The amount of each paid claim for the property was obtained from FEMA's RL list. A hypothetical $500 deductible was added to the amount paid for damage to the structure and to the amount paid for damage to contents. These adjustments were made to estimate the amount of the damages rather than the amount of the insurance reimbursement.
2. The estimated damages for each event were then adjusted for inflation based on factors supplied by FEMA in the "BCA Toolkit".
3. The inflation adjusted damages for each event were summed and divided by the number of years expired from the date of the first listed event through 3/31/2003 to determine the average annual benefit.

The BCR for each property was derived as follows:

$$BCR = \frac{B\left[\frac{1-(1+i)^{-T}}{i}\right]}{INV}$$

The RL properties within each participating jurisdiction were ranked according to BCR. Those properties with a BCR ≥ 1.0 would be eligible for acquisition individually or as part of a multi-property project. Properties with a BCR < 1 would only be eligible to participate in multi-property projects where the acquisition of such a property would be considered to be an integral part of the overall project. For such multi-property projects, the overall project BCR (the sum of the BCRs for each property) would be ≥ 1.0.

Repetitive loss maps and project descriptions are included with the local MAPs. Based on the applied methodology, certain jurisdictions have no RL properties that qualify for acquisition. Acquisition of such properties would only be considered if they were considered to be integral components of multi-property acquisition projects proposed for adjacent jurisdictions.

There are alternatives to acquisition and demolition of RL properties that should be explored during the course of project development. In general, the RL mitigation plans included in this document represent a preliminary identification of properties that might qualify for acquisition and demolition. Alternatives for reducing potential flood damage to these properties would encompass elevation or relocation of structures, structural flood control measures, and infrastructure improvements. These alternatives, or combinations of alternatives, may offer more cost effective solutions to the repetitive loss problem than would acquisition and demolition. As the participating jurisdictions develop grant applications for federal funding, the benefit/cost ratio of various feasible alternatives will be explored to determine the most cost effective solution for the identified problem.

In addition to the mitigation action plans presented under local jurisdictions, the SETRPC has proposed the region-wide mitigation actions found on the next several pages.

MITIGATION ACTION TABLE #1	
Jurisdiction:	SETRPC Region
Hazard:	Floods
Objective:	1.1, 1.2, 1.3, 2.1, 2.3, 3.1, 3.2, 3.4, 4.1, 4.2, 4.3, 5.1, 5.4
Mitigation Action:	Develop/coordinate regional Community Rating System (CRS) application and program.
Reason for Action:	Participation in the CRS program administered by the National Flood Insurance Program (NFIP) reduces flood losses, protects public health and safety, reduces damage to buildings and contents, prevents increases in flood damage from new construction, reduces the risk of erosion damage, protects natural and beneficial floodplain functions, facilitates accurate insurance rating, and promotes the awareness of flood insurance.
Benefits:	Benefits of the CRS include reduced flood insurance rates, enhanced public safety and the protection of the environment, reduction in damage to property and public infrastructure, effectiveness of flood program can be evaluated against a nationally recognized benchmark, implementation of some CRS activities can help a community qualify for certain federal assistance programs, and is an added incentive to maintaining flood programs since CRS status can be affected if eliminated.
Estimated Cost:	$150,000
Responsible Party:	SETRPC Region
Timeframe:	Within one year of MAP cycle

MITIGATION ACTION TABLE #2	
Jurisdiction:	SETRPC Region
Hazard:	Floods
Objective:	2.1, 3.2
Mitigation Action:	Conduct flood insurance educational seminars for area realtors to increase their knowledge of the National Flood Insurance Program (NFIP) and the benefits to homeowners of securing flood insurance.
Reason for Action:	Typically, realtors inform potential homeowners of the need for flood insurance only when the residence being purchased is located in a special flood hazard area and flood insurance is required by the lender under federal law.
Benefits:	In coastal communities with very flat topography, flood insurance is a wise investment regardless of the location of a residence relative to a special flood hazard area.
Estimated Cost:	$20,000 - $25,000
Responsible Party:	SETRPC Region
Timeframe:	Immediate

MITIGATION ACTION TABLE #3	
Jurisdiction:	SETRPC Region
Hazard:	Coastal Storms / Hurricanes / Floods / Extreme Summer Weather
Objective:	1.3, 2.1, 2.2
Mitigation Action:	Coordinate the identification of the special needs populations of the region that will need assistance in the event of a disaster. Identification will be made through home health agencies, medical equipment companies, local churches, and neighborhood associations. Organize strategies for evacuating them during a coastal storm, hurricane, or other such hazards.
Reason for Action:	The action recognizes a significant portion of the regional population that may have physical or mental limitations, and serves to provide help if necessary.
Benefits:	Allows a more effective and efficient provision of assistance to residents with special needs.
Estimated Cost:	$15,000
Responsible Party:	SETRPC Region
Timeframe:	Ongoing

MITIGATION ACTION TABLE #4	
Jurisdiction:	SETRPC Region
Hazard:	Coastal Storms / Hurricanes
Objective:	1.3, 2.1, 2.2, 3.1, 3.2
Mitigation Action:	Coordinate Emergency Management response action plans for coastal storm/hurricane events. Specific efforts will include encouraging jurisdictions to install and maintain back-up power at critical facilities, construct and designate alternate emergency operations center for disaster/emergency operations, and solicit participation in Community Emergency Response Training.
Reason for Action:	Critical facilities will be able to operate despite power outages. This, in turn, will better equip cities and counties to respond disasters as they occur.
Benefits:	These actions will increase the ability of critical/special facilities to continue operating on a functional level during and after disaster events.
Estimated Cost:	$500,000
Responsible Party:	SETRPC Region
Timeframe:	Ongoing

MITIGATION ACTION TABLE #5	
Jurisdiction:	SETRPC Region
Hazard:	Wildfires / Tornadoes / Thunderstorms and Lightning / Hailstorms
Objective:	1.1, 2.1, 3.1, 3.2, 5.1, 5.2, 5.3, 5.4
Mitigation Action:	Facilitate use of the Southeast Texas Alerting Network (STAN) to notify the public of impending hazardous events. The STAN system would also work as a public outreach effort to educate the citizens regarding natural hazards.
Reason for Action:	The South East Texas Industry Public Relations Association and emergency management personnel worked together to create a multi-function telephone messaging and notification system that provides local agencies and industries the ability to provide the community important and timely information about a high profile event.
Benefits:	Immediate notification of a potential hazardous event is one of the best methods of protection. An efficient and organized warning system enables the public to take immediate precautions to safeguard themselves and to protect their property.
Estimated Cost:	$0
Responsible Party:	SETRPC Region
Timeframe:	Ongoing

MITIGATION ACTION TABLE #6	
Jurisdiction:	SETRPC Region
Hazard:	Extreme Summer Weather
Objective:	5.2, 5.3
Mitigation Action:	Coordinate public/private partnerships to ensure the special needs populations is protected from health risks due to extreme heat. Actions may include providing fans and portable air conditioners to citizens who have physical limitations and may be unable to reach safety in times of extreme summer weather. Volunteer groups may be available to assist by visiting special needs groups to ensure their safety and comfort during such severe temperature extremes.
Reason for Action:	Citizens of a special needs population are at a disadvantage due to their limited access to safety. The jurisdictions within the region can work together to ensure safety for all citizens.
Benefits:	Residents in the special needs population of the region will be better able to care for themselves during these hazard events.
Estimated Cost:	$5,000
Responsible Party:	SETRPC Region
Timeframe:	Ongoing

MITIGATION ACTION TABLE #7	
Jurisdiction:	SETRPC Region
Hazard:	Extreme Summer Weather / Drought
Objective:	2.1, 2.3, 4.1, 5.1, 5.3, 5.4
Mitigation Action:	Facilitate a regional drought contingency plan to ensure safe and adequate water supply.
Reason for Action:	During times of extreme summer weather or drought, the demand for potable water may exceed the capacity to produce sufficient potable water for domestic use, sanitation purposes, and fire protection. The drought contingency plan provides the ability to regulate the use of potable water for non-essential uses.
Benefits:	The drought contingency plan ensures the region's ability to provide sufficient potable water for domestic, sanitation, and fire protection uses.
Estimated Cost:	$100,000
Responsible Party:	SETRPC Region
Timeframe:	Ongoing

MITIGATION ACTION TABLE #8	
Jurisdiction:	SETRPC Region
Hazard:	All Hazards
Objective:	5.1, 5.2, 5.3, 5.4
Mitigation Action:	Facilitate improvement of quality of local information on vulnerable items (assets and populations) such that the value of the risk assessment may be improved. Work with other jurisdictions in region to get data as up to date and complete as possible.
Reason for Action:	Vulnerability and risk assessments of hazards cannot be as comprehensive as possible without complete data. For example, first floor elevation of critical/special facilities is necessary to determine vulnerability to various flooding events.
Benefits:	Improves quality of vulnerability and risk assessment
Estimated Cost:	$25,000
Responsible Party:	SETRPC Region
Timeframe:	Ongoing

MITIGATION ACTION TABLE #9	
Jurisdiction:	SETRPC Region
Hazard:	All Hazards
Objective:	1.1, 2.1, 3.2, 4.1, 5.4
Mitigation Action:	Coordinate a natural hazards public awareness campaign among the jurisdictions. Efforts may include tropical storm/hurricane awareness presentations, shelter-in-place presentations, evacuation maps, floodplain maps, flood control projects, storm tracking maps, safety tips flyers, preparedness articles in local newspapers, and other such information as it relates to natural hazards. Target audiences will include schools, neighborhood watch groups, various civic groups, neighborhood associations, community groups, and industry groups. FEMA publications will also be made available in city hall libraries, municipal courts, police and fire departments, public works departments, public access TV channels, city libraries, and on the SETRPC and jurisdictional web sites.
Reason for Action:	The citizens of the SETRPC region would benefit from disaster knowledge made available to them. Outreach efforts by the region would serve to organize the strategies already employed by the local jurisdictions, and to improve the quality of future disaster information.
Benefits:	Public outreach has no disadvantages. A more informed and better educated public will enable citizens to better protect themselves and their property in the face of any disaster.
Estimated Cost:	$10,000
Responsible Party:	SETRPC Region
Timeframe:	Ongoing

Monitoring, Evaluating, and Updating the Plan

The South East Texas Hazard Mitigation Plan will be reviewed on an annual basis and updated periodically, but not less than once every five years.

The regional HMT, which consists of representatives of each participating jurisdiction and other interested parties, will meet in October of each year following approval of the plan. The meeting will occur after participating jurisdictions have completed the annual review of their local plans. The SETRPC will contact the committee members to establish the time and location for this meeting.

The regional HMT will review the goals and objectives of the regional plan and will track progress toward implementation and completion of action plans. Based on the review, modifications to the plan will be developed as necessary. The modifications resulting from annual review are expected to be minor in nature, and as such, will not require a material update of the plan. The results of the annual review will be reported to the regional liaison officer (RLO) within 30 days of this meeting.

At least once every five years, or more frequently if such a need is determined by the participating jurisdictions, the regional plan will undergo a major update. During this process, all sections of the plan will be updated with current information and analyses and new and/or modified mitigation action plans will be developed. The revised plan will be submitted to the state and to FEMA for review and approval and presented to the participating jurisdictions for approval. The plan will be updated every five years in accordance with 44cfr Section 201.6.

Incorporation into Existing Planning Mechanisms

The regional HMT will provide direction and oversight to ensure that the mitigation actions identified in this plan are incorporated into other ongoing regional and local planning activities.

Participating jurisdictions within the planning region employ land use planning, capital improvements planning, and building code enforcement to regulated development. Regional and local hazard mitigation action plans will be incorporated into these other planning mechanisms.

Following adoption of the plan by the participating jurisdictions, the regional HMT will take the lead in coordinating action plan implementation with the following organizational entities:

- County engineering, planning, and emergency management departments
- City engineering, planning, emergency management, and building code departments
- Drainage districts

- River authorities
- Elected officials of participating jurisdictions

Continued Public Involvement

The SETRPC and regional HMT will continue to involve the public in the process of monitoring, evaluation, and updating the regional MAP.

Copies of the plan will be available on the SETRPC web site and in hard copy format at participating county and municipal offices. Update information on the planning process will be posted on the SETRPC web site (www.setrpc.org).

Public meetings will be conducted annually following the regional HMT evaluation meetings. These meetings will be held to inform the public on progress implementing the plan and on proposed modifications to the plan. Public comment will be elicited.

Additionally, public participation with the planning process and with action plan implementation will be encouraged on a continuing basis. An ongoing relationship with the following entities in envisioned:

- Business and professional organizations
- Citizen-interest groups
- Media

The name and contact information of the person responsible for the local mitigation review and approval status for the SETRPC regional plan is located below.

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Copies of the SETRPC Regional Hazards Analysis and Mitigation Plan will be available for public review at the following location:

South East Texas Regional Planning Commission
2210 Eastex Freeway
Beaumont, Texas 77703
www.setrpc.org

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Appendix: FEMA Q3 Flood Data

As previously noted, the FEMA Q3 flood data was the source used to delineate the 100- and 500-year floodplains for the inland flooding analyses of all SETRPC reports. The Q3 flood data is a digital representation of certain features of FEMA's Flood Insurance Rate Map (FIRM), and is intended for use with desktop mapping and Geographic Information Systems (GIS) technology. The Q3 data is created by scanning the effective paper FIRMs and digitizing selected features and lines.

The Q3 flood data **CANNOT** be used to determine absolute delineations of flood risk boundaries. It is important to understand the "buffer" that FEMA recommends users apply to the floodplain boundary. The buffer is 250 feet outside of the floodplain boundary line. Users should reference the official paper FIRM if a site of interest falls within the buffer zone. The digital Q3 flood data is not designed to make precise in/out flood risk determinations. The data is designed to provide guidance and a *general proximity* of the location of Special Flood Hazard Areas.

The Q3 flood data for Texas was produced in 1998, which means that any Letters of Map Change (LOMC) or physical map revisions since 1998 will not appear in the Q3 data. The digital Q3 flood data can be a valuable tool in screening property addresses within a GIS to determine flood risks. However, since the geographic processing performed to develop digital Q3 flood data may present differences with the FIRM paper map, users must apply considerable care and judgment in the use of the Q3 data.

The table below compares the FIRMs used to create the Q3 flood data to the current effective paper FIRMs. The Q3 FIRMs that are outdated from the current effective FIRMs are identified. The current effective paper FIRMs should be utilized to make all final determinations regarding whether or not structures are located within the floodplain.

Community	Current Effective FIRMs	Effective Date	Q3 FIRM Panels (used for SETRPC flood analysis)	Outdated Q3 FIRM	LOMC (?)
Jefferson County	4803850020C	8/6/2002	4803850020B	Yes	
Jefferson County	4803850040D	8/6/2002	4803850040C	Yes	
Jefferson County	4803850065B	6/1/1983	4803850065B		
Jefferson County	4803850100B	6/1/1983	4803850100B		
Jefferson County	4803850110C	8/6/2002		N/A	
Jefferson County	4803850120C	8/6/2002		N/A	
Jefferson County	4803850125C	8/6/2002	4803850125B	Yes	
Jefferson County	4803850130C	11/20/1991	4803850130C		
Jefferson County	4803850140D	8/6/2002	4803850140C	Yes	
Jefferson County	4803850145D	8/6/2002	4803850145C	Yes	
Jefferson County	4803850155B	6/1/1983	4803850155B		
Jefferson County	4803850160B	6/1/1983	4803850160B		
Jefferson County	4803850165C	11/20/1991	4803850165C		
Jefferson County	4803850170C	11/20/1991	4803850170C		

Community	Current Effective FIRMs	Effective Date	Q3 FIRM Panels (used for SETRPC flood analysis)	Outdated Q3 FIRM	LOMC (?)
Jefferson County	4803850190B	6/1/1983	4803850190B		
Jefferson County	4803850225B	6/1/1983	4803850225B		
Jefferson County	4803850235C	8/6/2002		N/A	
Jefferson County	4803850240C	8/6/2002		N/A	
Jefferson County	4803850245C	8/6/2002		N/A	
Jefferson County	4803850250C	8/6/2002	4803850250B	Yes	
Jefferson County	4803850255C	8/6/2002	4803850255B	Yes	
Jefferson County	4803850260D	8/6/2002	4803850260C	Yes	
Jefferson County	4803850265C	8/6/2002	4803850265B	Yes	
Jefferson County	4803850270C	8/6/2002	4803850270B	Yes	
Jefferson County	4803850280C	11/20/1991	4803850280C		
Jefferson County	4803850285C	11/20/1991	4803850285C		
Jefferson County	4803850290B	6/1/1983	4803850290B		
Jefferson County	4803850295B	6/1/1983	4803850295B		
Jefferson County	4803850305B	6/1/1983	4803850305B		
Jefferson County	4803850310B	6/1/1983	4803850310B		
Jefferson County	4803850315B	6/1/1983	4803850315B		
Jefferson County	4803850320B	6/1/1983	4803850320B		
Jefferson County	4803850330B	6/1/1983	4803850330B		
Jefferson County	4803850355C	8/6/2002	4803850355B	Yes	
Jefferson County	4803850360C	8/6/2002	4803850360B	Yes	
Jefferson County	4803850375B	6/1/1983	4803850375B		
Jefferson County	4803850380C	8/6/2002	4803850380B	Yes	
Jefferson County	4803850385C	8/6/2002	4803850385B	Yes	
Jefferson County	4803850400B	6/1/1983	4803850400B		
Jefferson County	4803850425C	4/2/1992	4803850425C		
Jefferson County	4803850430B	6/1/1983	4803850430B		
Jefferson County	4803850440D	4/2/1992	4803850440D		
Jefferson County	4803850475D	4/2/1992	4803850475D		
Jefferson County	4803850500C	4/2/1992	4803850500C		
Jefferson County	4803850525D	4/2/1992	4803850525D		
Jefferson County	4803850550D	4/2/1992	4803850550D		
Jefferson County	4803850600D	4/2/1992	4803850600D		
Orange County	4805100025B	1/6/1983	4805100025B		Yes
Orange County	4805100050B	1/6/1983	4805100050B		Yes
Orange County	4805100075C	6/5/1997	4805100075B	Yes	Yes
Orange County	4805100100C	6/5/1997	4805100100B	Yes	Yes
Orange County	4805100125B	1/6/1983	4805100125B		
Orange County	4805100150B	1/6/1983	4805100150B		
Orange County	4805100175B	1/6/1983	4805100175B		
Orange County	4805100200C	6/5/1997	4805100200B	Yes	
Orange County	4805100225B	1/6/1983	4805100225B		
Orange County	4805100250B	1/6/1983	4805100250B		
Bridge City	4805110005B	9/2/1982	4805110005B		

Community	Current Effective FIRMs	Effective Date	Q3 FIRM Panels (used for SETRPC flood analysis)	Outdated Q3 FIRM	LOMC (?)
City of Orange	4805120005C	6/5/1997	4805120005B		
City of Orange	4805120010C	6/5/1997	4805120010B	Yes	
City of Orange	4805120015C	6/5/1997	4805120015B	Yes	
City of Orange	4805120020C	6/5/1997	4805120020B	Yes	
Pinehurst	4805130005B	1/6/1983	4805130005B		
Vidor	4805140005B	1/6/1983	4805140005B		
West Orange	4805150005A	1/6/1983	4805150005A		
Pine Forest	4806970005A	2/16/1983	4806970005A		
Bevil Oaks	4808780005C	9/4/1987	4808780005C		
Rose City	4810610005B	1/6/1983	4810610005B		
Nome	4812970001B	2/2/1983	4812970001B		
Hardin County	48199C0000A		48199C0000A		
Hardin County	48199C0025C		48199C0025C		
Hardin County	48199C0050C		48199C0050C		
Hardin County	48199C0075C	12/2/1992	48199C0075C		Yes
Hardin County	48199C0100C	12/2/1992	48199C0100C		
Hardin County	48199C0125C		48199C0125C		
Hardin County	48199C0130C		48199C0130C		
Hardin County	48199C0135C	12/2/1992	48199C0135C		
Hardin County	48199C0140C		48199C0140C		
Hardin County	48199C0145C		48199C0145C		
Hardin County	48199C0152C	12/2/1992	48199C0152C		
Hardin County	48199C0154C	12/2/1992	48199C0154C		
Hardin County	48199C0158C	12/2/1992	48199C0158C		
Hardin County	48199C0164C	12/2/1992	48199C0164C		
Hardin County	48199C0166C	12/2/1992	48199C0166C		
Hardin County	48199C0175C	12/2/1992	48199C0175C		
Hardin County	48199C0200E	4/17/1996	48199C0200D	Yes	
Hardin County	48199C0204C	12/2/1992	48199C0204C		Yes
Hardin County	48199C0212C	12/2/1992	48199C0212C		
Hardin County	48199C0225C	12/2/1992	48199C0225C		
Hardin County	48199C0250C	12/2/1992	48199C0250C		
Beaumont	4854570005D	8/6/2002	4854570005C	Yes	
Beaumont	4854570010D	8/6/2002	4854570010C	Yes	
Beaumont	4854570015C	8/6/2002	4854570015B	Yes	
Beaumont	4854570020C	8/6/2002	4854570020B	Yes	
Beaumont	4854570025D	8/6/2002	4854570025C	Yes	
Beaumont	4854570030C	8/6/2002	4854570030B	Yes	
Beaumont	4854570035C	8/6/2002	4854570035B	Yes	Yes
Beaumont	4854570040D	8/6/2002	4854570040C	Yes	
Beaumont	4854570045C	8/6/2002	4854570045B	Yes	
Beaumont	4854570050D	8/6/2002	4854570050C	Yes	Yes
Beaumont	4854570055D	8/6/2002	4854570055C	Yes	
Beaumont	4854570060C	8/6/2002	4854570060B	Yes	

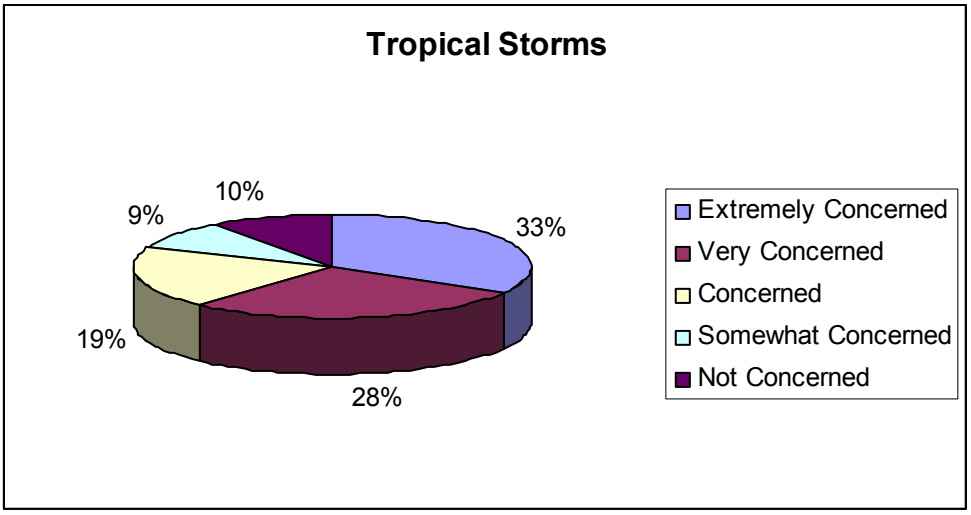
Community	Current Effective FIRMs	Effective Date	Q3 FIRM Panels (used for SETRPC flood analysis)	Outdated Q3 FIRM	LOMC (?)
Beaumont	4854570065D	8/6/2002	4854570065C	Yes	
Groves	4854750005E	1/6/1983	4854750005E		
Nederland	4854920005D	6/3/1991	4854920005D		
Port Arthur	4854990005E	4/17/1984	4854990005E		
Port Arthur	4854990010E	4/17/1984	4854990010E		Yes
Port Arthur	4854990015E	4/17/1984	4854990015E		
Port Arthur	4854990020E	4/17/1984	4854990020E		
Port Arthur	4854990025E	4/17/1984	4854990025E		
Port Arthur	4854990030E	4/17/1984	4854990030E		
Port Arthur	4854990035E	4/17/1984	4854990035E		Yes
Port Arthur	4854990040E	4/17/1984	4854990040E		
Port Arthur	4854990045E	4/17/1984	4854990045E		
Port Arthur	4854990050E	4/17/1984	4854990050E		
Port Arthur	4854990055F	5/4/1992	4854990055F		
Port Arthur	4854990060F	5/4/1992	4854990060F		
Port Arthur	4854990065F	5/4/1992	4854990065F		
Port Arthur	4854990070F	5/4/1992	4854990070F		
Port Arthur	4854990075F	5/4/1992	4854990075F		
Port Arthur	4854990080F	5/4/1992	4854990080F		
Port Arthur	4854990435B		4854990435B		
Port Neches	4855000005D	1/6/1983	4855000005D		
Port Neches	4855000010D	1/6/1983	4855000010D		

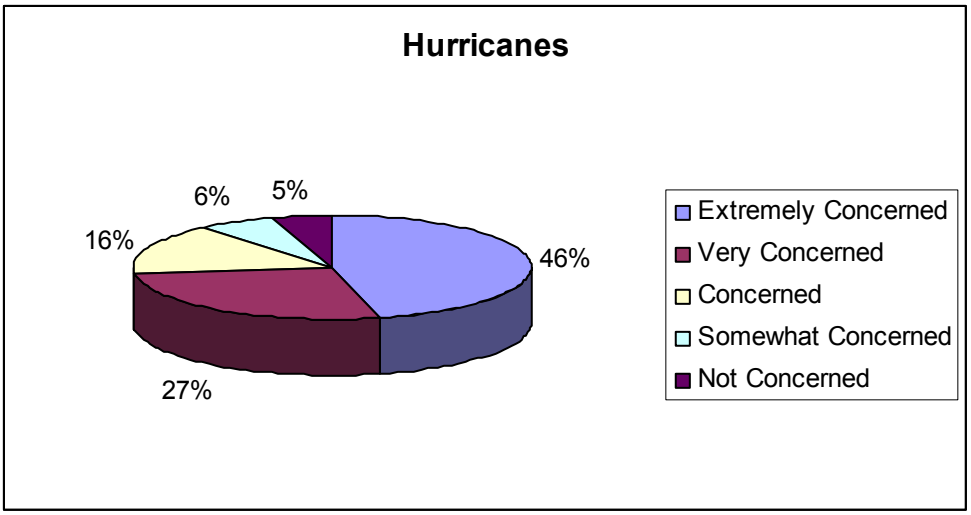
Appendix: Household Natural Hazards Preparedness Questionnaire

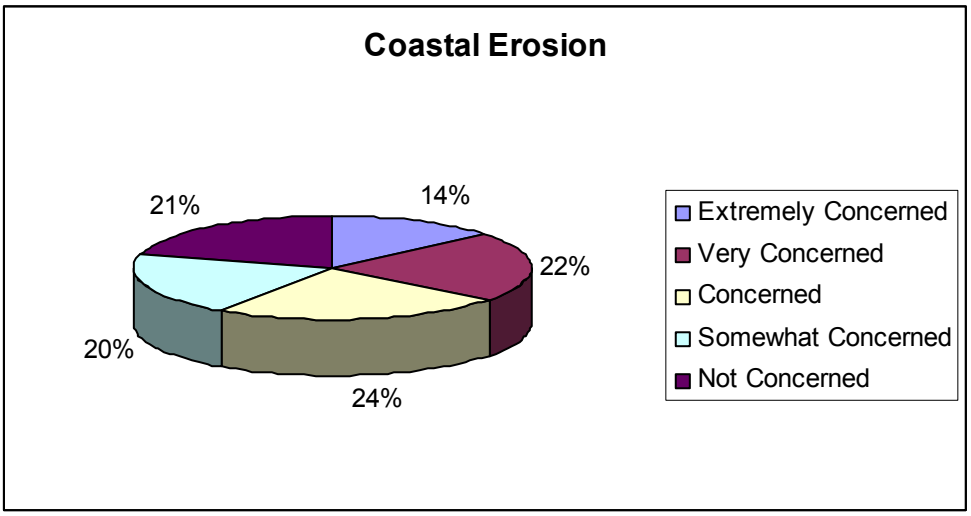
The Homeland Security and Emergency Management Planning Division (HSEMPD) of the South East Texas Regional Planning Commission posted a Household Natural Hazards Preparedness Questionnaire (questionnaire) to its homepage: www.setrpc.org/hsempd. The following excerpt was taken directly from the web site's description of the questionnaire and its purpose for completion:

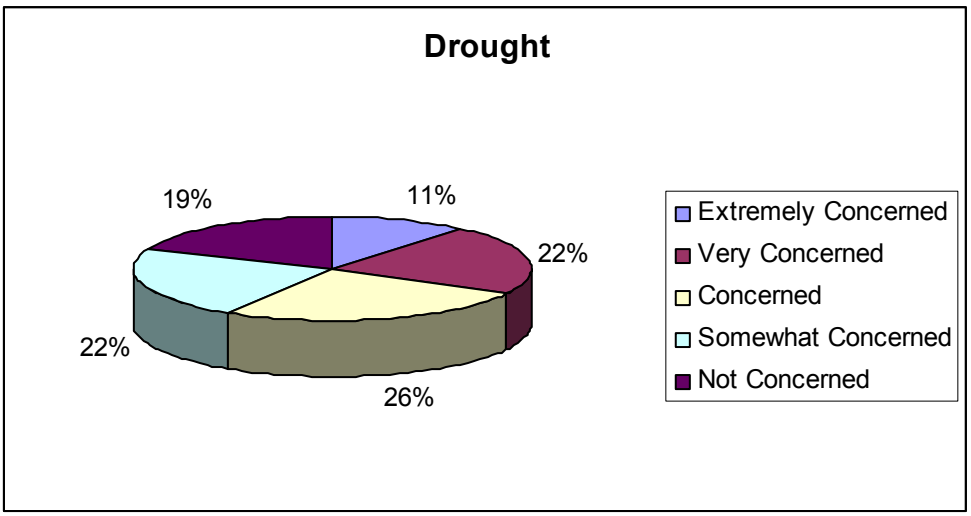
"This questionnaire is designed to help emergency management professionals in Hardin, Jefferson and Orange Counties and the cities within the three counties gauge household preparedness for disasters and knowledge of tools and techniques that assist in reducing risk and loss from natural hazards. The information [provided] about…needs for disaster preparedness will help improve public/private coordination of preparedness and risk reduction activities within the state." (web site last modified June 30, 2003)

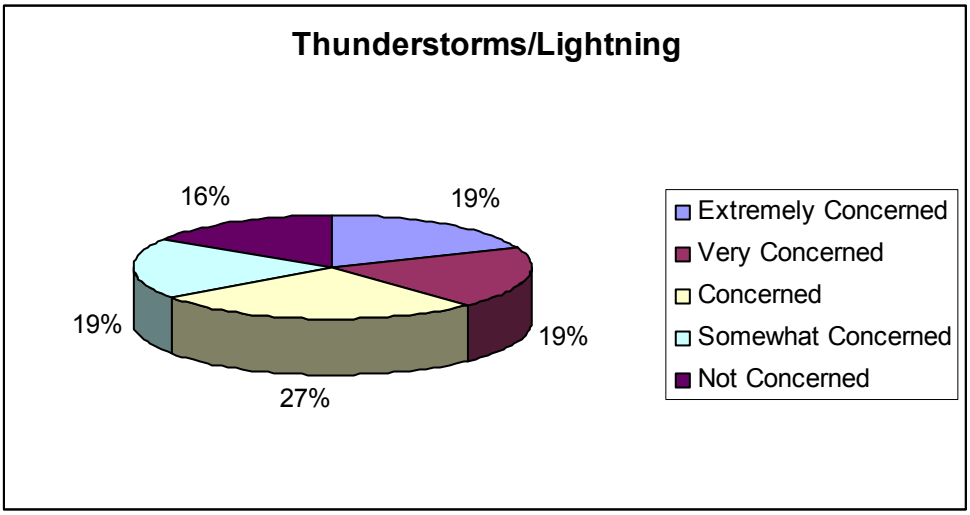
The next few pages display the results of the questionnaire regarding several of the hazards reviewed and assessed in the Hazards Analysis section of the hazard mitigation plans. The results are displayed in pie charts illustrating the percentage of respondents (281 total) and their survey answers. The results of the questionnaire in their entirety can be viewed on the SETRPC HSEMPD web site.

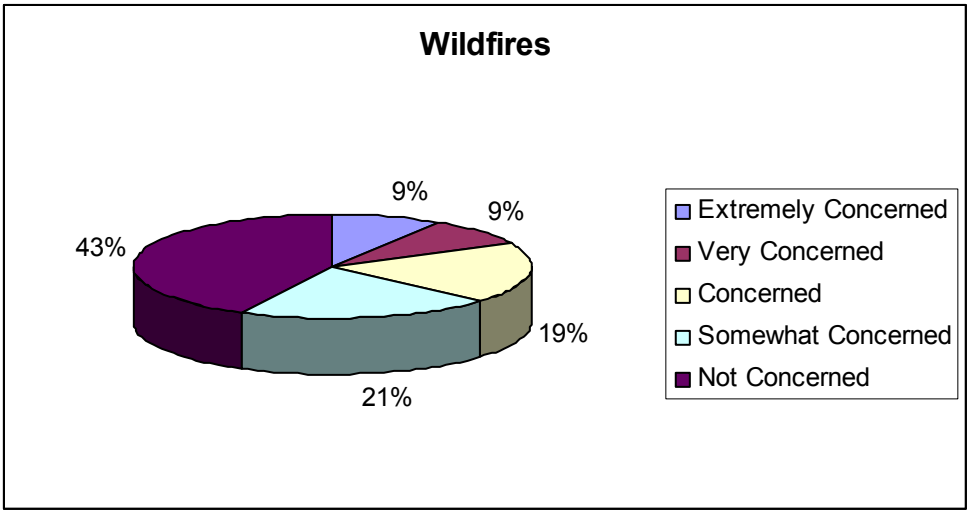


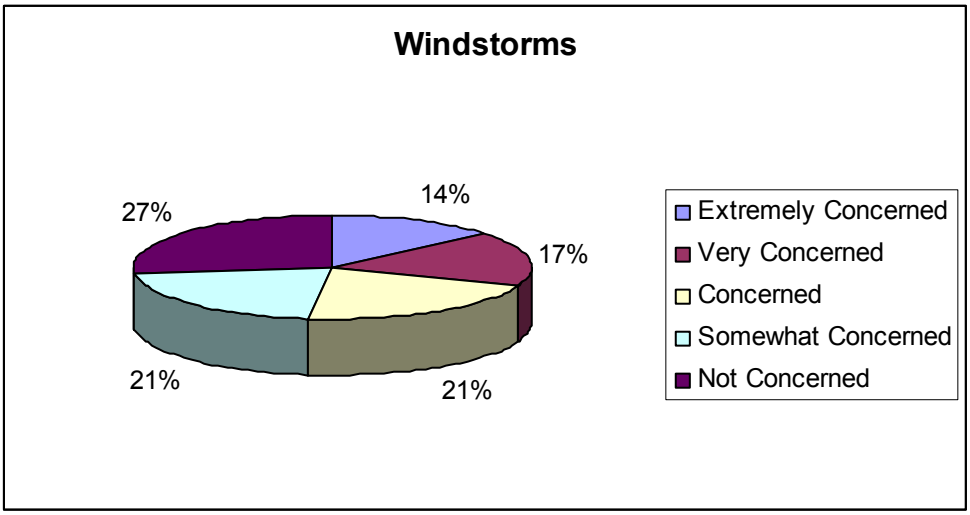

Hurricanes
6%
5%
16%
46%
27%
Extremely Concerned
Very Concerned
Concerned
Somewhat Concerned
Not Concerned

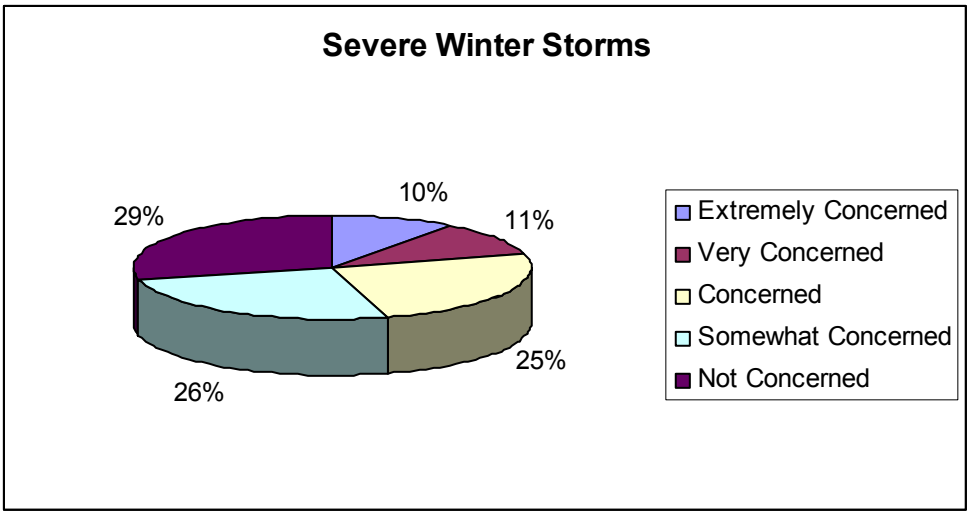

Coastal Erosion
21%
14%
22%
20%
24%
Extremely Concerned
Very Concerned
Concerned
Somewhat Concerned
Not Concerned

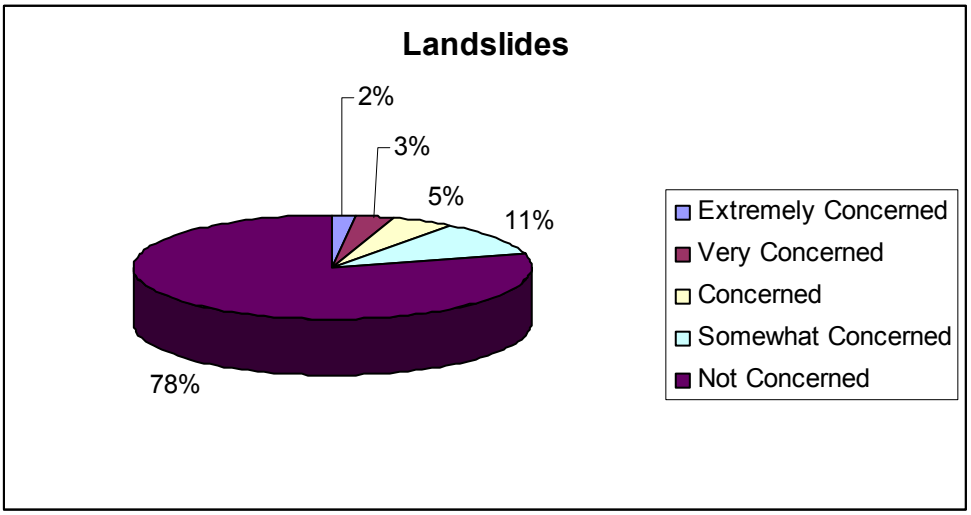

Drought
19%
11%
22%
22%
26%
Extremely Concerned
Very Concerned
Concerned
Somewhat Concerned
Not Concerned

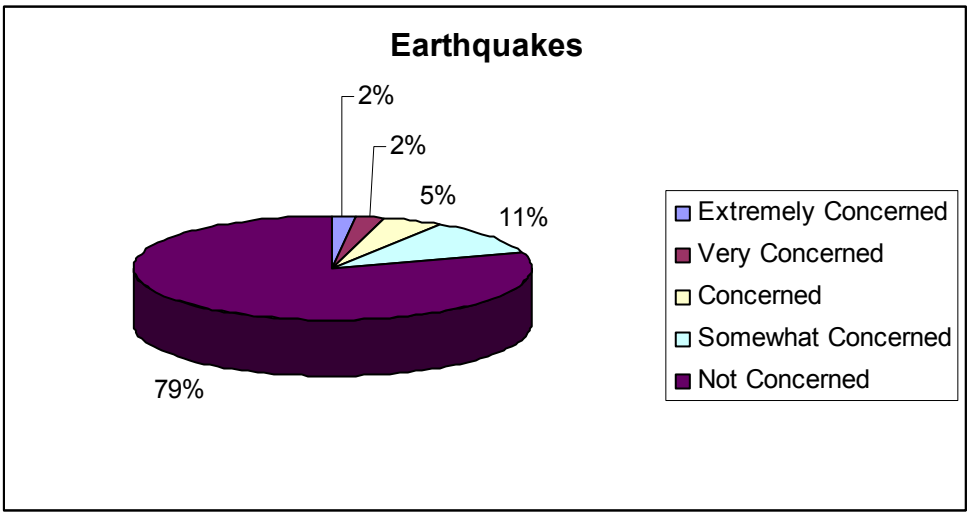

Thunderstorms/Lightning
16%
19%
19%
19%
27%
Extremely Concerned
Very Concerned
Concerned
Somewhat Concerned
Not Concerned


Wildfires
9%
9%
43%
19%
21%
Extremely Concerned
Very Concerned
Concerned
Somewhat Concerned
Not Concerned


Windstorms
14%
27%
17%
21%
21%
Extremely Concerned
Very Concerned
Concerned
Somewhat Concerned
Not Concerned


Severe Winter Storms
10%
11%
29%
25%
26%
Extremely Concerned
Very Concerned
Concerned
Somewhat Concerned
Not Concerned


Landslides
2%
3%
5%
11%
78%
Extremely Concerned
Very Concerned
Concerned
Somewhat Concerned
Not Concerned


Earthquakes
2%
2%
5%
11%
79%
Extremely Concerned
Very Concerned
Concerned
Somewhat Concerned
Not Concerned