Volume 1-2
Technical Data Report
Apalachee Region

Chapter II
Regional Hazards Analysis

Prepared by

APALACHEE REGIONAL PLANNING COUNCIL

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Table of Contents

A. Hazards Identification and Risk Assessment II-1
B. Coastal Storms and Hurricanes II-5
1. Coastal Storms / Hurricane Hazard Profile II-5
2. Hurricane Hazards II-6
3. Storm Surge: The SLOSH Model II-7
a. Hypothetical Storm Simulations II-8
b. The Grids for the SLOSH Models II-10
c. Storm Scenario Determinations II-10
d. Determining Storm Surge Height and Flooding Depth II-11
e. Variations to Consider II-12
f. Storm Tide Atlas II-13
g. Factors Influencing Model Accuracy II-14
4. Hurricane Wind Analysis II-16
a. Wind Risk Assessment: Inland Wind Model II-17
b. Wind Risk Assessment: Florida Building Code II-21
c. Wind Risk Assessment: Hazards US Multi-Hazard (HAZUS-MH) II-21
5. Tornadoes II-23
6. Hazardous Materials II-24
7. Freshwater Flooding and the Inundation of Evacuation Routes II-25
8. History of Hurricanes in the South Florida Region II-26
a. The 1830 - 1900 Hurricane Seasons II-26
b. The 1901 - 1984 Hurricane Seasons II-27
c. The 1985 Hurricane Season II-28
d. Then 1986 – 2003 Hurricane Seasons II-28
e. The 2004 Hurricane Season II-29
f. The 2005 Hurricane Season II-30
g. The 2006 – 2008 Hurricane Seasons II-31
9. Probability of Future Hurricane Events II-32
a. Monthly Zones of Origin and Hurricane Tracks II-34
b. NOAA Historical Analysis for the Region II-37
C. Freshwater Flooding: The 100-Year Flood Plain II-41
1. Inland / Riverine Flooding Profile II-41
2. Probability of Flooding: Flood Insurance Rate Maps (FIRMs) II-42
3. Dam Failure II-45
4. History of Inland Flooding II-45
5. Repetitive Loss Areas II-47
D. Wildfires and the Urban Interface II-48
1. Wildfire Hazard Profile II-48
2. History of Wildfire in the Region II-49
3. Wildland – Urban Interface (WUI) II-49

E. Hazardous Material Incidents II-52
1. Overview II-52
2. History of the Local Emergency Planning Committees (LEPCs) II-52
3. LEPC Mission Statement II-54
4. Hazards Analysis of Hazardous Materials II-67
5. Regional Hazardous Materials Commodity Flow Study II-56
F. Terrorism and Domestic Security II-59
1. Overview II-59
a. Explosions II-59
b. Biological Threats II-59
c. Chemical Threats II-60
d. Nuclear Blast II-0
(1) Hazards of Nuclear Devices II-61
(2) Radioactive Fallout II-61
e. Radiological Dispersion Device (RDD) II-62
2. The Regional Domestic Security Task Forces (RDSTFs) II-62
3. History of Events II-63
4. Vulnerability Assessments II-63
G. Nuclear Power Plant Incidents II-63
H. Tsunami II-64

List of Tables

Table	Title	Page
Table II-1	Hazards Identified in Florida	II-2
Table II-2	Saffir-Simpson Hurricane Wind Scale	II-6
Table II-3	Florida Bay Basin Hypothetical Storm Parameters	II-9
Table II-4	Potential Storm Tide Height(s) by County (in feet above NAVD88)	II-11
Table II-5	Enhanced Fujita-Pearson Tornado Intensity Scale	II-23
Table II-6	U.S. Mainland Hurricane Strikes by State (1851-2006)	II-33
Table II-7	Major Hurricane Direct Hits on the U.S. Coastline, 1851-2006, by Month	II-34
Table II-8	Tropical Storms and Hurricanes Passing within 100 NMi of Apalachicola	II-38
Table II-9	Summary for Hurricanes and Tropical Storms, 1870-2007	II-40
Table II-10	Definitions of National Flood Insurance Program (NFIP) Zones	II-42
Table II-11	Flood Plain Acreage by County	II-44
Table II-12	Dams in the Apalachee Bay Region	II-45
Table II-13	Repetitive Loss Properties	II-47
Table II-14	Top Ten Section 302 Chemicals, 2007	II-56

List of Figures

Figure	Title	Page
Figure II-1	SLOSH Grid – Apalachee	II-10
Figure II-2	SLOSH Grid with Surge Values	II-10
Figure II-3	Apalachee Region Storm Tide Map	II-15
Figure II-4	Inland Wind Decay	II-17
Figure II-5	Maximum Inland Extent of Winds for Hurricanes Approaching the Gulf Coast	II-19
Figure II-6	Maximum Inland Extent of Winds for Hurricanes Approaching the East Coast	II-20
Figure II-7	ASCE 7-98 Wind Zones	II-21
Figure II-8	Hurricane Wind Risk Assessment (HAZUS)	II-22
Figure II-9	Prevailing Tracks – June	II-35
Figure II-10	Prevailing Tracks – July	II-35
Figure II-11	Prevailing Tracks – August	II-35
Figure II-12	Prevailing Tracks – September	II-36
Figure II-13	Prevailing Tracks – October	II-36
Figure II-14	Prevailing Tracks – November	II-36
Figure II-15	Hurricane Return Intervals for the Apalachee Bay Region – Apalachicola	II-40
Figure II-16	Apalachee FEMA Flood Zones (FIRM Q3)	II-44
Figure II-17	Levels of Concern: Risk for Wildfire	II-51
Figure II-18	Section 302 Facilities in Apalachee Bay Region	II-55

CHAPTER II
REGIONAL HAZARDS ANALYSIS

A. Hazards Identification and Risk Assessment

The regional evacuation studies in Florida have traditionally focused specifically on the hurricane hazard. Considering the region's vulnerability to tropical storms and hurricanes as well as the complex nature of the evacuation and the emergency response and recovery, the priority of hurricane planning remains a necessity. However, history has also demonstrated the need to address other significant hazards which have the potential for initiating regional evacuations.

The major hazards facing the state are identified in the Statewide Regional Evacuation Study (SRES), using the *Statewide Hazard Mitigation Plan* (*SHMP*, 2009). Additional focus was given to those hazards which have the potential for initiating a multi-jurisdictional evacuation. A number of factors were considered in assessing the risk of each hazard event including the frequency of occurrence, the severity of the event and the areas vulnerable to its impact. These factors were assigned numerical values in the assessment as follows:

1. Frequency of Occurrence
a. Annual Event
b. Every 5 years or less
c. Every 6-10 years
d. Every 11-30 years
e. Greater than 30 years

2. Vulnerability Factors
a. Low
b. Moderate
c. High
d. Extreme
e. Catastrophic

3. Vulnerability Impact Areas
a. Population
b. Property
c. Environment
d. Operations

Twelve major hazards were identified including floods, coastal storms and hurricanes; severe storms and tornadoes; wildfire; drought and extreme heat; winter storms and freezes; erosion, sinkholes, landslides and seismic events; tsunamis; technological (hazardous materials, etc.); terrorism and mass migration.

Table II-1
Hazards Identified in Florida[1]

Hazard	Methodology of Identification	Significant Concerns	Potential to Initiate a Regional Evacuation
Floods (including related potential for dam failure)	• Review of past disaster declarations. • Review of Federal Flood Insurance Rate Maps (FIRMs) • Input from state floodplain manager. • Identification of NFIP repetitive loss properties in the state.	• Florida is affected by flooding nearly every year. • Floods have caused extensive damage and loss of life in the state in the past. • The most recent federally declared disaster event (Feb 8 2007) in Florida included flooding from severe storms. • There are a number of dams in the state that could impact the nearby population.	Yes; although more difficult to determine which areas are vulnerable to a particular event.
Coastal Storms & Hurricanes	• Review of past disaster declarations. • Review of National Climatic Data Center (NCDC) Severe Storms Database. • National Oceanographic and Atmospheric Association (NOAA) climatology data • Research including new media and the Internet	• Hurricanes and coastal storms affect Florida every year. • Hurricanes have caused extensive damage and loss of life across the state for the last 50 years. • 8 out of the last 10 federally declared disaster events in Florida were hurricanes.	Yes; this hazard requires the evacuation of coastal areas and mobile home residents, even in minor tropical storm events. Major hurricanes can have catastrophic impacts.
Severe Storms & Tornadoes	• Review of past disaster declarations. • Review of National Climatic Data Center (NCDC) Severe Storms Database. • National Weather Service input and data. • Public input including newspapers and media.	• Florida experiences a tornado nearly every year. • Tornadoes have caused extensive damage and loss of life to county residents. • The two most recent federally declared disaster event in Florida (Feb 8 and Feb 3 2007) were a severe storm with tornadoes.	No; these events provide little to no warning and the specific areas cannot be determined prior to the event. Exceptions: Tornado warnings can send residents to safe rooms or mobile home parks community centers, etc.
Wildfire	• Florida Division of Forestry statistics and input. • USDA Forest Service Fire, Fuel, and WUI mapping. • Input from FL DEM about wildfires and the EOC activations. • Public input including newspapers and media.	• Florida experiences wildfires every year. • Development in much of the state is occurring at the Wildland-Urban Interface (WUI). • Cyclical drought patterns result in increases of brush and other dry materials. This increases the overall risk for significant fires. • Fires in 2007 were significant due to the number and magnitude including closures to the interstate system.	Yes; while we can determine areas that may be more vulnerable and plan accordingly, it is difficult to predict where a wildfire may ignite.

[1] *Statewide Hazard Mitigation Plan* (SHMP), 2007

Hazard	Methodology of Identification	Significant Concerns	Potential to Initiate a Regional Evacuation
Drought & Extreme Heat	• National Weather Service data. • National Oceanographic and Atmospheric Association (NOAA) paleoclimatology data. • The US Drought Monitor • Keetch Byram Drought Index (KBDI) • Agricultural community throughout the state.	• Significant drought trends during the last 10 years including moderate and severe drought index conditions in2007 and 2008 for parts of the state. • Drought has a severe economic impact on the state due to the large amounts of citrus, agriculture and livestock.	No; this event does not typically initiate an evacuation.
Winter Storms and Freezes	• Review of past disaster declarations. • Review of NCDC Severe Storms Database. • National Weather Service input and data. • Public input including newspapers and media.	• Florida is affected by winter storms cyclically • Significant freezes particularly during the 1980s that affected the citrus industry • 5 federally declared disasters since 1971 • The population is unprepared for cold weather with many having inadequate heating capabilities.	No; this event does not typically initiate an evacuation, although cold weather shelters may be opened for homeless, special needs or those with no power.
Erosion	• Coordination with the Florida Department of Environmental Protection – Bureau of Beaches and Coastal systems. • ***Statewide Hazard Mitigation Plan*** **-** interview and input. • *Evaluation of Erosion Hazards*, the report from the Heinz Center that was presented to FEMA in April 2000. • Public input including newspapers and media.	• Due to the gradual, long-term erosion, as many as one in four houses along the coast, could fall into the ocean in the next 60 years • Eighty to 90 percent of the nation's sandy beaches are facing erosion problems. • Significant economic impact for the state due to property damages, loss of actual beach front real estate and affects on tourism.	No; this event does not typically initiate an evacuation, but it may result in a retreat from the coast over long period of time or following a major coastal storm.
Sinkholes, Landslides and Seismic Events	• Coordination with the Florida Geographical Survey • The Florida Sinkhole Database • Coordination with the Florida Department of Transportation • Input from the Central United States Earthquake Consortium • USGS Landslide Hazard maps.	• Sinkholes are a common feature of Florida's landscape. • 2843 sinkholes have been reported in the state since the 1970s. • Growing issues as development continues in high risk areas. • Impact on the roads and physical infrastructure of the state. • Earthquake risk is considered extremely low.	Earthquake is considered very low risk. Sinkholes, while prevalent, will not initiate an evacuation at a regional scale.
Tsunamis	• Input from the NOAA Center for Tsunami Research • Coordination with the Florida Division of Emergency Management • Input from the United States Geological Survey	• Tsunamis are common events that occur in large bodies of water. • Almost all perimeters of Florida's boundaries are made up of large bodies of water. • Recent Tsunamis from around the world have caused widespread destruction. • Residential and commercial development along Florida's coastlines are at risk to the effects of Tsunamis.	This event has an extremely low probability of occurrence. If a Cumbre Vieja tsunamis event were to occur, it could have a catastrophic impact on the east coast of Florida. A maximum of 6 hours would be available for evacuations. Typically, there is little to no warning.

Hazard	Methodology of Identification	Significant Concerns	Potential to Initiate a Regional Evacuation
Technological	• Coordination with the State Emergency Response Commission • Interaction with the Local Emergency Planning Committees (LEPC) • Coordination with the Nuclear Regulatory Commission (NRC) • Communications with the FL Department of Environmental Protection	• Numerous accidental hazardous material releases occur every year • Potential for human and environmental impacts • Threat of radiation from a nuclear related incident	Yes, these incidents may initiate evacuations, but it is impossible to predict precise location, extent and timing. Nuclear power plant evacuation planning conducted w/NRC.
Terrorism	• Coordination with FEMA and Department of Homeland Security • Coordination with the Florida Department of Law Enforcement (FDLE) • Interaction with local law enforcement agencies	• National priority with federal government requirements • Potential for devastating impacts to life and infrastructure • Protection for the citizens of Florida and the USA	Yes, these incidents may initiate evacuations, but it is impossible to predict precise location, extent and timing.
Mass Migration	• Coordination with the US Citizens and Immigration Service (USCIS) • Data from local law enforcement	• Historic precedence for migration to Florida by boat • Large amounts of unpatrolled coastlines	No; evacuation is not the solution.

For purposes of the SRES, the potential evacuation from (1) coastal storms and hurricanes, (2) freshwater flooding (including related potential for dam failure) and (3) wildfires and the urban Interface will be analyzed in detail.

As indicated above, any evacuation initiated by a tsunami, terrorist event or a hazardous material incident will have little or no warning. In addition, the location, scope and extent of the evacuation response therefore, are difficult or impossible to predict or model before the incident. Planning for these events however, is ongoing at the state, regional and local levels. The identification of key infrastructure and facilities, vulnerable areas, response capabilities and mitigation strategies will be discussed in the hazards profile of each of these potential hazards.
The hazards analysis shall identify the potential hazards to the region and shall include investigations of:

- General Information about each hazard (Hazards Profile);
- History of activity in the region;
- A geo-spatial analysis of the potential effects of the hazard; i.e., inundation areas, wind fields, dam locations, urban interface, etc.

The vulnerability analysis will then identify the following:

- Human and social impacts including the identification of the population-at-risk, potential shelter and mass care demand evacuee behavioral assumptions and the vulnerability of critical facilities.
- The potential for multiple hazard impacts such as the release of hazardous materials in a wildfire or flooding event or security risks following a hurricane.

B. Coastal Storms and Hurricanes

1. Coastal Storms / Hurricane Hazard Profile

A hurricane is defined as a weather system with a closed circulation developing around a low pressure center over tropical waters. The winds rotate counterclockwise in the northern hemisphere (clockwise in the southern hemisphere). Tropical storms and hurricanes act as safety valves that limit the build-up of heat and energy in the tropical regions by maintaining the atmospheric heat and moisture balance between the tropics and the pole-ward latitudes SHMP, 2007). Tropical cyclones are named when their winds reach tropical storm strength (sustained 39 mph).

- **Tropical Depression:** The formative stages of a tropical cyclone in which the maximum sustained (1-minute mean) surface wind is <39 mph.
- **Tropical Storm:** A warm core tropical cyclone in which the maximum sustained surface wind (1-minute mean) ranges from 39 to <74 mph.
- **Hurricane:** A warm core tropical cyclone in which the maximum sustained surface wind (1 minute mean) is at least 74 mph.

The table below displays the Saffir-Simpson Scale used to define and describe the intensity of hurricanes. The central pressure of the hurricanes is measured in millibars or inches. The wind speed is also a significant indicator in determining the category of the storm. The wind speed is tied to both wind damage and potential storm surge and resulting coastal flooding damages.

It should be noted that the range of storm surge is highly dependent upon the configuration of the continental shelf (narrow or wide) and the depth of the ocean bottom (bathymetry). A narrow shelf or one that drops steeply from the shoreline and subsequently produces deep water in close proximity to the shoreline tends to produce a lower surge but higher and more powerful storm waves. This is the situation along the Atlantic Ocean side of the state. However, the Gulf Coast of Florida has a long gently sloping shelf and shallow water depths and can expect a higher surge but smaller waves. South Dade County is an exception to these general rules due to Biscayne Bay (wide shelf and shallow depth). In this instance, a hurricane has a larger area to “pile up” water in advance of its landfall. Nowhere is the threat of storm surge more prevalent than in Apalachee Bay Region. The Big Bend region of the state extends out into the Gulf of Mexico creating a naturally enclosed pocket. This area has some the highest computer projected storm surge heights in the nation.

Hurricanes Dennis, Katrina and Ike also demonstrated that the size of the hurricane can significantly impact the potential storm surge. These storms which had particularly large radii of maximum winds produced storm surge comparable to much more intense categories of storm if measured using only wind speeds. This storm characteristic was modeled to determine its impact on the ultimate storm surge.

Table II-2
Saffir-Simpson Hurricane Wind Scale

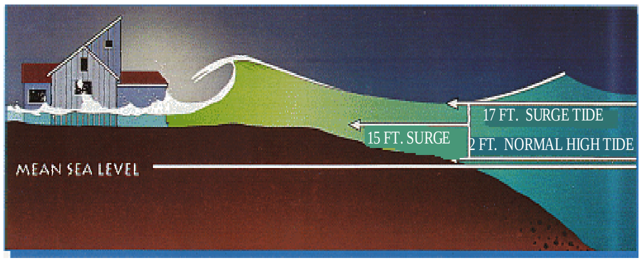
Category	Wind Speeds	Potential Damage
Category 1	(Sustained winds 74-95 mph)	*Very dangerous winds will produce some damage*
Category 2	(Sustained winds 96-110 mph)	*Extremely dangerous winds will cause extensive damage*
Category 3	(Sustained winds 111-130 mph)	*Devastating damage will occur*
Category 4	(Sustained winds 131-155 mph)	*Catastrophic damage will occur*
Category 5	(Sustained winds of 156 mph and above)	*Catastrophic damage will occur*

2. Hurricane Hazards

The five major hazards produced by a hurricane are the storm surge, high winds, tornadoes, rainfall (freshwater flooding) and the potential for hazardous material incidents.

Storm surge is the abnormal rise in water level caused by the wind and pressure forces of a hurricane or tropical storm. Storm surge produces most of the flood damage and causes most of the drowning associated with storms that make landfall or that closely approach the coastline. Of the hurricane hazards, the storm surge is considered to be the most dangerous as nine out of ten hurricane-related deaths are caused by drowning.

The high winds also can have a devastating effect on persons outside, in mobile homes, in substandard structures or in structures with unprotected windows or glass exposures. In an earlier study[2] it was concluded that while a fully-engineered multi-story structure could withstand the storm surge of a major storm, without protection on the windows and other cladding, occupants within any structure would be at serious risk. This factor held true for all types of structures exposed to sustained winds in excess of 115 mph. The winds of Hurricane Andrew (1992) caused major destruction in South Florida throwing the insurance industry into a tailspin.



Rainfall associated with hurricanes varies with hurricane size, forward speed and other meteorological factors. The rainfall associated with a hurricane is from 6-12 inches on average, with higher amounts common. Freshwater flooding has not historically been considered a life-threatening hazard. Over the past 20 years, however,

[2] ***Hurricane Shelter Alternative Study***, TBRPC and USACOE, 1986

freshwater flooding had become the leading cause of death related to hurricanes. This is due in part to the successful evacuation planning efforts in the United States which had significantly reduced the number of deaths (in the U.S.) related to storm surge. Hurricane Katrina tragically illustrated the danger of storm surge flooding in both Louisiana and Mississippi. However, it is also recognized that many coastal and inland residents do not recognize the risk associated with freshwater flooding, especially when driving. In response, a national program, *"Turn Around, Don't Drown"* was implemented in 2002. The freshwater flooding associated with a hurricane, may also inundate potential evacuation routes and prevent people from evacuating areas vulnerable to storm surge. Flooded roads and storm drains have resulted in fatal accidents in the Apalachee Bay Region. Leon County experienced excessive flooding in 2008 from Tropical Storm Fay.

Hurricanes can also produce **tornadoes** that add to the storm's destructive power. Tornadoes are most likely to occur in the right front quadrant of the hurricane, but they are also often found elsewhere embedded in the rain bands well away from the center of the hurricane. Some hurricanes seem to produce no tornadoes, while others develop multiple ones. Studies have shown that more than half of the landfalling hurricanes produce at least one tornado; Hurricane Buelah (1967) spawned 141 according to one study. According to the NOAA, Hurricane Ivan (2004) spawned 117 tornadoes.

Sometimes one emergency event can trigger another. Facilities which generate or store quantities of potentially hazardous materials, propane storage facilities, natural gas pipeline terminals, fuel storage facilities and tank farms all pose additional potential threats during a hurricane.

3. Storm Surge: The SLOSH Model

The principal tool used in this study for analyzing the expected hazards from potential hurricanes affecting the study area is the Sea, Lake and Overland Surges from Hurricane (SLOSH) numerical storm surge prediction model. The SLOSH computerized model predicts the tidal surge heights that result from hypothetical hurricanes with selected various combinations of pressure, size, forward speed, track and winds. Originally developed for use by the National Hurricane Center (NHC) as a tool to give geographically specific warnings of expected surge heights during the approach of hurricanes, the SLOSH model is used in regional studies for several key hazard and vulnerability analyses.

The SLOSH modeling system consists of the model source code and model basin or grid. SLOSH model grids must be developed for each specific geographic coastal area individually incorporating the unique local bay and river configuration, water depths, bridges, roads and other physical features. In addition to open coastline heights, one of the most valuable outputs of the SLOSH model for evacuation planning is its predictions of surge heights over land which predicts the degree of propagation or run-up of the surge into inland areas.

The first SLOSH model was completed in 1979 for the Tampa Bay area and represented the first application of SLOSH storm surge dynamics to a major coastal area of the United

States. The first SLOSH model for the Apalachee Bay area was completed in 1984. The model was developed by the Techniques Development Lab of the National Oceanic and Atmospheric Administration (NOAA) under the direction of the late Dr. Chester P. Jelesnianski. In March 1997 the NHC updated the SLOSH model for the Apalachicola basin. A major improvement to the model was the incorporation of wind speed degradation overland as the simulated storms moved inland. This duplicated the pressure "filling" and increases in the radii of maximum winds (RMW) as the hurricanes weaken after making landfall. The grid configuration provided more detail and additional information including a tropical storm scenario.

The newest generation of SLOSH model incorporated in the 2010 SRES reflects major improvements, including higher resolution basin data and grid configurations. Faster computer speeds allowed numerous hypothetical storms to be run to create the MOMs (maximum potential storm surge) values for each category of storm. Storm tracks were run in ten different directions; and for each set of tracks in a specific direction storms were run at forward speeds of 5, 10, 15 and 25 mph. For each direction, at each speed, storms were run at two different sizes (25 mile radius of maximum winds and 45 miles radius of maximum winds). Finally, each scenario was run at both mean tide and high tide. Both tide levels are now referenced to North American Vertical Datum of 1988 (NAVD88) as opposed to the National Geodetic Vertical Datum of 1929 (NGVD29).

a. Hypothetical Storm Simulations

Surge height depends strongly on the specifics of a given storm including, forward speed, angle of approach, intensity or maximum wind speed, storm size, storm shape and landfall location. The SLOSH model was used to develop data for various combinations of hurricane strength, wind speed and direction of movement. Storm strength was modeled using the central pressure (defined as the difference between the ambient sea level pressure and the minimum value in the storm's center), the storm eye size and the radius of maximum winds using the five categories of hurricane intensity as depicted in the Saffir-Simpson Hurricane Wind Scale (see Table II-2) plus a hypothetical tropical storm intensity.

The modeling for each tropical storm/hurricane category was conducted using the mid-range pressure difference (△p, millibars) for that category. The model also simulates the storm filling (weakening upon landfall) and radius of maximum winds (RMW) increase.

Ten storm track headings (WSW, W, WNW, NW, NNW, N, NNE, NE, E, ENE) were selected as being representative of storm behavior in the West Central Florida regions, based on observations by forecasters at the National Hurricane Center. Additional inputs into the model included depths of water offshore, and heights of the terrain and barriers onshore (all measurements were made relative to NAVD88). A total of 11,760 runs were made consisting of the different parameters shown in Table II-3.

Table II-3
Apalachicola Basin Hypothetical Storm Parameters

Directions, speeds, (Saffir/Simpson) intensities, number of tracks and the number of runs. Tropical storms (T.S.) are larger but weaker than the weakest (category 1) hurricane.

Direction	Speeds (mph)	Size (Radius of Maximum winds)	Intensity	Tides	Tracks	Runs
WSW	5,10,15, 25 mph	30 mile, 45 mile	1 through 5	Mean/High	13	1040
W	5,10,15, 25 mph	30 mile, 45 mile	1 through 5	Mean/High	13	1040
WNW	5,10,15, 25 mph	30 mile, 45 mile	1 through 5	Mean/High	13	1040
NW	5,10,15, 25 mph	30 mile, 45 mile	1 through 5	Mean/High	12	960
NNW	5,10,15, 25 mph	30 mile, 45 mile	1 through 5	Mean/High	12	960
N	5,10,15, 25 mph	30 mile, 45 mile	1 through 5	Mean/High	13	1248
NNE	5,10,15, 25 mph	30 mile, 45 mile	1 through 5	Mean/High	13	1248
NE	5,10,15, 25 mph	30 mile, 45 mile	1 through 5	Mean/High	14	1344
ENE	5,10,15, 25 mph	30 mile, 45 mile	1 through 5	Mean/High	15	1440
E	5,10,15, 25 mph	30 mile, 45 mile	1 through 5	Mean/High	15	1440
TOTAL						11,760

b. The Grid for the Apalachicola Basin SLOSH Model

Figure II-1 illustrates the area covered by the grid for the Apalachicola Basin SLOSH Model. To determine the surge values the SLOSH model uses a telescoping elliptical grid as its unit of analysis with 188 arc lengths (1<I>188) and 215 radials (1<J> 215). Use of the grid configuration allows for individual calculations per grid square which is beneficial in two ways: (1) provides increased resolution of the storm surge at the coastline and inside the harbors, bays and rivers, while decreasing the resolution in the deep water where detail is not as important; and, (2) allows economy in computation.

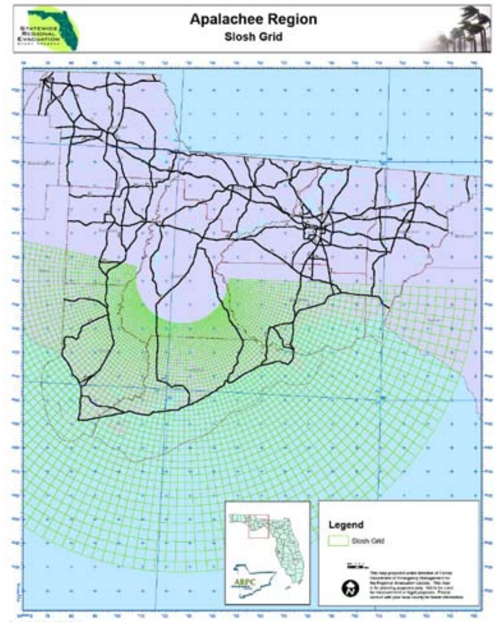


Figure II-1
SLOSH Grid

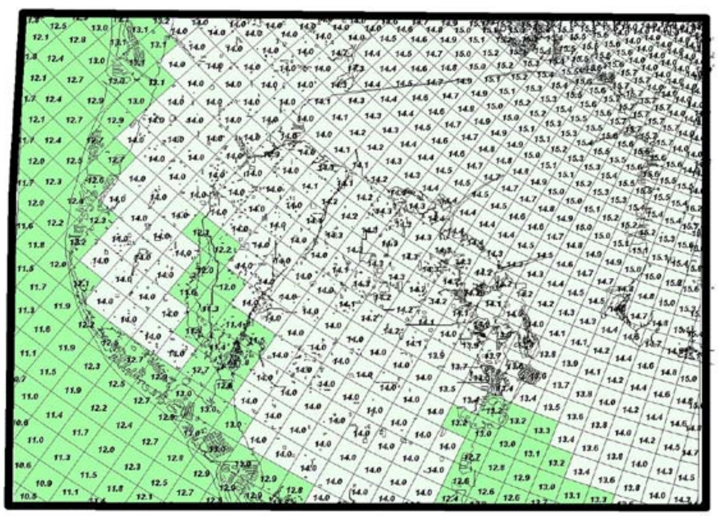


Figure II-2
SLOSH Grid with Surge Values

c. Storm Scenario Determinations

As indicated, the SLOSH model is the basis for the "hazard analysis" portion of coastal hurricane evacuation plans. Thousands of hypothetical hurricanes are simulated with various Saffir-Simpson Wind categories, forward speeds, landfall directions, and landfall locations. An envelope of high water containing the maximum value a grid cell attains is generated at the end of each model run. These envelopes are combined by the NHC into various composites which depict the possible flooding. One useful composite is the Maximum Envelopes of Water (MEOW) which incorporates all the envelopes for a particular category, speed, and landfall direction. Once surge heights have been determined for the appropriate grids, the maximum surge heights are plotted by storm track and tropical storm/hurricane category. These plots of maximum surge heights for a given storm category and track are referred to as MEOWs. The MEOWs or reference hurricanes can be used in evacuation decision making when and if sufficient forecast information is available to project storm track or type of storm (different landfalling, paralleling, or exiting storms).

The MEOWs provide information to the emergency managers in evacuation decision making. However, in order to determine a scenario which may confront the county in a hurricane threat 24-48 hours before a storm is expected, a further compositing of the MEOWs into Maximums of the Maximums (MOMs) is usually required.

The Maximum of the MEOWs (MOMs) represent the maximum surge expected to occur at any given location, regardless of the specific_storm track/direction of the hurricane. The only variable is the intensity of the hurricane represented by category strength (Category 1-5) and the type (landfalling, paralleling, exiting).

The MOM surge heights, which were furnished by the NHC, have 2 values, mean tide and high tide. Mean tide has 0' tide correction. High tide has a 1' tide correction added to it. All elevations are now referenced to the NAVD88 datum. These surge heights were provided within the SLOSH grid system as illustrated on Figure II-2. The range of maximum surge heights for each county in the region based upon the model is provided for each category of storm in Table II-4.

Table II-4
Potential Storm Tide Height(s) by County**
(In Feet above NAVD88)

*Storm Strength	Franklin	Gulf	Jefferson	Leon	Wakulla
Category 1	up to 10'	up to 6'	up to 11'	N/A	up to 11'
Category 2	up to 14'	up to 11'	up to 18'	up to 16'	up to 18'
Category 3	up to 21'	up to 13'	up to 24'	up to 24'	up to 24'
Category 4	up to 24'	up to 17'	up to 37'	up to 34'	up to 33'
Category 5	up to 28'	up to 20'	up to 39'	up to 35'	up to 39'

**Based on the category of storm on the Saffir-Simpson Hurricane Wind Scale*
*** Surge heights represent the maximum values from selected SLOSH MOMs*

d. Determining Storm Surge Height and Flooding Depth

SLOSH and SLOSH related products reference storm surge heights relative to the model vertical datum, in this case NAVD88. In order to determine the inundation depth of surge flooding at a particular location the ground elevation (relative to NAVD88) at that location must be subtracted from the potential surge height. It is important to note that one must use a consistent vertical datum when post-processing SLOSH storm surge values

Surge elevation, or water height, is the output of the SLOSH model. At each SLOSH grid point, the water height is the maximum value that was computed at that point. With the new SLOSH Model, water height is calculated relative to NAV88.

Within the SLOSH model an average elevation is assumed within each grid square. Height of water above terrain was not calculated using the SLOSH average grid elevation because terrain height may vary significantly within a SLOSH grid square. For example, the altitude of a 1-mile grid square may be assigned a value of 1.8 meters (6 feet), but this value represents an average of land heights that may include values ranging from 0.9 to 2.7 meters (3 to 9 feet). In this case, a surge value of 2.5 meters (8 feet) in this square would imply a 0.7 meters (2 feet) average depth of water over the grid's terrain. However, in reality within the grid area portion of the grid would be "dry" and other parts could experience as much as 1.5 meters (5 feet) of inundation. Therefore, in order to determine the storm tide limits, the depth of surge flooding above terrain at a specific site in the grid square is the result of subtracting the terrain height determined by remote sensing from the model-generated storm surge height in that grid square. [3]

As part of the SRES, all coastal areas as well as areas surrounding Lake Okeechobee was mapped using laser terrain mapping (LIDAR[4]) providing the most comprehensive, accurate and precise topographic data for this analysis. As a general rule, the vertical accuracy of the laser mapping is within a 15 centimeter tolerance. However, it should be noted that the accuracy of these elevations is limited to the precision and tolerance in which the horizontal accuracy for any given point is recorded. Other factors such as artifact removal algorithms (that remove buildings and trees) can affect the recorded elevation in a particular location. For the purposes of this study, the horizontal accuracy cannot be assumed to be greater than that of a standard USGS 7 minute quadrangle map, or a scale of 1:24,000**.**

The Storm Tide Limits based on the SLOSH MOMs have been determined using the methodology described above, mapped and published in the *Storm Tide Atlas*.

e. Variations to Consider

Variations between modeled versus actual measured storm surge elevations are typical of current technology in coastal storm surge modeling. In interpreting the data, emergency planners should recognize the uncertainties characteristic of mathematical models and severe weather systems such as hurricanes. The storm surge elevations developed for this study and presented in the *Storm Tide Atlas* should be used as guideline information for planning purposes.

(1). Storm Surge & Wave Height

It is important to understand that the configuration and depth (bathymetry) of the Gulf bottom will have a bearing on surge and wave heights. A narrow shelf, or one that drops steeply from the shoreline and subsequently produces deep water in close proximity to the shoreline, tends to produce a lower surge but a higher and more powerful wave. Those regions, like parts of the Apalachee Bay Region, which have a gently sloping shelf and shallower normal water depths, can expect a higher surge but smaller waves. The reason this occurs is because

[3] Note: This represents the regional post-processing procedure. When users view SLOSH output within the SLOSH Display Program, the system still uses average grid cell height when subtracting land.

[4] Light Imaging Detection and Ranging

a surge in deeper water can be dispersed down and out away from the hurricane. However, once that surge reaches a shallow gently sloping shelf it can no longer be dispersed away from the hurricane, consequently water piles up as it is driven ashore by the wind stresses of the hurricane. Wave height is NOT calculated by the SLOSH model and is not reflected within the storm tide delineations.

(2). Forward Speed

Under actual storm conditions it may be expected that a hurricane moving at a slower speed could have higher coastal storm surges than those depicted from model results. At the same time, a fast moving hurricane would have less time to move storm surge water up river courses to more inland areas. For example, a minimal hurricane, like Hurricane Dennis or a storm further off the coast which stalls off the coast for several tidal cycles, could cause extensive beach erosion and move large quantities of water into interior lowland areas. In the most recent version of the Apalachee Bay SLOSH model, for each set of tracks in a specific direction, storms were run at forward speeds of 5, 10, 15 and 25 mph.

(3). Radius of Maximum Winds

As indicated previously, the size of the storm or radius of maximum winds (RMW) can have a significant impact on storm surge especially in bay areas and along the Gulf of Mexico. All of the hypothetical storms were run at two different sizes, 25 mile radius of maximum winds and 30 mile radius of maximum winds.

(4). Astronomical Tides

Surge heights were provided for both mean tide and high tide. Both tide levels are referenced to NAVD88. The storm tide limits reflect high tide in the region.

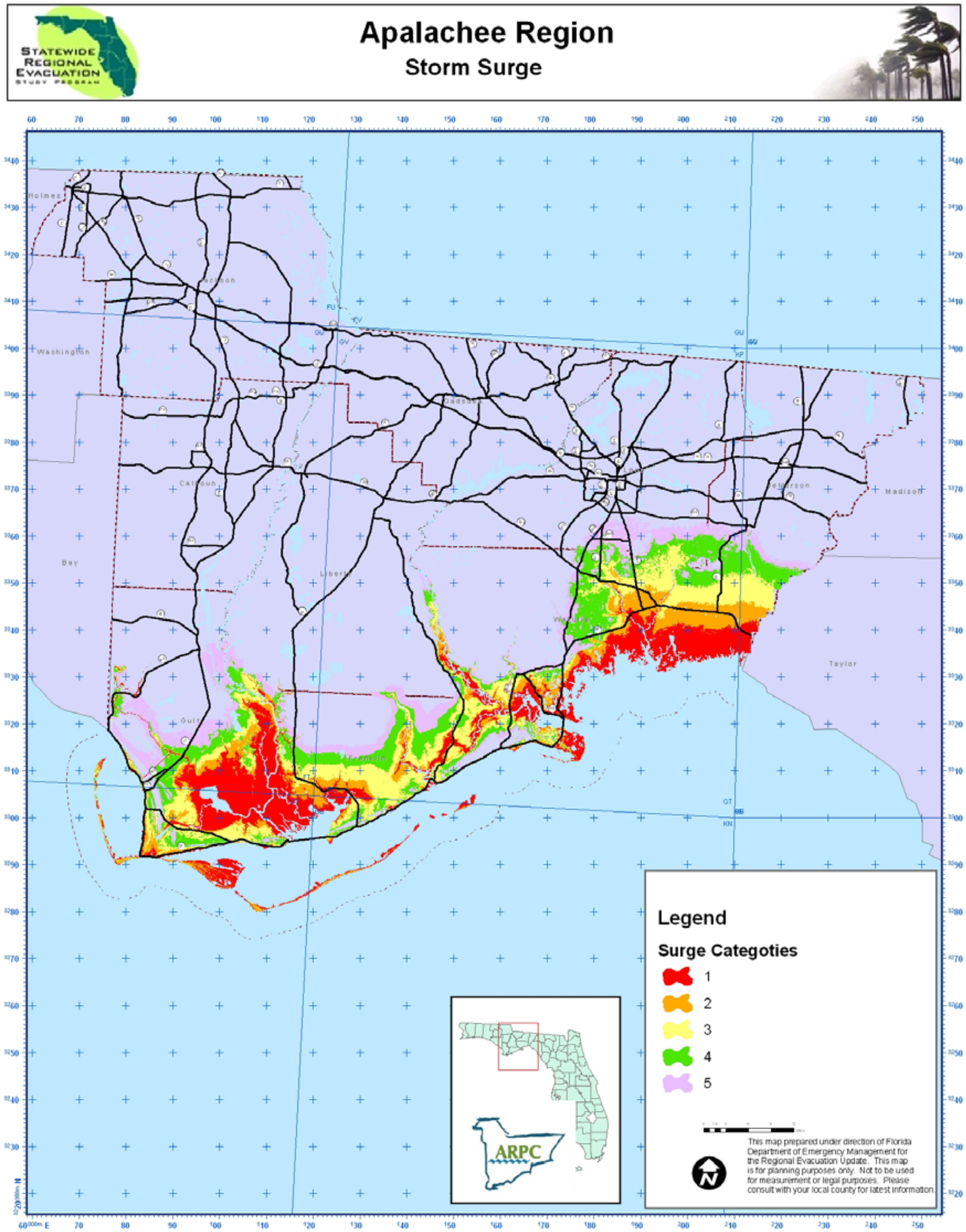
f. Storm Tide Atlas

The surge inundation limits (MOM surge heights minus the ground elevations) are provided as GIS shape files and graphically displayed on maps in the *Hurricane Storm Tide Atlas for the Apalachee Bay Region*. The *Atlas* was prepared by Apalachee Regional Planning Council under contract to the State of Florida, Division of Emergency Management, as part of this study effort. The maps prepared for the *Atlas* consist of base maps (1:24000) including topographic, hydrographic and highway files (updated using 2008 county and state highway data). Detailed shoreline and storm tide limits for each category of storm were determined using the region's geographic information system (GIS). Figure II-3 presents a compilation of the *Storm Tide Atlas* for the region.

g. Factors Influencing Model Accuracy

The purpose of the maps contained in the Atlas is to reflect a worst probable scenario of the hurricane storm surge inundation and to provide a basis for the hurricane evacuation zones and study analyses. While the storm tide delineations include the addition of an astronomical mean high tide and tidal anomaly, it should be noted that the data reflects only stillwater saltwater flooding. Local processes such as waves, rainfall and flooding from overflowing rivers, are usually included in observations of storm surge height, but are not surge and are not calculated by the SLOSH model. It is incumbent upon local emergency management officials and planners to estimate the degree and extent of freshwater flooding as well as to determine the magnitude of the waves that will accompany the surge.

Figure II-3
Apalachee Bay Storm Tide Map



4. Hurricane Wind Analysis

As discussed previously, hurricane winds are a devastating element of the hurricane hazard. Based on the Saffir-Simpson Hurricane Wind Scale (see Table II-2), hurricane force winds range from sustained winds of 74 mph to more than 155 mph.

The intensity of a landfalling hurricane is expressed in terms of categories that relate wind speeds and potential damage. According to the Saffir-Simpson Hurricane Wind Scale, a Category 1 hurricane has lighter winds compared to storms in higher categories. A Category 4 hurricane has winds between 131 and 155 mph and, on average, would usually be expected to cause 100 times the damage of the Category 1 storm. Depending on circumstances, less intense storms may still be strong enough to produce damage, particularly in areas that have not prepared in advance.

Tropical storm force winds are strong enough to be dangerous to those caught in them. For this reason, emergency managers should plan on having their evacuations complete and their personnel sheltered before the onset of tropical storm force winds, not hurricane force winds.

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

High-rise buildings are also vulnerable to hurricane force winds, particularly at the higher levels since wind speed tends to increase with height. Recent research suggests you should stay below the tenth floor but still above any floors at risk for flooding. It is not uncommon for high-rise buildings to suffer a great deal of damage due to windows being blown out. Consequently, the areas around these buildings can be very dangerous.

The strongest winds usually occur in the right side of the eyewall of the hurricane. Wind speed usually decreases significantly within 12 hours after landfall. Nonetheless, winds can stay above hurricane strength well inland. Hurricane Hugo (1989), for example, battered Charlotte, North Carolina (which is 175 miles inland) with gusts to nearly 100 mph. Tropical Storm Fay turned northeastward on August 19, 2008, making landfall early that day on the southwestern coast of the Florida peninsula at Cape Romano with maximum winds of 60 mph. Even after moving inland, TS Fay strengthened, exhibiting what resembled a classical eye in radar and satellite imagery, and it reached its peak intensity of about 65 mph as it passed over the western shores of Lake Okeechobee. During August 20-23 however, TS Fay continued interaction with the landmass of northern Florida causing the cyclone to weaken slightly. TS Fay's maximum winds remained 50-60 mph during most of that period.

Several key factors should be remembered about wind speeds. First, there is evidence that gusts rather than sustained winds cause the majority of damage associated with severe weather. The methodology described above does not specifically address wind gusts and does not address building codes/standards or construction practices.

a. Wind Risk Assessment: Inland Wind Model

The Inland High Wind Model can be used by emergency managers to estimate how far inland strong winds extend. The inland wind estimates can only be made shortly before landfall when the windfield forecast errors are relatively small. This information is most useful in the decision making process to decide which people might be most vulnerable to high winds at inland locations.

Onshore winds at the coast will decrease as the storm system moves across the land as a result of friction characteristics. The NHC has developed adjustment ratios to account for this effect. In addition, as the wind path continues around the storm, further reduction in wind speed occurs until equilibrium is reached or the wind path again crosses the coast to an open water area. The onshore and offshore winds are assumed to reach equilibrium after being over any underlying friction surface a distance of 10 nautical miles.

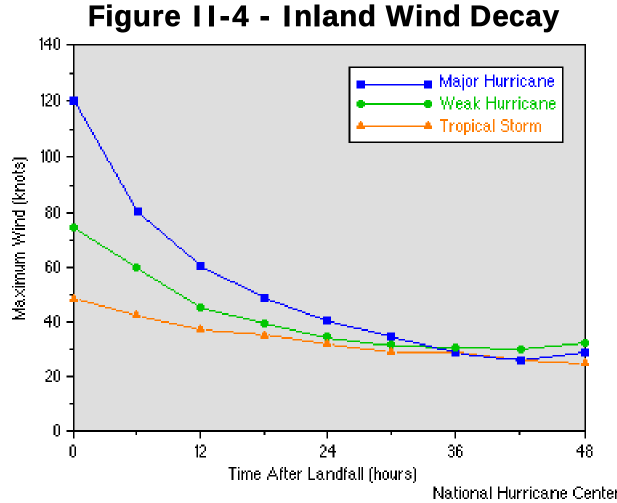
There are four friction categories defined as follows:

1. Open water
2. Awash - normally dry ground with tree or shrub growth, hills or dunes (non-inundated from storm surge)
3. Land - relatively flat non-inundated terrain or buildings
4. Rough terrain - major urban areas, dense forests, etc.

The graph below (Figure II-4) shows how wind speed rapidly decreases once a tropical cyclone reaches land. Part of the reason for this is that the roughness of the terrain increases friction, slowing the air. Another reason is that, once the storm is over land, it is usually cut off from the heat and moisture sources that sustain it. However, wind gusts (as opposed to the sustained winds shown in the graph) may actually increase because the greater turbulence over land mixes faster air to the surface in short bursts.

The graph shows that the sustained winds in a hurricane will decrease at a relatively constant rate (approximately half the wind speed in the first 24 hours). Therefore, the faster the forward speed of a landfalling hurricane, the further the inland penetration of hurricane force winds.

Figure II-4 - Inland Wind Decay



(Source:www.nhc.noaa.gov/HAW2/english/wind/wind_decay.shtml)

The inland wind model was developed by Mark DeMaria (NOAA/NWS/TPC) and John Kaplan (NOAA/AOML/HRD).[5] The model applies a simple two parameter decay equation to the hurricane wind field at landfall to estimate the maximum sustained surface wind as a storm moves inland. This model can be used for operational forecasting of the maximum winds of landfalling tropical cyclones. It can also be used to estimate the maximum inland penetration of hurricane force winds (or any wind threshold) for a given initial storm intensity and forward storm motion.

A model wind field, which illustrates the combined wind profiles from hurricanes striking the coast at different locations, has been developed for each category of hurricane and forward speed of the storm system. It demonstrates the potential wind speeds at different locations based upon a *"maximum of wind"* analysis.[6] Figures II-5 and II-6 illustrate the Maximum Inland Extent of Winds for Hurricanes Approaching the Gulf and East Coasts, respectively, from any direction. Looking at the results down the table by hurricane category, the increase in winds is highlighted. By reviewing the results across the table, the dramatic impact of the forward speed on the wind is apparent. (Map source: www.nhc.noaa.gov/aboutmeow.shtml)

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[5] Kaplan, J., DeMaria, M., 1995: ***A Simple Empirical Model for Predicting the Decay of Tropical Cyclone Winds After Landfall.*** *J. App. Meteor.*, **34**, No. 11, 2499-2512.

[6] One storm alone will not produce the following inland winds. This is the **combination** of multiple storm tracks and is for planning purposes.

Figure II-5: Maximum Inland Extent of Winds for Hurricanes Approaching the Gulf Coast

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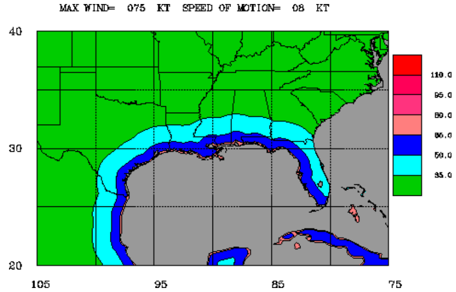
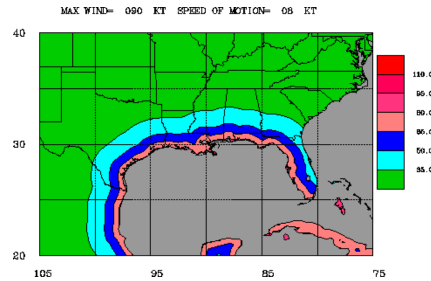
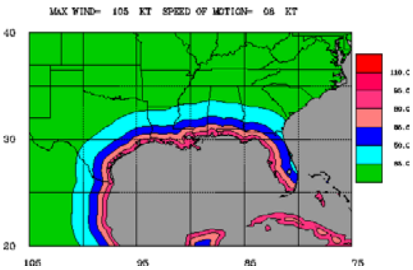
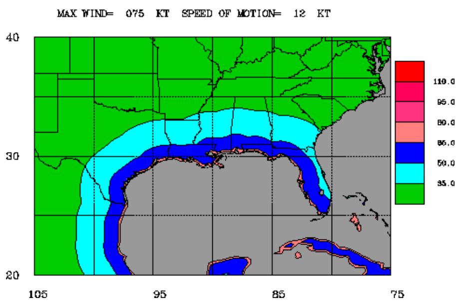
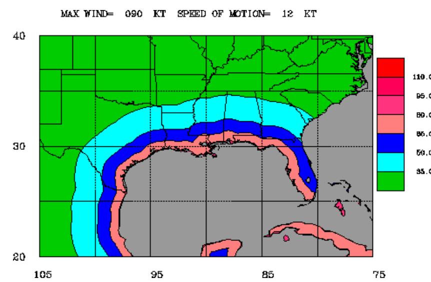
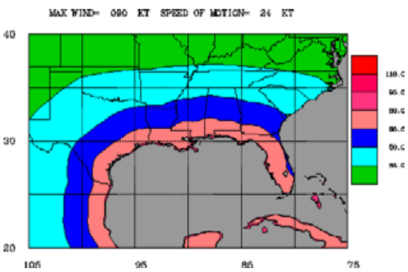
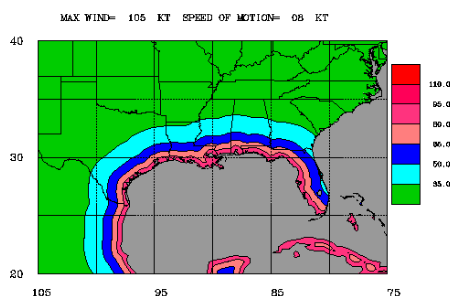
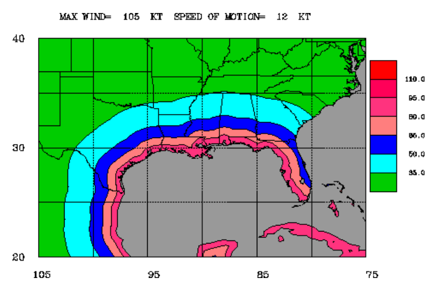
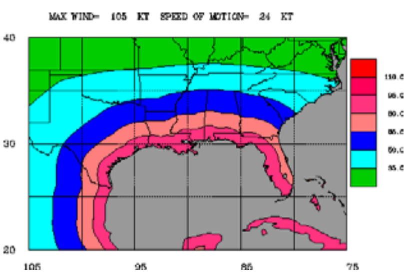
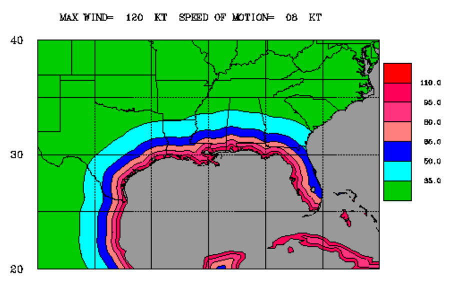
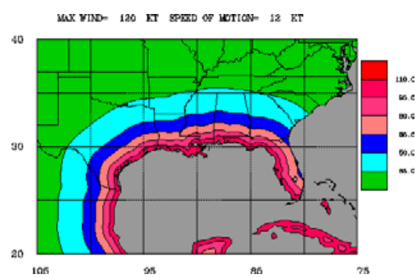
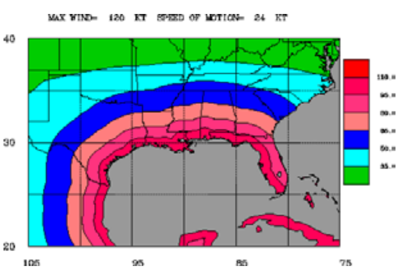
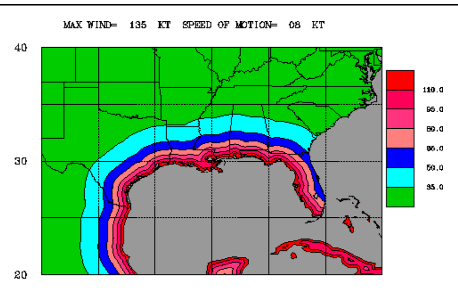
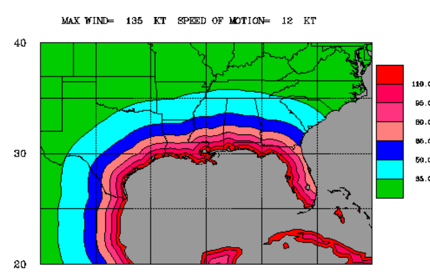
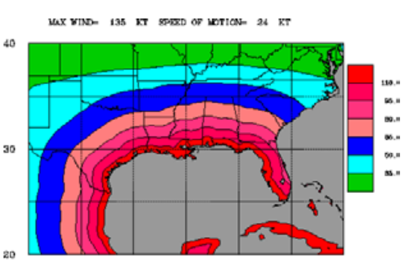
1			
2			
3			
4			
5			

Cat	Figure II-6: Maximum Inland Extent of Winds for Hurricanes Approaching the East Coast		
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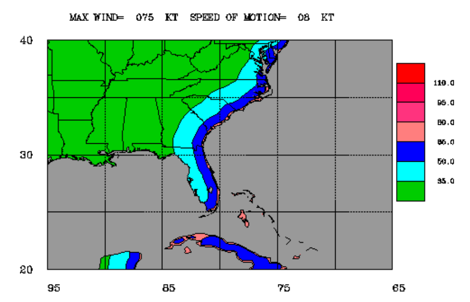
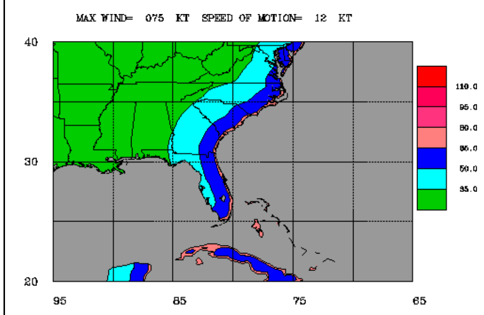
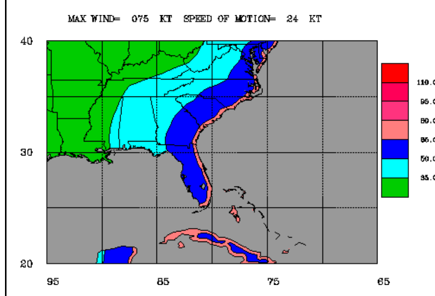
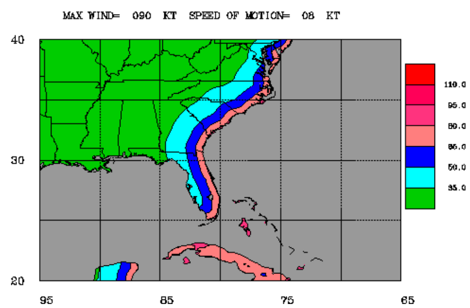
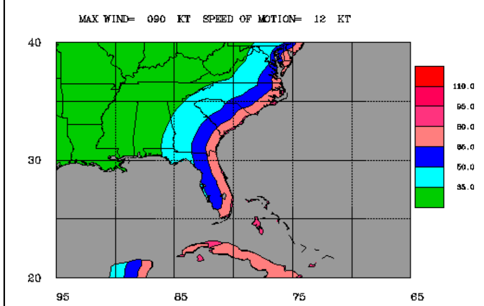
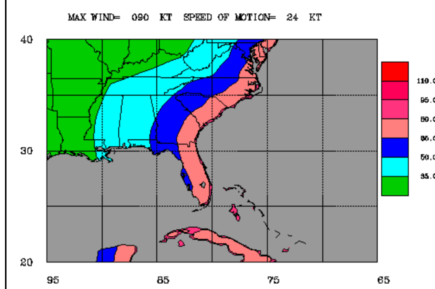
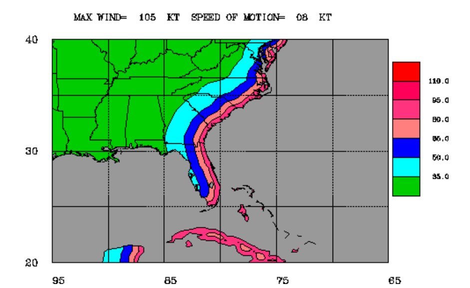
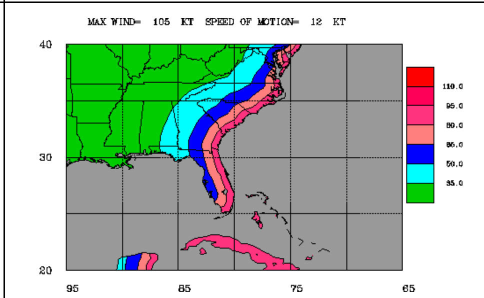
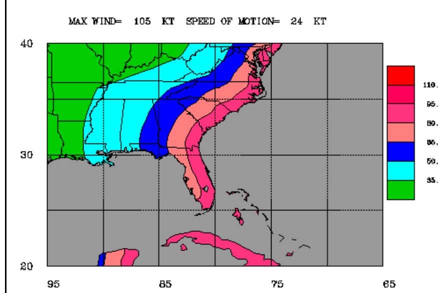
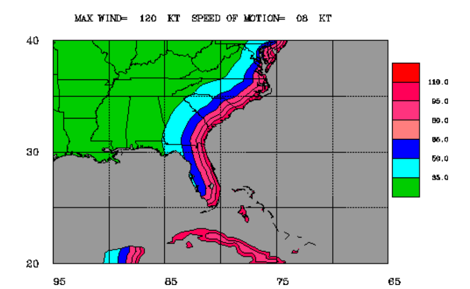
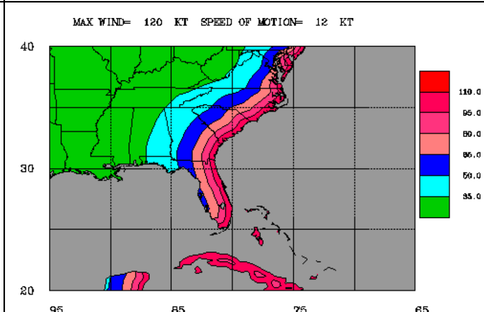
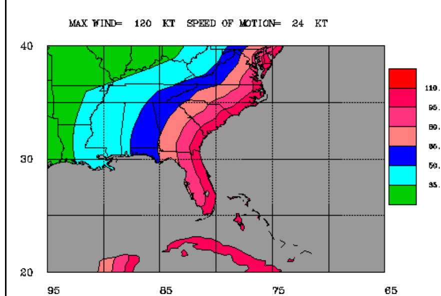
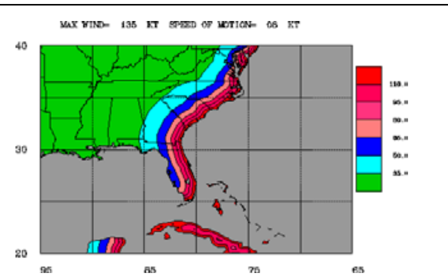
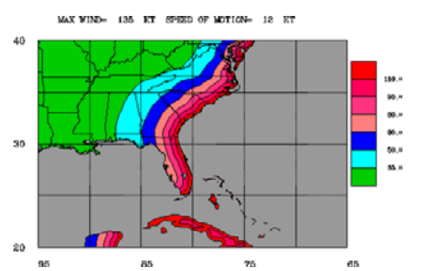
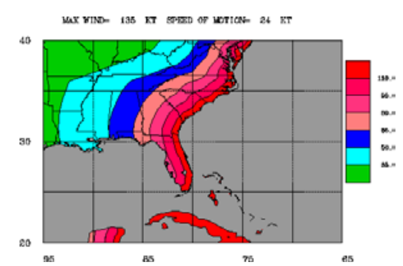
1			
2			
3			
4			
5			

b. Wind Risk Assessment: Florida Building Code

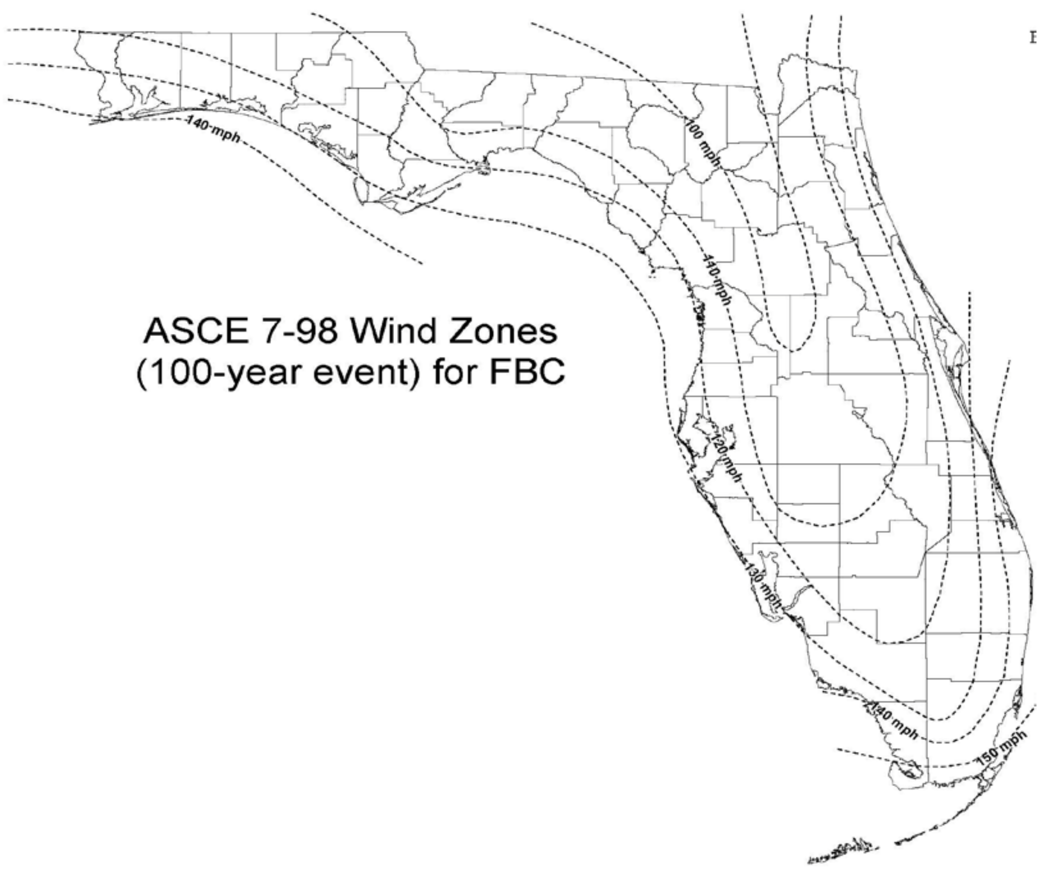
In March of 2002 a Statewide Building Code was fully adopted and implemented in Florida. A critical element of that new building code was the adoption of stricter building standards based on wind hazard associated with hurricanes. To establish variable building standards for locales throughout Florida, the American Society of Civil Engineer's Standard 7 for the 1998 (ASCE 7-98) was adopted. The ASCE 7-98 provides wind risk assessments for areas throughout Florida along with associated building standards.

Figure II-7 presents the ASCE 7-98 Wind Contour of the 100-year 3-minute wind.

c. Wind Risk Assessment: HAZUS

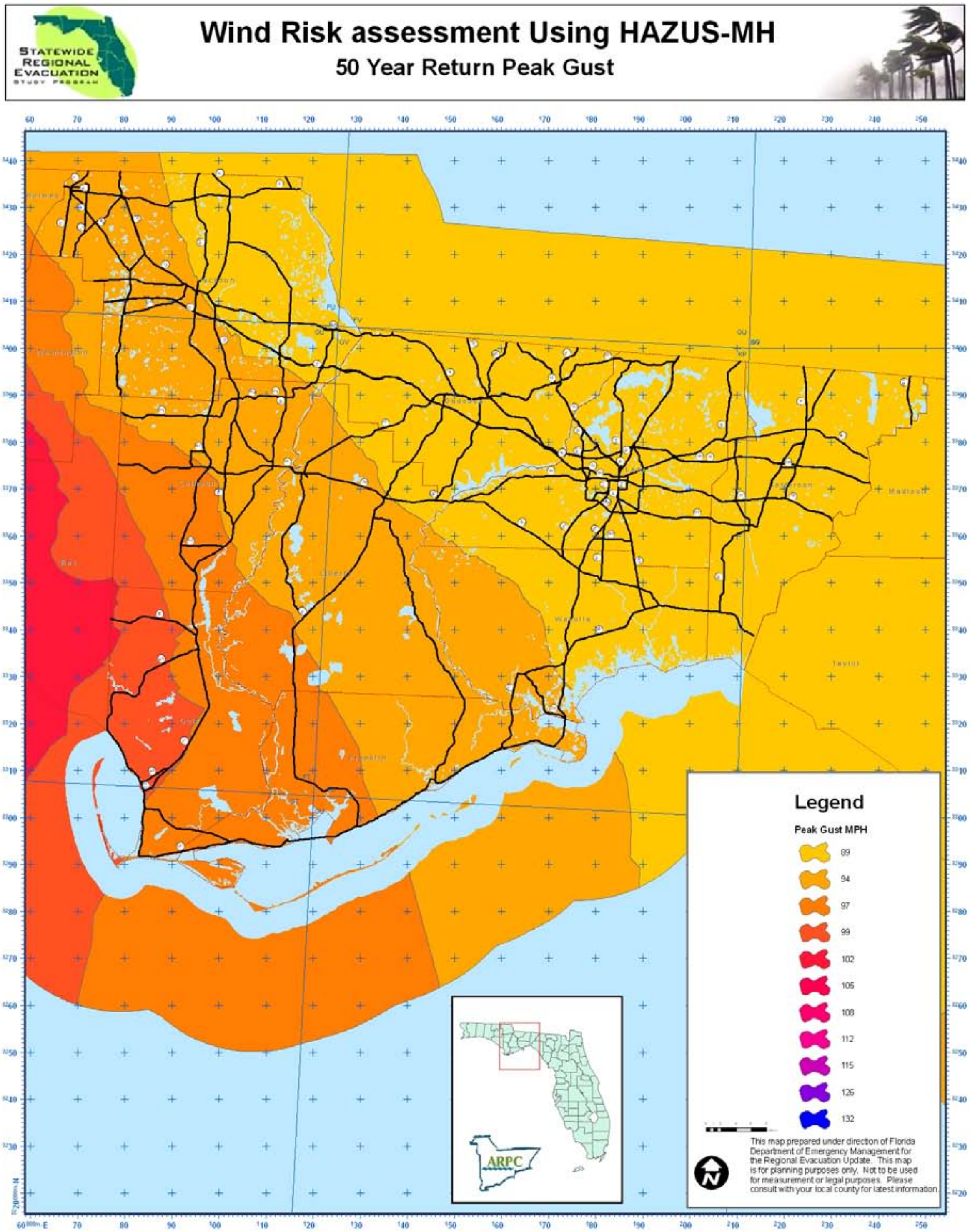
HAZUS-MH also includes a vulnerability analysis incorporating other factors such as housing stock, vegetation and friction coefficients based on land cover. Figure II-8 provides a Level 1 wind risk assessment using this tool.

Figure II-7
ASCE 7-98 Wind Zones



Source: FBC: Florida Building Code 2001, Chapters 2, 16, 17, & 22 ASCE 7-98: "Minimum Design Loads for Buildings and Other Structures", by American Society of Civil Engineers.

Figure II-8
Hurricane Wind Risk Assessment (HAZUS)



5. Tornadoes

In general, tornadoes associated with hurricanes are less intense than those that occur in the Great Plains. Nonetheless, the culminated effects of tornadoes, storm surge and inland flooding and the swath of hurricane force winds, can produce substantial damage.

Sixty–nine percent of all tornadoes are weak tornadoes, EF0-EF2 sizes. Twenty-nine percent of all tornadoes are strong and can last 20 minutes or longer. Two percent of all tornadoes fall into the EF-4 and EF-5 categories. The most powerful tornadoes are spawned by supercell thunderstorms. These are storms that, under the right conditions, are affected by horizontal wind shears (winds moving in different directions at different altitudes.) These wind shears cause horizontal columns of air to begin to rotate the storm. This horizontal rotation can be tilted vertically by violent updrafts, and the rotation radius can shrink, forming a vertical column of very quickly swirling air. This rotating air can eventually reach the ground, forming a tornado. We have no way at present to predict exactly which storms will spawn tornadoes or where they will touch down. The Doppler radar systems have greatly improved the forecaster's warning capability, but the technology usually provides lead times from only a few minutes up to about 30 minutes. Consequently, early warning systems and preparedness actions are critical.

Table II-5
Enhanced Fujita-Pearson Tornado Intensity Scale

The Enhanced F-scale is a set of wind estimates (not measurements) based on damage. It uses three-second gusts estimated at the point of damage based on a judgment of 8 levels of damage (listed at www.spc.noaa.gov/faq/tornado/efscale.html). These estimates vary with height and exposure. **Important**: the three-second gust is not the same wind as in standard surface observations. Standard measurements are taken by weather stations in open exposures using a directly measured, "one minute mile" speed.

- **EF0 Gale Tornado -** 65-85 mph
  Some damage to chimneys. Tree branches broken off. Shallow rooted trees uprooted.
- **EF1 Moderate Tornado -** 86-110 mph
  Peels surface off roofs. Mobile homes overturned. Moving autos pushed off roads.
- **EF2 Significant Tornado -** 111-135 mph
  Considerable damage. Roofs torn off frame houses. Large trees snapped or uprooted. Light-object missiles generated.
- **EF3 Severe Tornado -** 136-165 mph
  Severe damage. Roofs and some walls torn off well constructed homes. Trains overturned. Most trees in forests uprooted. Heavy cars lifted off ground.
- **EF4 Devastating Tornado -** 166-200 mph
  Well-constructed houses leveled. Structures with weak foundations blown off some distance. Cars thrown and large missiles generated.

- **EF5 Incredible Tornado -** Over 200 mph
  Strong frame houses lifted off foundations and disintegrated. Automobile-sized missiles fly through the air in excess of 100 mph. Trees debarked.

Damage f scale		Little Damage	Minor Damage	Roof Gone	Walls Collapse	Blown Down	Blown Away
		f0	f1	f2	f3	f4	f5
Windspeed F scale (m/s)		17–32	32–50	50–70	70–92	92–116	116–142
		F0	F1	F2	F3	F4	F5
Windspeed F scale (mph)		40–73	73–113	113–158	158–207	207–261	261–319
To convert f scale into F scale, add the appropriate number							
Weak Outbuilding	-3	f3	f4	f5	f5	f5	f5
Strong Outbuilding	-2	f2	f3	f4	f5	f5	f5
Weak Framehouse	-1	f1	f2	f3	f4	f5	f5
Strong Framehouse	0	F0	F1	F2	F3	F4	F5
Brick Structure	+1	-	f0	f1	f2	f3	f4
Concrete Building	+2	-	-	f0	f1	f2	f3

Fig. 2.4-1 The Fujita tornado scale (F scale) pegged to damage-causing windspeeds. The extent of damage expressed by the damage scale (f scale) varies with both windspeed and the strength of structures.

6. Hazardous Materials

Sometimes one emergency event can trigger another. Facilities which generate or store quantities of potentially hazardous materials, propane storage facilities, natural gas pipeline terminals, fuel storage facilities and tank farms all pose an additional potential threat in a hurricane. Identifying the location of these facilities is important to provide additional information to facility managers to secure their operation and protect the employees, facility and inventory before the storm and to assist emergency responders in safe re-entry into areas after the storm has passed. It may also serve to identify where mitigation strategies should be implemented to reduce the risk to resident and the environment.

The Hazard Materials Information System (HMIS) database was accessed to identify the current facilities storing Extremely Hazardous Substances (EHS) – also known as Section 302 facilities – in the Apalachee Bay Region. The geo-coded inventory of the Section 302 facilities is included in the Critical Facility Inventory Database. A regional map which illustrates the vulnerability of all Section 302 facilities is included on Figure II-18. The inventory and vulnerability assessments are considered For Official Use Only

(FOUO) and are not available to the public for security reasons. Evacuation for hazardous material incidents will be discussed later in the chapter.

7. Freshwater Flooding and the Inundation of Evacuation Routes

Inland riverine and freshwater flooding often becomes a significant factor as a result of tropical storms and hurricanes. Typically the rainfall associated with, and in advance of, a hurricane does not in itself necessitate the emergency evacuation of residents during the passage of a hurricane unlike storm surge. Following a storm, however, the coastal flooding and rainfall – particularly from slow moving storms - necessitates an evacuation of flooded inland residents days after as swollen rivers and streams breach their bank or levees.

As noted previously, due to the slow motion of Tropical Storm Fay, total storm rainfall amounts in some areas were staggering including a few locations in east-central Florida that received more than two feet of rain. Rain from Tropical Storm Fay induced floods which caused significant damage and were directly responsible for numerous deaths in the Dominican Republic, Haiti and Florida. (www.nhc.noaa.gov)

Inland flooding will be discussed later in the chapter as a separate hazard. For hurricane evacuation, however, rainfall may cause the early inundation of roadways used as evacuation routes by vehicles attempting to escape from areas vulnerable to the approaching storm surge. In addition, given Florida climatology and the normal summer weather, flooding may occur as a disassociated event prior to the hurricane, flooding evacuation routes and saturating the ground.

Those roadways known historically to be vulnerable from freshwater flooding have been identified using GIS systems in relation to the floodplain. These routes are presented on maps in the county Appendices to Chapter IV – Regional Vulnerability and Population Analysis.

Contingency plans including rerouting, sandbagging and pumping will be coordinated with local and state law enforcement and the State Department of Transportation. The impacts of road closures, rain and ambient conditions on evacuation times are addressed in the transportation analysis. An evacuation simulation of the closing of these major routes was modeled as part of the transportation analysis to determine the impact on clearance times.

Rainwater inundation of evacuation routes must be addressed in an evacuation plan. The planning strategy to address this problem is to plan for the passage of all vehicles over such roadways before substantial rainfall from the hurricane was expected to arrive. Hourly records of rainfall rates and accumulation for past hurricanes indicate that rates high enough to surpass drainage capabilities normally parallel in time the arrival of sustained tropical storm force winds. Using this as an assumption of the timing of freshwater roadway inundation, the pre-landfall hazards time quantification for sustained tropical storm force winds will also compensate for early rainfall inundation of evacuation routes.

8. History of Hurricanes in the Apalachee Bay Region

Hurricanes are a natural yet very dangerous phenomenon, one for which the Apalachee Bay Region must always be prepared. Packing 74-200 mph winds and a storm surge which can exceed 35 feet, hurricanes represent a serious threat to the safety of residents and visitors and economic health of this metropolitan region.

Emergency management and atmospheric scientists agree that global weather patterns have moved back into a period of increased tropical storm activity and of increased frequency of major hurricanes, a category 3 or higher on the Saffir-Simpson Hurricane Wind Scale (See Table II-2), particularly in the state of Florida. An analysis of hurricane activity since the 1840's demonstrates that hurricane activity appears cyclical and that, after a period of relative inactivity since the early 1960's, the state of Florida is in a more active period.

a. The 1830 – 1900 Hurricane Seasons

By the late 1830s the towns along Florida's northwest coast were growing steadily. Historian identify a flurry of hurricane activity in the Apalachicola Bay region from the 1830s – 1850s. The hurricane season of 1837 was active with at least 11 tropical storms one of which impacted Tallahassee. In 1842, a major hurricane, considered to be one of the most severe on record, made landfall near St. Marks on October 5th causing heavy damage to the lighthouse at East Pass and damage to residences in Apalachicola. The estimated damage in Tallahassee was $500,000 and roads to the capital were blocked from all directions with fallen trees. The following year, the recently established town of Port Leon, south of St. Marks, was washed away by severe storm surge from a major hurricane which made landfall on September 13th. In 1844 a "tremendous gale" was reported in Apalachicola, while it only caused approximately $20,000 in damages, residents of the region had become accustomed to annual hurricane events. The *Tallahassee Sentinel*, the newspaper at the time reported that "Last night our annual September gale came in all its fury." (Barnes, 2007) In 1848, two weeks after the worst hurricane to ever impact the Tampa area, another storm made landfall along the west coast. Its effects were felt from Cape San Blas to Tampa Bay.

Apalachicola was again impacted in 1850 by a hurricane with significant storm tide. Warehouses were flooded and trade ships were damaged and sunk. The local newspaper of the time reported water covering Water Street, Commerce Street and the upper end of Market Street and the Wakulla Bridge was swept away by the storm. The Great Middle-Florida Hurricane of 1851 is still considered one of the most destructive storms to impact Apalachicola. It made landfall on August 22nd and the winds blew for more than 20 hours, leveling houses and businesses. Again, severe storm surge caused significant damage, destroying all of the buildings on Water Street and ruining residences on Front and Commerce Streets. (Barnes, 2007) All three lighthouses were blown or washed away and it was reported in Tallahassee that the storm raged from 6:00 p.m. August 22nd until sunrise on August 24, 1851. Tide at St. Marks was recorded as 12 feet above normal water levels. In October of 1852 yet another major hurricane made landfall east of Apalachicola causing significant damage to St. Marks and impacted Tallahassee. It was several years before another hurricane impacted the Apalachee Bay Region, but in 1856 another major hurricane made landfall near Cape San Blas causing storm surge and flooding in downtown Apalachicola. This storm moved inland over Marianna and caused significant damage to the town.

It was not until 1877 that another tropical storm impacted the region. Although winds were measured at only 66mph, the tide rose to 12 feet above normal, indicating yet again that this region is susceptible to storm tide flooding even during less severe tropical events. In 1886 two significant hurricanes impacted Apalachicola and Tallahassee within nine days of each other. The first storm, considered a "Great Hurricane" had winds of over 100 mph and caused destruction throughout northern Florida and southern Georgia. The second storm had winds which measured over 80 mph and was accompanied by heavy rains.

Two more storms, one in 1894 and the other in 1898 made landfall near Apalachicola, both were smaller storms that still caused damage. In 1899, a small but severe storm made landfall near Carrabelle and although the diameter of the storm was only 40 miles wide, it caused significant damage to the fishing community.

b. The 1901 – 1984 Hurricane Seasons

While other parts of Florida were significantly impacted by severe storms, this period of time was less active for the Apalachee Bay Region. Small storms impacted Apalachicola in 1915, 1924 and 1941. By the time the Category 2 storm impacted the region in October of 1941, citizens were well warned. Still, five men in Panacea drowned when the storm tide arrived, an indication that storm tide continues to be the biggest killer during a tropical event. Damages to Tallahassee and the surrounding area was estimated at $675,000 for this storm (Barnes 2007).

In the mid-1950s only two hurricanes impacted the Sunshine State. In 1953 Hurricane Florence, which made landfall near Panama City, put five to seven feet of storm tide into Apalachicola, Carrabelle and Panacea. The heaviest damage was in Franklin County where hundreds of homes destroyed and many businesses impacted. Hurricane Flossy in 1956 made landfall at Fort Walton Beach and spawned several tornadoes, one of which impacted Wewahitchka in Gulf County.

In the 1960s Hurricanes Dora and Alma impacted the region. Hurricane Dora did minimal damage in Tallahassee after making landfall in Jacksonville and wreaking destruction to that coastal community. In 1966 the citizens of Apalachicola were ready for Hurricane Alma. Having moved fishing boats up river and sheltered themselves off of the coastline, they were able to breath a sigh of relief when the winds diminished and the storm turned towards the northeast. Still, because of the shape of the coastline, storm tide was four to ten feet higher than normal.

Coming ashore at Cap San Blas, Hurricane Agnes in 1972 dumped tremendous amounts of rain on the region. In addition, storm tide was again a great destructor. Alligator Point was inundated and at least 20 houses were washed away and another 50 damaged. Both St. Marks and Apalachicola had four to five feet of water in their downtown districts.

c. The 1985 Season

The skies darkened in 1985 when two hurricanes and a destructive tropical storm affected the Florida upper west coast. It was the busiest year for tropical events since 1916 with eight of the 11 named storms impacted the American coastline. Over the Labor Day Holiday, Hurricane Elena, with an unusually erratic track sent Floridians from the Tampa Bay region evacuating inland. The storm did an about face and started moving west along the Florida northwest coastline. This Hurricane Center extended its hurricane warnings and hundreds of thousands of citizens from Sarasota to Taylor County evacuated in two days. While the storm eventually made landfall in Mississippi, winds damaged or destroyed residences along the Apalachee Bay Region coastline.

Tropical Storm Juan made landfall on Halloween later that year. TS Juan dumped abundant amounts of rain over Louisiana, Mississippi, Alabama, Florida and the Carolinas. Tornadoes were reported throughout the Big Bend and Central Florida areas. While destruction in Florida was minimal, oil rigs off of the coast of Louisiana were sunk, flooded rivers inundated communities and total damages from TS Juan were enormous – $1.5 billion.

While the Gulf region was still recovering, three weeks later a rare late November storm made landfall near Mexico Beach. With sustained winds of 108 mph and gusts up to 135 mph, Hurricane Kate was one of only four storms to reach category 3 status during the month of November. The most severe effects of the storm were experienced east of its landfall site. In Tallahassee wind gusts were recorded at 87 mph and Apalachicola experienced sustained winds of 62 mph. Storm tide ranged from six to eight feet above normal from Port St. Joe to east of Apalachicola. In Gulf, Franklin and Wakulla counties, more than 300 homes were destroyed, 6 miles of paved road were lost and the tip of Cape San Blas was reshaped. Parts of the region were without power for over a week and the courthouse in Apalachicola was severely damaged.

d. The 1986 – 2003 Hurricane Seasons

While Hurricane Andrew, 1993 did not directly strike the Apalachee Bay Region, it did however, affect the entire state in many ways. Only two other hurricanes in history, both category 5 storms - the Labor Day storm of 1935 and Camille in 1969 - were stronger than Hurricane Andrew when they made landfall in the United States. It struck South Florida with a storm surge of over 16 feet and winds which gusted over 175 mph. The scale of the disaster was enormous and the massive recovery that ultimately ensued was of epic proportions. The damages were staggering -- surpassing $50 billion – affecting emergency management policies and procedures, the insurance industry and land development regulations (including the statewide building code).

Hurricane forecasters and scientists had warned with Hurricane Hugo (1989) that the strengthening of *El Nino* and rainfall patterns in the African Sahel desert were signaling increased patterns of hurricane activity. The 1995 hurricane season certainly gave credence to those predictions. Two tropical storms and two hurricanes struck the state of Florida, the most since 1953 -- Hurricanes Opal and Erin and Tropical Storms Jerry and Allison.

In 1995, Hurricane Allison threatened the Apalachee Bay Region. Thankfully, the storm weakened and made landfall as a tropical storm. However, the TS Allison still did approximately $1.7 million in damages, mostly to a new roadway to Alligator Point. Hurricane Earl in 1998 was the next tropical event to directly impact the Apalachee Bay Region. Making landfall near Panama City, most of the force of the hurricane was well to the east of its center. Gusts of over 90 mph were recorded near St. George Island and storm tide of more than six feet was experienced along the Apalachee Bay coastline. Residents of St. George Island were temporarily isolated because the bridge was inundated. More than 20,000 residents were without power and 2,000 people moved into public shelters. More than 1,300 homes

Hurricane activity has indeed increased but it has been in the last five years that the deadly predictions have come to fruition and while the Apalachee Bay Region has been spared the direct hit of a major hurricane, the region has experienced both evacuations and impacts from exiting storms. In addition the experiences in other parts of Florida as well as the other states have resulted in a greater awareness of the challenges and obstacles facing this metropolitan region.

e. The 2004 Hurricane Season

In 2004 the State of Florida was hit by an unprecedented four hurricanes: Charley, Frances, Ivan and Jeanne. Of these, Hurricanes Frances and Jeanne impacted the Apalachee Bay Region directly.

(1). **August, 2004 – *Hurricane Frances*** was a Cape Verde-type hurricane that reached a peak intensity of category 4 on the Saffir-Simpson Hurricane Wind Scale. Frances hit the Florida east coast as a category 2 hurricane before moving over the Gulf and moving ashore for the final time at the mouth of the Aucilla River as a tropical storm. While the coastal communities in the Apalachee Bay Region experienced moderate storm surge, five (5) above normal tide, the remnants of Hurricane Francis produced more than 10 inches of rainfall. Frances spawned 101 tornadoes, 23 of them in Florida and was directly responsible for five deaths in Florida. (www.nhc.noaa.gov)

(2). **September, 2004 – *Hurricane Jeanne*** moved across central Florida weakening to tropical storm strength while centered about 30 nautical miles north of Tampa, passing east of Tallahassee. The hurricane eventually weakened to a tropical depression while moving northward across central Georgia accompanied by heavy rain. Areas still flooded from Frances, three weeks before, received additional flood waters. (www.nhc.noaa.gov)

f. The 2005 Hurricane Season

The impact of the 2005 Atlantic hurricane season and the resulting death, injury, destruction and population displacement were unprecedented in U.S. history. During 2005, 15 tropical storms became hurricanes and for the first time, four major hurricanes, made landfall in the United States; three of those Katrina, Rita and Wilma, impacted the Gulf and Florida Atlantic regions.

The worst effects were felt from Hurricanes Katrina and Rita. Although these storms did not seriously impact the state of Florida, they have had a significant impact on emergency management and hurricane planning at the national, state and local levels.

On August 29, Hurricane Katrina struck the U.S. Gulf Coast, causing severe damage from a two-story storm surge, powerful winds, and heavy rains. Approximately 80% of New Orleans was flooded after the surge from the Gulf of Mexico forced breaks in a levee, releasing water from Lake Pontchartrain into the city. Katrina became the deadliest U.S. hurricane since 1928 and likely the costliest natural disaster on record in the United States. On September 24, response and recovery activities in the wake of Katrina were interrupted when Hurricane Rita struck the Gulf Coast. Rita rendered more homes uninhabitable and thousands more seeking shelter elsewhere. More than 200,000 persons were displaced by the hurricanes and dispersed to evacuee shelters in 18 states. The economic and health consequences of Hurricanes Katrina and Rita extended far beyond the Gulf region and ultimately affected states and communities throughout the United States. (http://www.cdc.gov/mmwr/mguide_nd.html)

August, 2005 - ***Hurricane Katrina*** was a large and intense hurricane that struck a portion of the United States coastline along the northern Gulf of Mexico that is particularly vulnerable to storm surge, leading to loss of life and property damage of immense proportions. The scope of human suffering inflicted by Hurricane Katrina in the United States has been greater than that of any hurricane to strike this country in several generations.

The total number of fatalities known, as of this writing, to be either directly or indirectly related to Katrina is 1,336, including 14 deaths in Florida. Despite the fact that inland fresh water floods produced the majority of fatalities due to tropical cyclones during the past few decades, Katrina provides a grim reminder that storm surge poses the greatest potential cause for large loss of life in a single hurricane in this country.

The economic and environmental ramifications of Katrina have been widespread and could in some respects be long-lasting due to impacts on large population and tourism centers, the oil and gas industry and transportation. The hurricane severely impacted or destroyed workplaces in New Orleans and other heavily populated areas resulting in thousands of lost jobs and millions of dollars in lost tax revenues

g. The 2006 - 2008 Seasons

The 2006 Hurricane season was a much quieter season for the state of Florida, with only one hurricane affecting the state, Hurricane Ernesto, which was actually a tropical storm when it impacted Florida. Tropical Storm Alberto also crossed the eastern Florida panhandle. The 2007 Hurricane Season was also a relatively quite season, with no hurricanes directly affecting the State of Florida.

The 2008 Atlantic Hurricane Season marked the end of a season that produced a record number of consecutive storms to strike the United States and ranks as one of the more active seasons in the 64 years since comprehensive records began. Overall, the season is tied as the fourth most active in terms of named storms (16) and major hurricanes (5), and is tied as the fifth most active in terms of hurricanes (8) since 1944, which was the first year aircraft missions flew into tropical storms and hurricanes.

For the first time on record, six consecutive tropical cyclones (Dolly, Edouard, Fay, Gustav, Hanna and Ike) made landfall on the U.S. mainland and a record three major hurricanes (Gustav, Ike and Paloma) struck Cuba. This is also the first Atlantic season to have a major hurricane (Category 3) form in five consecutive months (July: Bertha, August: Gustav, September: Ike, October: Omar, November: Paloma).

The National Hurricane Center attributes the 2008 above-normal season to conditions that include:

- An ongoing multi-decadal signal. This combination of ocean and atmospheric conditions has spawned increased hurricane activity since 1995.

- Lingering La Niña effects. Although the La Niña that began in the Fall of 2007 ended in June, its influence of light wind shear lingered.

- Warmer tropical Atlantic Ocean temperatures. On average, the tropical Atlantic was about 1.0 degree Fahrenheit above normal during the peak of the season.

In 2008 Tropical Storm Fay made history as the only storm on record to make landfall four times in the state of Florida and to prompt tropical storm and hurricane watches and warnings for the state's entire coastline (at various times during its August lifespan).

Though Florida was spared a direct hit from a major hurricane, Floridians saw major flooding throughout the State from Tropical Storm Fay. Fay came ashore in the Florida Keys August 18 and continued northward up the Florida Peninsula. Fay made records as the first storm to make four landfalls in one state impacting the

Florida Keys, South Florida, exiting off the east coast and coming back inland near Flagler Beach and exiting off the Gulf Coast and making landfall again near Carrabelle. The slow-moving storm also caused record rainfall and flooding throughout the state with some areas getting as much as 25 inches of rain. Millions of dollars in damage and 15 deaths were caused in Florida by Fay. (www.noaa.nhc.gov)

9. Probability of Future Hurricane Events

Table II-6 provides the number of direct hits on the mainland U.S. coastline (1900-2006) for individual states. Florida is divided into four sections. The Apalachee Bay Region is located in the Northwest area.

Table II-6
U.S. Mainland Hurricane Strikes by State (1900-2006)

Area	Category					All (1-5)	Major (3-5)
	1	2	3	4	5		
U.S. (Texas to Maine)	110	73	75	18	3	279	96
Texas	23	18	12	7	0	60	19
Louisiana	18	14	15	4	1	52	20
Mississippi	2	5	8	0	1	16	9
Alabama	16	4	6	0	0	26	6
Florida	43	33	29	6	2	113	37
(Northwest)	26	17	14	0	0	57	14
(Northeast)	12	8	1	0	0	21	1
(Southwest)	18	10	8	4	1	41	13
(Southeast)	13	13	11	3	1	41	15
Georgia	15	5	2	1	0	23	3
South Carolina	18	6	4	2	0	30	6
North Carolina	24	14	11	1	0	50	12
Virginia	7	2	1	0	0	10	1
Maryland	1	1	0	0	0	2	0
Delaware	2	0	0	0	0	2	0
New Jersey	2	0	0	0	0	2	0
Pennsylvania	1	0	0	0	0	1	0
New York	6	1	5	0	0	12	5
Connecticut	5	3	3	0	0	11	3
Rhode Island	3	2	4	0	0	9	4
Massachusetts	6	2	3	0	0	11	3
New Hampshire	1	1	0	0	0	2	0
Maine	5	1	0	0	0	6	0

Notes: State totals will not necessarily equal U.S. totals, and Florida totals will not necessarily equal sum of sectional totals.

Table II-7 provides the total of major hurricane direct hits on the mainland (1900-2006) by month. Most major hurricanes occur in the later part of the hurricane season in September, October and November. Category one and two hurricanes tend to “spring up” in the Caribbean affecting the northwest Florida area in the early part of the season.

Table II-7
Major Hurricane Direct Hits on the U.S. Coastline 1900-2006 by Month

	Jun	Jul	Aug	Sep	Oct	All
U.S. (Texas to Maine)	2	4	30	44	16	96
Texas	1	1	10	7	0	19
(North)	1	1	3	2	0	7
(Central)	0	0	2	2	0	4
(South)	0	0	5	3	0	8
Louisiana	2	0	7	8	3	20
Mississippi	0	1	4	4	0	9
Alabama	0	1	1	4	0	6
Florida	0	2	6	19	10	37
(Northwest)	0	2	1	7	3	13
(Northeast)	0	0	0	1	0	1
(Southwest)	0	0	2	5	6	13
(Southeast)	0	0	4	8	3	15
Georgia	0	0	1	1	1	3
South Carolina	0	0	2	2	2	6
North Carolina	0	0	4	8	1	13
Virginia	0	0	0	1	0	1
Maryland	0	0	0	0	0	0
Delaware	0	0	0	0	0	0
New Jersey	0	0	0	0	0	0
Pennsylvania	0	0	0	0	0	0
New York	0	0	1	4	0	5
Connecticut	0	0	1	2	0	3
Rhode Island	0	0	1	3	0	4
Massachusetts	0	0	0	3	0	3
New Hampshire	0	0	0	0	0	0
Maine	0	0	0	0	0	0

Taken from The Deadliest, Costliest, and Most Intense United States Hurricanes of this Century [NOAA Technical Memorandum NWS TPC-5] Updated in 2007. http://www.nhc.noaa.gov/pdf/NWS-TPC-5.pdf . Storms can affect more than one area in the state. Therefore, the total number of storms affecting Florida is less than the total number affecting all regions.

a. Monthly Zones of Origin and Hurricane Tracks

The figures below (Figures II-9 - II-14) show the zones of origin and tracks for different months during the hurricane season. These figures only depict average conditions and hurricanes can originate in different locations and travel much different paths from the average. Nonetheless, having a sense of the general pattern can give you a better picture of the average hurricane season for your area.

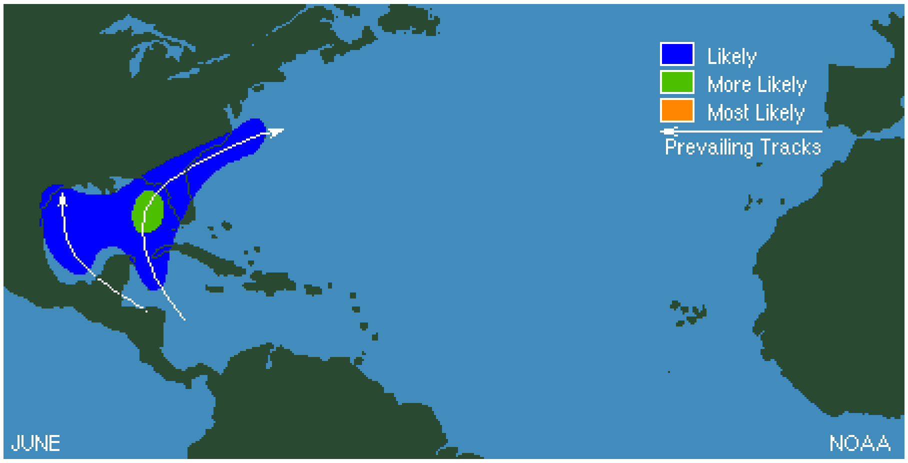


Figure II-9

Prevailing Tracks - June

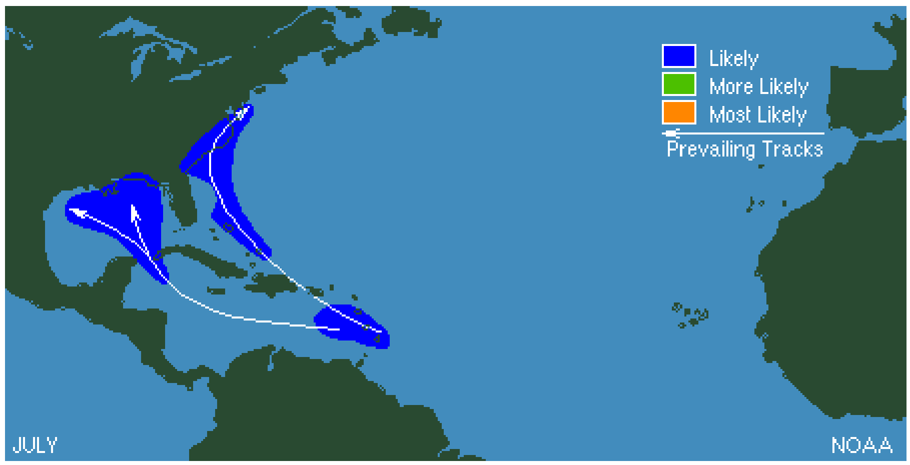


Figure II-10

Prevailing Tracks - July

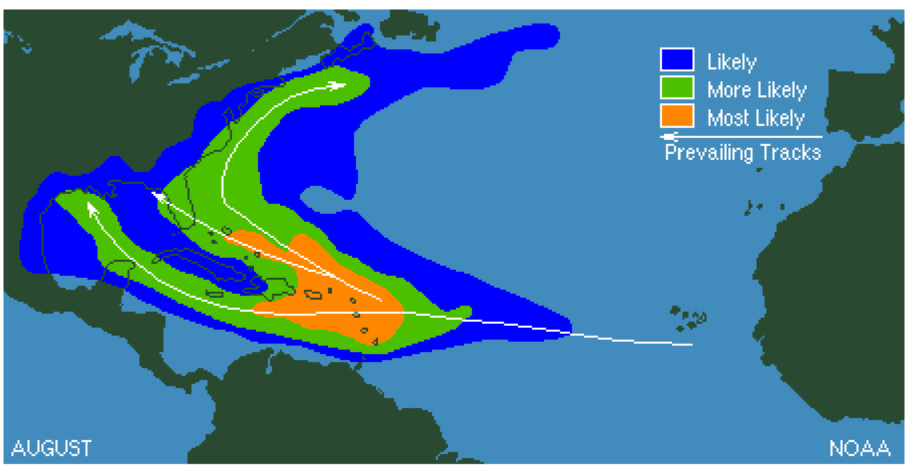


Figure II-11

Prevailing Tracks - August

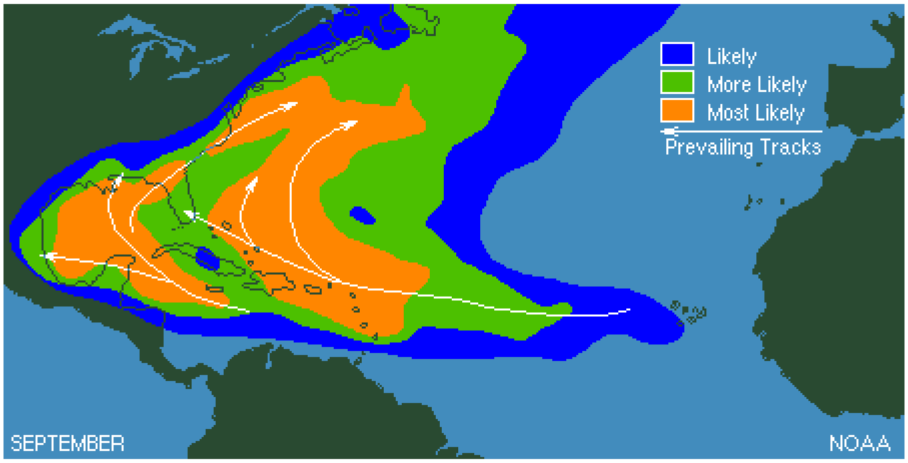
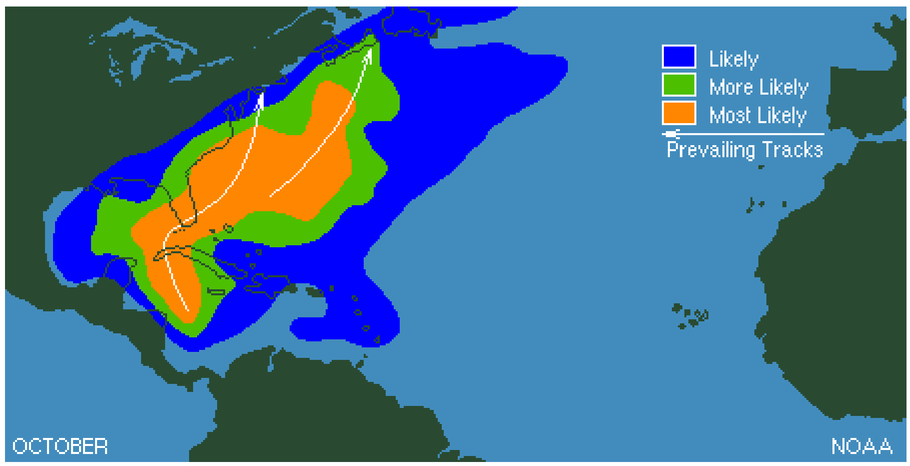


Figure II-12

Prevailing Tracks - September

Figure II-13

Prevailing Tracks - October



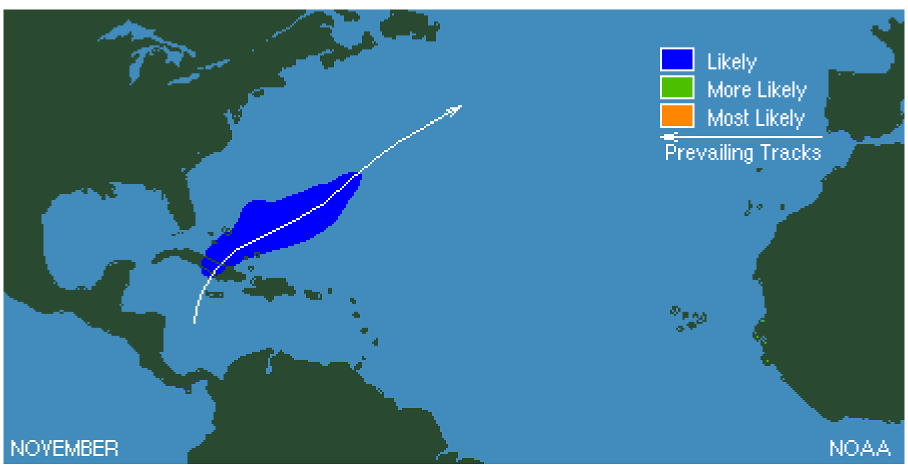


Figure II-14

Prevailing Tracks - November

b. NOAA Historical Analysis for the Region

In the Table below the NHC provides a list of all the tropical storms and hurricanes that have passed within 100 nautical miles of Apalachicola in the Apalachee Bay Region. Using an historical analysis, return intervals were and are presented in Table II-8.

Table II-8
Tropical Storm and Hurricanes within 100NMi of Apalachicola

TROPICAL STORMS AND HURRICANES PASSING WITHIN 100 NMi OF APALACHICOLA 1870-2007

1 STORM INDEX NUMBER	2 STORM NAME	3 YEAR	4 MONTH	5 DAY	6 STORM NUMBER FOR YEAR	7 MAX WIND AT STORM CENTER (SEE NOTES)	8 CPA (CLOSEST POINT OF APPROACH)	9 DDD/SS.S DDD=HEADING SS.S=FORWARD SPEED AT CPA
1	NOT NAMED	1871	AUG	26	4	40(40)	55 (NE)	326/ 7.5
2	NOT NAMED	1871	SEP	6	6	70(70)	82 (SE)	057/ 8.4
3	NOT NAMED	1871	OCT	5	7	62(60)	10 (SSE)	062/ 8.8
4	NOT NAMED	1873	SEP	19	3	70(70)	22 (SE)	044/21.7
5	NOT NAMED	1875	SEP	27	4	50(46)	40 (NNW)	056/ 9.3
6	NOT NAMED	1877	SEP	20	2	70(55)	61 (N)	081/11.4
7	NOT NAMED	1877	OCT	3	4	100(95)	28 (NW)	045/ 7.9
8	NOT NAMED	1877	OCT	26	7	40(40)	43 (S)	080/24.9
9	NOT NAMED	1878	OCT	10	8	50(50)	20 (NNW)	061/28.1
10	NOT NAMED	1879	OCT	16	6	50(50)	58 (WSW)	328/13.9
11	NOT NAMED	1880	AUG	31	4	70(70)	4 (NNE)	296/ 9.2
12	NOT NAMED	1880	SEP	8	6	50(50)	56 (SE)	042/19.2
13	NOT NAMED	1882	SEP	10	2	100(93)	97 (NW)	039/13.9
14	NOT NAMED	1882	OCT	11	6	70(70)	82 (ESE)	027/ 8.1
15	NOT NAMED	1885	AUG	31	3	50(48)	34 (NNW)	071/18.3
16	NOT NAMED	1885	SEP	21	4	50(48)	25 (NNW)	075/25.0
17	NOT NAMED	1885	OCT	11	8	60(60)	92 (ESE)	020/15.0
18	NOT NAMED	1886	JUN	21	2	85(85)	49 (E)	003/14.0
19	NOT NAMED	1886	JUN	30	3	85(85)	7 (NW)	043/21.1
20	NOT NAMED	1887	JUL	27	4	75(75)	92 (WNW)	024/10.9
21	NOT NAMED	1888	OCT	10	7	95(95)	95 (SE)	040/17.4
22	NOT NAMED	1893	JUN	15	1	60(60)	40 (SE)	048/22.4
23	NOT NAMED	1894	OCT	9	5	105(105)	39 (NW)	054/17.1
24	NOT NAMED	1896	JUL	7	1	85(85)	87 (NW)	034/11.5
25	NOT NAMED	1898	AUG	3	1	70(70)	7 (NE)	311/13.1
26	NOT NAMED	1899	AUG	1	2	85(85)	11 (ENE)	330/ 6.3
27	NOT NAMED	1900	OCT	11	6	40(40)	44 (SSE)	070/22.1
28	NOT NAMED	1901	JUN	13	1	35(35)	19 (E)	355/10.0
29	NOT NAMED	1901	SEP	17	7	50(48)	93 (NW)	040/17.9
30	NOT NAMED	1901	SEP	28	9	40(40)	20 (E)	005/18.1
31	NOT NAMED	1902	JUN	14	1	50(50)	65 (ESE)	015/10.3
32	NOT NAMED	1903	SEP	13	3	80(80)	20 (WSW)	332/ 8.1
33	NOT NAMED	1904	NOV	3	5	35(33)	79 (NNW)	058/19.2
34	NOT NAMED	1906	JUN	12	1	45(45)	32 (W)	359/11.0
35	NOT NAMED	1907	JUN	29	1	50(48)	46 (NNW)	076/20.4
36	NOT NAMED	1907	SEP	28	3	45(45)	42 (NNW)	056/23.8
37	NOT NAMED	1909	JUN	30	3	35(30)	46 (NE)	317/ 2.6
38	NOT NAMED	1911	AUG	11	2	70(64)	64 (SW)	313/ 5.9
39	NOT NAMED	1912	JUL	16	2	34(33)	95 (N)	270/12.5
40	NOT NAMED	1912	SEP	11	4	74(50)	43 (S)	266/ 1.8
41	NOT NAMED	1914	SEP	18	1	35(35)	85 (NNW)	255/13.9
42	NOT NAMED	1915	SEP	4	4	80(80)	20 (W)	355/15.2
43	NOT NAMED	1917	SEP	29	4	100(81)	88 (NW)	048/10.4
44	NOT NAMED	1919	JUL	4	1	55(55)	97 (W)	355/ 8.1
45	NOT NAMED	1920	SEP	30	5	55(55)	95 (SSE)	063/26.1
46	NOT NAMED	1924	SEP	15	4	68(54)	43 (NNW)	063/ 6.8
47	NOT NAMED	1924	SEP	29	5	50(50)	54 (SE)	040/27.3
48	NOT NAMED	1926	SEP	20	6	115(110)	62 (WSW)	329/ 6.2
49	NOT NAMED	1928	AUG	10	1	35(35)	70 (NE)	320/ 7.3
50	NOT NAMED	1928	AUG	14	2	50(45)	16 (ENE)	335/10.0
51	NOT NAMED	1929	SEP	30	2	92(86)	14 (WSW)	344/ 6.6
52	NOT NAMED	1932	AUG	31	3	70(70)	78 (SW)	310/12.5
53	NOT NAMED	1932	SEP	15	5	45(45)	32 (SSE)	064/22.7
54	NOT NAMED	1933	AUG	20	6	40(40)	51 (E)	006/ 9.1
55	NOT NAMED	1933	SEP	5	12	45(44)	84 (ENE)	345/ 5.0
56	NOT NAMED	1934	JUL	23	3	40(40)	72 (S)	261/13.3
57	NOT NAMED	1935	SEP	4	2	80(75)	79 (E)	007/ 9.2
58	NOT NAMED	1936	JUL	31	5	100(83)	46 (SW)	324/ 9.1
59	NOT NAMED	1936	AUG	22	9	34(29)	37 (N)	276/13.9
60	NOT NAMED	1937	AUG	31	3	34(30)	38 (NNE)	291/10.3

NOTES:
Datetimes are UTC, winds are in knots and distances are in nautical miles (nmi). Directions in column 8 refer to bearing of storm from site at the closest point of approach (CPA). Two winds are listed in column 7. First is the maximum wind anywhere within the 100 nmi scan radius. Second (in parenthesis) is the maximum wind at CPA. If this is <34 kts, it is treated as a weak tropical storm (34kts) in tables and charts. Site location (degs and degs/100) is 29.72N 84.99W.

CHART 1A (Page 1)

Table II-8 (continued)

TROPICAL STORMS AND HURRICANES PASSING WITHIN 100 NMi OF APALACHICOLA 1870-2007

1 STORM INDEX NUMBER	2 STORM NAME	3 YEAR	4 MONTH	5 DAY	6 STORM NUMBER FOR YEAR	7 MAX WIND AT STORM CENTER (SEE NOTES)	8 CPA (CLOSEST POINT OF APPROACH)	9 DDD/SS.S DDD=HEADING SS.S=FORWARD SPEED AT CPA
61	NOT NAMED	1937	SEP	20	6	40(40)	13 (S)	089/ 5.2
62	NOT NAMED	1938	OCT	24	7	40(40)	43 (SSE)	057/40.6
63	NOT NAMED	1939	AUG	13	2	70(70)	1 (NNE)	300/ 8.0
64	NOT NAMED	1941	OCT	7	5	85(85)	16 (E)	356/11.1
65	NOT NAMED	1941	OCT	20	6	45(44)	75 (SE)	037/ 5.4
66	NOT NAMED	1947	SEP	7	5	40(40)	87 (SW)	308/17.9
67	NOT NAMED	1948	JUL	9	2	35(35)	68 (WNW)	031/ 6.5
68	EASY	1950	SEP	4	5	110(110)	100 (SSE)	249/13.6
69	LOVE	1950	OCT	21	13	60(60)	97 (ESE)	026/18.1
70	ALICE	1953	JUN	6	1	60(38)	42 (W)	360/ 7.7
71	NOT NAMED	1953	SEP	20	7	60(52)	11 (SSE)	074/ 7.2
72	FLORENCE	1953	SEP	26	8	82(65)	65 (NNW)	061/10.8
73	FLOSSY	1956	SEP	25	7	70(44)	67 (NNW)	067/11.4
74	NOT NAMED	1957	JUN	8	1	35(35)	14 (SE)	044/24.4
75	DEBBIE	1957	SEP	8	5	35(35)	78 (NW)	045/ 9.9
76	DORA	1964	SEP	11	6	78(48)	51 (NE)	310/ 5.4
77	HILDA	1964	OCT	5	10	43(38)	56 (NNW)	073/14.3
78	NOT NAMED	1965	JUN	15	1	45(45)	66 (NW)	046/20.9
79	ALMA	1966	JUN	9	1	87(80)	20 (ESE)	017/ 8.3
80	SUBTROP	1969	OCT	1	12	37(30)	78 (W)	001/15.0
81	BECKY	1970	JUL	22	2	44(40)	10 (WNW)	026/ 7.8
82	AGNES	1972	JUN	19	2	75(65)	28 (WNW)	020/ 9.7
83	ELOISE	1975	SEP	23	5	110(110)	74 (WNW)	017/24.3
84	SUBTROP	1976	MAY	23	1	40(40)	26 (SE)	054/21.7
85	ELENA	1985	SEP	1	5	110(110)	39 (SSW)	298/10.8
86	KATE	1985	NOV	21	11	92(83)	24 (NW)	044/13.2
87	ALBERTO	1994	JUL	3	1	55(55)	86 (WNW)	026/ 8.7
88	BERYL	1994	AUG	15	2	50(37)	31 (W)	354/ 1.7
89	ALLISON	1995	JUN	5	1	62(60)	17 (SE)	035/13.5
90	ERIN	1995	AUG	3	5	80(68)	41 (SSW)	301/10.1
91	JOSEPHINE	1996	OCT	8	10	60(60)	36 (SE)	050/21.0
92	EARL	1998	SEP	3	5	80(66)	40 (NW)	052/18.9
93	GORDON	2000	SEP	18	11	56(55)	95 (ESE)	021/ 9.7
94	HELENE	2000	SEP	22	12	38(33)	94 (NW)	040/15.2
95	BARRY	2001	AUG	6	3	60(60)	68 (W)	360/11.0
96	HENRI	2003	AUG	5	12	50(48)	94 (SSE)	062/ 2.3
97	BONNIE	2004	AUG	12	2	45(38)	4 (SSE)	057/21.8
98	FRANCES	2004	SEP	6	6	55(50)	56 (ENE)	335/ 9.8
99	JEANNE	2004	SEP	27	10	42(38)	87 (ENE)	329/11.3
100	DENNIS	2005	JUL	10	4	118(115)	90 (WSW)	340/15.0
101	ALBERTO	2006	JUN	13	1	59(47)	48 (ESE)	023/ 7.4

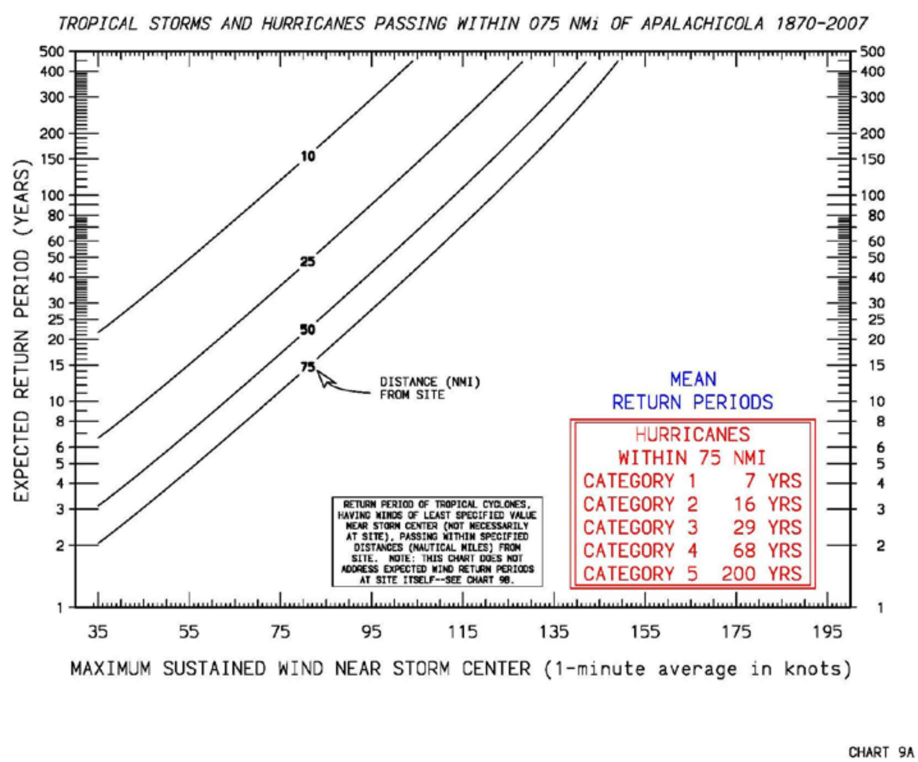
NOTES:
Datetimes are UTC, winds are in knots and distances are in nautical miles (nmi). Directions in column 8 refer to bearing of storm from site at the closest point of approach (CPA). Two winds are listed in column 7. First is the maximum wind anywhere within the 100 nmi scan radius. Second (in parenthesis) is the maximum wind at CPA. If this is <34 kts, it is treated as a weak tropical storm (34kts) in tables and charts. Site location (degs and degs/100) is 29.72N 84.99W.

CHART 1A (Page 2)

Table II-9
Summary for Hurricanes and Tropical Storms

Number of Years: 137
Number of Hurricanes and Tropical Storms: 70
Mean Number of Occurrences per Year 0.51
Mean Recurrence Interval: 1.96 Years

Figure II-15
Hurricane Return Intervals for Apalchicola



C. Freshwater Flooding: The 100 Year Flood Plain

1. Inland / Riverine Flooding Profile

Flooding refers to the *general or temporary conditions of partial or complete inundation of normally dry land areas by surface water runoff from any source* (*Statewide Hazard Mitigation Plan*, 2009). The State of Florida and the Apalachee Bay Region are affected by a large number of weather systems which result in flooding.

Flooding can be divided into two major categories: coastal and riverine. As indicated previously, interrelated hazards, such as hurricanes and severe storms, can result in both types of flooding, sometimes in difference locations. Many areas of Florida are susceptible to flooding from both storm surge and watershed runoff.

Coastal flooding is usually the result of a severe weather system such as a tropical cyclone, hurricane, tropical storm or “northeaster” which contains the element of wind. The damaging effects of coastal floods are caused by a combination of higher water levels of the storm surge, the winds, rains, erosion and battering by debris. Loss of life and property damage are often more severe since it involves velocity wave action and accompanying winds.

Riverine flooding is associated with a river’s watershed, which is the natural drainage basin that conveys water runoff from rain. Riverine flooding occurs when the flow of runoff is greater than the carrying capacities of the natural drainage systems. Rainwater that is not absorbed by soil or vegetation seeks surface drainage lines following natural topography lines. These lines merge to form a hierarchical system of rills, creeks, streams and rivers. Generally, floods can be slow or fast rising depending on the size of the river or stream. The rivers in north Florida drain portions of Alabama and Georgia and excessive rainfall in those states often causes flood conditions in Florida.

Flash floods are much more dangerous and flow much faster than riverine floods. They can result from tropical storms, dam failures or excessive rain and snow. Flash floods pose more significant safety risks because of the rapid onset, the high water velocity, the potential for channel scour and the debris load.

The variations of flooding including severe thunderstorms, hurricanes, seasonal rain and other weather related conditions are a natural part of the earth’s hydrologic system; however, when buildings and infrastructure are constructed within the natural drainage system, there are significant losses. Based on frequency, floods are the most destructive category of natural hazards in the United States. The loss of life, property, crops, business facilities, utilities and transportation are major impacts of flooding. Economic losses from impacts to major transportation routes and modes, public health and other environmental hazards are key factors in long-term recovery. (*Statewide Hazard Mitigation Plan*, 2009)

2. Probability of Flooding: FIRM Maps

The probability of freshwater flooding has been quantified by the Federal Emergency Management Agency (FEMA) through the National Flood Insurance Program (NFIP). Areas subject to flooding, the Velocity Zone, 100-year flood plain and the 500-year floodplain, have been delineated on Flood Insurance Rate Maps (FIRMs) for every jurisdiction in the region. Moderate to low risk areas include zones B, C and X. High risk areas include zones A, AE, AH, AO, and AR. High risk coastal areas include the Velocity zones (Zones V, VE, V1-V30 and undetermined risk areas (Zone D).

Table II-10
Definitions of NFIP Zones

AE Areas with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. In most instances base flood elevations (BFEs) derived from detailed analyses are shown at selected intervals within these zones.

X500 An area inundated by 500-year flooding; an area inundated by 100-year flooding with average depths of less than 1 foot or with drainage areas less than 1 square mile; or an area protected by levees from the 100-year flooding.

X Areas outside the 1-% annual chance floodplain, areas of 1% annual chance sheet flow flooding where average depths are less than 1 foot, areas of 1% annual chance stream flooding where the contributing drainage area is less than 1 square mile, or areas protected from the 1% annual chance flood by levees. No Base Flood Elevations or depths are shown within this zone. Insurance purchase is not required in these zones.

A Flood zone area with a 1% annual chance of flooding and a 26% chance of flooding over the life of a 30-year mortgage. Because detailed analyses are not performed for such areas, no depths of base flood elevations are shown within these zones.

ANI An area that is located within a community or county that is not mapped on any published FIRM.

IN An area designated as within a “Special Flood Hazard Area” (of SFHA) on a FIRM. This is an area inundated by 100-year flooding for which no BFEs or velocity may have been determined. No distinctions are made between the different flood hazard zones that may be included within the SFHA. These may include Zones A, AE, AO, AH, AR, A99, V, or VE.

VE Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.

UNDES A body of open water, such as a pond, lake, ocean, etc., located within a community’s jurisdictional limits that has no defined flood hazard.

AO River or stream flood hazard areas and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These areas

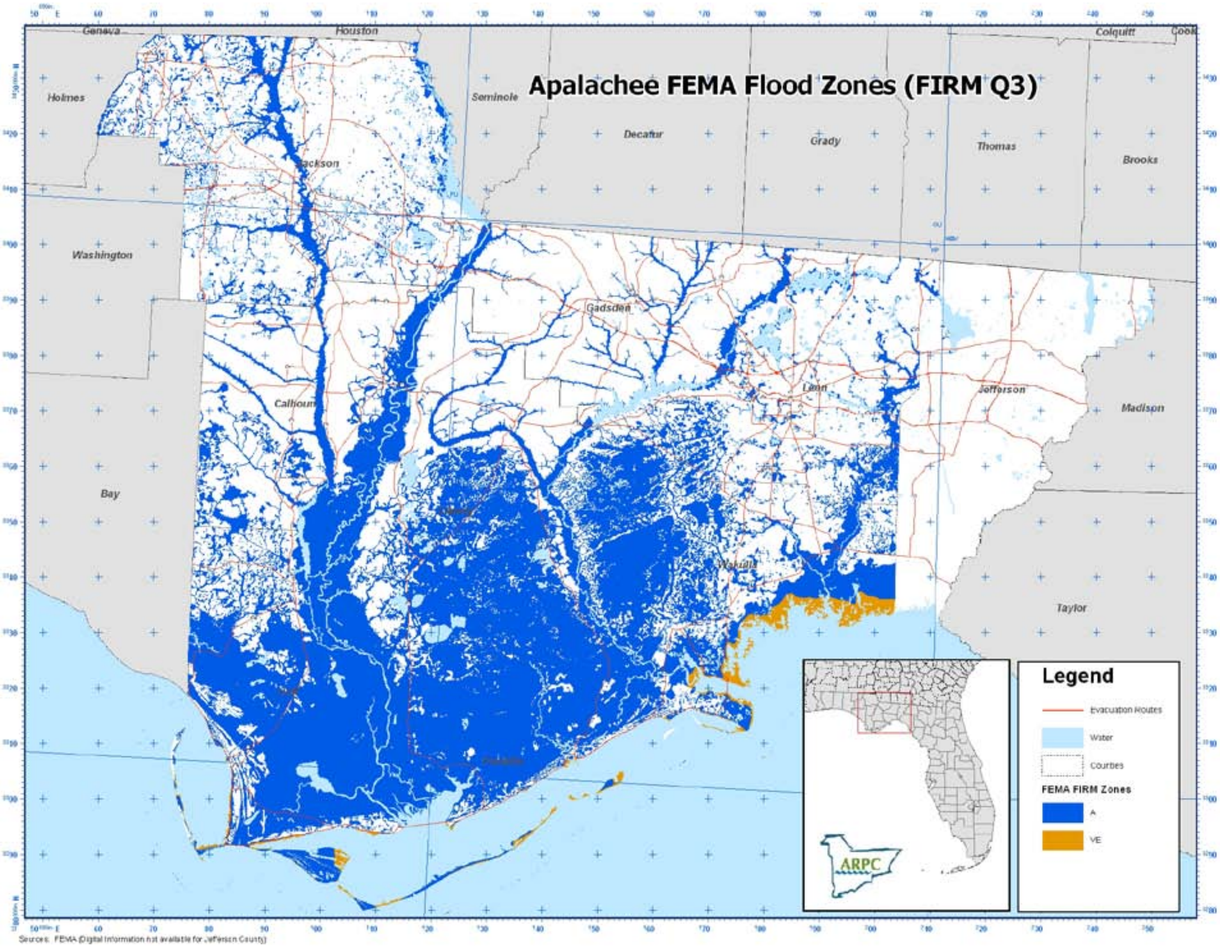
	have a 26% chance of flooding over the life of a 30-year mortgage. Average flood depths derived from detailed analyses are shown within these zones.
D	Areas with possible but undetermined flood hazards. No flood hazard analysis has been conducted. Flood insurance rates are commensurate with the uncertainty of the flood risk.
AH	Areas with a 1% annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over the life of a 30-year mortgage. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
V	Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over the life of a 30-year mortgage. No base flood elevations are shown within these zones.
100IC	An area where the 100-year flooding is contained within the channel banks and the channel is too narrow to show to scale. An arbitrary channel width of 3 meters is shown. BFEs are not shown in this area, although they may be reflected on the corresponding profile.

The model used to determine the flood plain, like the SLOSH MEOWs or MOMs and the Inland Wind model, is a cumulative model. In other words, it is based on several storm events; no one storm will inundate all the areas within the flood zone. In addition, because there is a return interval (1% or greater chance of flooding in any given year) associated with the flood level, there is a basis for planning and cost-benefit analysis.

While the 6-12 inches of rain typically associated with a hurricane is not considered life-threatening, freshwater flooding along rivers and streams can and does cause significant property damage and has the potential of causing personal injury and deaths. Hurricane Floyd (September 1999) caused billions of dollars in property damage in North Carolina alone. Over the past two decades, freshwater flooding has become a leading cause of death in hurricane events with most of those deaths the result of driving or walking in flood waters.

In order to identify the potential magnitude of inland flooding, the 100-year flood plain was delineated using FEMA's most recent digital files. County maps illustrating the 100-year flood plain are presented in the county appendices of Chapter IV of the Technical Data Report. Within the flood zone it is recognized that there are properties which have sustained repeated damage from flooding and are extremely susceptible to flood damage. These local neighborhoods should be warned prior to hurricane events that flooding is very probable.

Figure II-16
Apalachee FIRM Q3



The total acreage within the floodplain by county is presented below. It was calculated using the total acreage as determined by the Soil Conservation Service and the FEMA FIRM Maps as of 2009.

Table II-11
Floodplain Acreage by County
Apalachee Bay Region

County	Total Acreage	Floodplain Acreage	Percentage in Floodplain
Calhoun	367,574	106,323	29%
Franklin	663,985	312,125	47%
Gadsden	338,230	37,921	11%
Gulf	476,540	273,303	57%
Jackson	610,932	120,173	20%
Leon	407,454	121,183	30%
Liberty	539,621	316,282	58%
Wakulla	470,873	218,404	46%

Source: U.S. Census Bureau (Total Acreage); FEMA

3. Dam Failure

A flood event may also trigger a dam failure. The dam impounds water in the reservoir or upstream area. The amount of water impounded is measured in acre-feet.[7] Dam failures are not routine but the results can be significant. Two factors influence the potential severity of a dam failure: (1) the amount of water impounded and (2) the density, type and value of the development downstream. (Statewide Hazard Mitigation Plan, 2009)

The "dam hazard" is a term indicating the potential hazard to the downstream area resulting from failure or mis-operation of the dam or facilities. According to the USGS National Inventory of Dams, there are 149 major dams in the state of Florida which have been identified by a hazard risk of low, significant and high.

- Low hazard: A dam where failure or mis-operation results in no probable loss of human life and low economic and/or environmental loss. Losses are principally limited to the owner's property.
- Significant hazard: A dam where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities or impact other concerns. These dams are often located in predominantly rural or agricultural area but could be located in areas with population and significant infrastructure.
- High – A dam where failure or mis-operation will probably cause loss of human life. (*Statewide Hazard Mitigation Plan, 2009)*

Table II-12
Dams in the Apalachee Bay Region

DAM NAME	NIDID	LONG.	LAT.	COUNTY	RIVER	HAZARD [8]
Jim Woodruff Dam	FL00280	-84.86	30.71	Gadsden	Apalachicola River	H
Jackson Bluff Dam	FL00108	-84.65	30.38	Leon	Ochlockonee River	H

Source: US Army Corps of Engineers, (2009)

4. History of Inland Flooding

Based on data collected by the National Climatic Data Center (NCDC), there were 993 flooding events in Florida between 1950 and 2009, for an average of 16.83 flooding events per year. Total property damages were estimated at $1.43 billion with an additional $972.01M in crop related damages. (**www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms**)

Below is a summary of the major flooding events in the Apalachee Bay Region from 1994 - 2008.

[7] An acre-foot of water is the volume that covers an acre of land to the depth of one foot.
[8] Hazard Reference: H= High, S=Significant, L=Low

July 1994, Tropical Storm Alberto: Flood crests on the Apalachicola River exceeded 100-year events from the six to 14 inches of rainfall associated with Tropical Storm Alberto. The flooding caused 3,000 people in the panhandle to evacuate and cost more than $75 million in damages to public and private properties and the agriculture industry including 90% of the oysters in Apalachicola Bay.

March 1998, Flooding/El Nino: In 1998, the inland flood caused an overall property damage estimated at $367 million. In Calhoun County, 28 county roads and State Road 69 were closed due to flooding. Approximately 400 homes and businesses sustained flood damage. The Chipola River at Altha crested near 31.2 feet on March 14, 1998. The Apalachicola River at Blountstown crested near 27.2 feet (the third highest crest) on March 13, 1998. In Franklin County, rising waters along the Apalachicola River flooded 40 to 50 homes near Fort Gadsden and Bay City. In Gadsden County, floodwaters closed State Road 12 near Concord. In Gulf County, nearly 600 homes sustained flood damage and more than 60 county and secondary roads were closed where water was four feet deep in some places. More than 2,000 people were evacuated. Howard Creek (pop. 400) experienced the worst flooding. In Jackson County, 75 to 100 families fled floodwaters as the Chipola River overflowed its banks. An estimated 140 residences were damaged and 40 roads were closed. The worst flooding was along State Highway 2 near Campbellton. The Chipola River at Marianna crested near 24.1 feet on March 11.

March 2003, Flooding: Periods of heavy rainfall, which ranged from three to six inches in Leon County to 14 inches in Taylor County, flooded many roads, homes and area with poor drainage. Residents along the Munson Slough in northern Wakulla County were forced to evacuate as floodwaters seeped into their homes. Some residents along the swollen Apalachicola and Ochlockonee Rivers in Liberty County experienced minor flooding. Local states of emergencies were declared in Leon, Wakulla and Liberty counties. Total property damages were estimated at $1 million.

April 2005, Flash Floods: Five to ten inches of rain over a few days combined with significant rainfall amounts upstream, caused severe flooding along the Apalachicola River and nearby low-lying areas. Forty to fifty roads throughout the area were closed due to high water and many residents along Lake Grove Road were adversely affected as reservoirs, creeks and streams surged above their banks. The affected communities had damages totaling $5 million and one hundred and fifty residences were damaged by flood waters.

August, 2008, Tropical Storm Fay: This storm made its fourth and final landfall in Florida near Carrabelle. Rainfall amounts exceeded 24 inches in some locations and severe flooding occurred throughout the Apalachee Bay region. Calhoun, Gulf, Jefferson, Leon, Liberty and Wakulla counties were deemed eligible for Public Assistance by FEMA. In totality, TS Fay caused $195 million in damages in Florida alone.

5. Repetitive Loss Areas

The location of repetitive loss structures[9] helps to identify specific areas in the community where flooding continues to be a problem and where mitigation efforts should be concentrated. For many of these flood-prone areas, mitigation will involve significant property owner investment and will probably be delayed until redevelopment/ reconstruction occurs. New construction or significant remodeling will require adherence to current floodplain management regulations. In regards to evacuation planning, these areas are important to consider as they represent the most vulnerable areas subject to flooding from significant rainfall and minor tropical storm activity. In addition, these areas may not be coastal or reside in hurricane evacuation areas. Therefore, the residents in these areas may constitute additional evacuation impacts.

The repetitive loss properties and repetitive loss areas are addressed in the Local Mitigation Plans (LMSs). A breakdown of the properties by structure type is provided in the table below.

Table II-13
Repetitive Loss Properties

Community Name	Repetitive Loss Structures	SF	2-4 Family	Other Res	Condo Assoc.	Non-Res.
Blountstown	8	8	0	0	0	0
Calhoun County	20	20	0	0	0	0
Apalachicola	6	3	0	0	0	3
Carrabelle	6	2	0	0	2	2
Franklin County	409	325	16	6	9	53
Gadsden County	4	4	0	0	0	0
Port St. Joe	30	28	0	0	2	0
Wewahitchka	8	8	0	0	0	0
Gulf County	130	104	2	0	0	14
Tallahassee	170	101	16	7	0	46
Leon County	65	60	3	0	0	2
St. Marks	87	27	0	0	3	57
Wakulla County	336	307	3	0	12	14

Source: Florida Division of Emergency Management, NFIP (Numbers based on latest Repetitive Loss List dated 03/31/10)

[9] A "repetitive-loss property" is one that has suffered two or more flood losses over 10 years with the cumulative cost of repairs equaling or exceeding 50 percent of the value of the structure. Increased Cost of Compliance for repetitive-loss structures is available only in communities that have repetitive-loss provisions in their floodplain-management ordinances and track repetitive-loss damages.

D. Wildfires and the Urban Interface

Florida is home to millions of residents who enjoy the state's beautiful scenery and warm climate. But few people realize that these qualities also create severe wildfire conditions. Each year, thousands of acres of wildland and many homes are destroyed by fires that can erupt at any time of the year from a variety of causes, including arson, lightning and debris burning. Adding to the fire hazard is the growing number of people living in new communities built in areas that were once wildland. This growth places even greater pressure on the state's wildland firefighters. As a result of this growth, fire protection becomes everyone's responsibility (Florida Division of Emergency Management, 2008 http://www.floridadisaster.org/ bpr/EMTOOLS/wildfire/wildfire.htm)

1. Wildfire Hazard Profile

A wildfire is any fire occurring in the wildlands (i.e., grasslands, forest, brushland, etc). Wildfires have burned across the woodlands of Florida for centuries and are part of the natural management of much of Florida's ecosystems (Statewide Hazard Mitigation Plan, 2009). There are four types of forest fires:

- Surface fires are the most common type of wildfire burns along the floor of the forest, moving slowly killing or damaging trees.
- Ground fires (muck fires) are usually started by carelessness, burn on or below the forest floor. These fires are hard to detect and even harder to extinguish.
- Crown fires are spread rapidly by the wind and move fastest of all types of fires by jumping along the tops of trees.
- Wildland-Urban Interface (WUI) fires are in a geographical area where structures and other human development meet or intermingle with wildlands or vegetative fuels.

Florida's typical fire season is from January to May. During relatively dry months the potential for wildfires increases dramatically. The driest months, combined with low humidity and high wind, have the highest number of fires reported (January, February and March). During these months, fine fuels (i.e., grass, leaves, pine needles) are in optimal burning condition. The largest number of fires caused by lighting occurs in July coinciding with the peak of the thunderstorm season.

Each wildfire, especially near development, can threaten human life, structures and natural resources. Urban development has moved into wildland areas where the hazard is more severe and fire control is more difficult.

2. History of Wildfire in the Region

Florida's typical forest fire season is the dry portion of the year between January and May. The largest number of naturally caused fires occurs in July due to lightning and coincides with the height of the thunderstorm season. However, lightning accounts for only 11.7% of the fires started during 1974 - 1990. Other sources are manmade, including arson, carelessness, debris/trash burning, and operating equipment which may emit sparks. Because so much of the region is comprised of timber lands, a major portion of the region is vulnerable to forest fires, although the threat to the population at large is not considered significant.

From 1981 through 1996, an average of 6,080 wildfires occurred per year, burning 219,725 acres. Because of changing weather conditions, the yearly figures range from a low of 3,985 wildfires (86,944 acres burned) in 1991 to a record high of 14,042 wildfires (587,400 acres burned) in 1981. Florida experienced a record high (645,326 acres burned) in 1989 as a result of drought conditions around the state.

The beginning months of 1998 brought widespread flooding. After the rain stopped severe drought conditions developed and lasted from April through June of 1998. As a result of the extreme drought conditions, high temperatures and buildup of flammable wildland fuels, the 1998 wildfires began. The first fire broke out on May 25th in the Apalachicola National Forest. In a two-month period almost 500,000 acres of the state had burned in approximately 2,300 separate wildfires. The cost of this event reached over $160 million. The wildfires of 1998 damaged or destroyed over 300 homes and the value of lost timber exceeded $300 million.

Spring/Summer 2007 - The wildfires that put much of Florida in a several weeks-long smoky haze were started May 5 by a lightning strike on Bugaboo Island in Georgia's Okefenokee National Wildlife Refuge. Thick smoke from area wildfires forced officials to close stretches of I-75 and I-10 in northern Florida. A section of I-95 in Duval County, from Pecan Park to State Road A1A, was also closed due to smoke, as was a section of I-75 in Broward County near fire-ravaged Collier County in southern Florida. The fires scorched at least 212,000 acres, according to the joint information center, a coalition of state and federal agencies. Of those acres, 101,000 were in Florida and about 111,000 were in Georgia. Interstate 75 was closed from Valdosta, Georgia south to Lake City, Florida and Interstate 10 was closed from Sanderson, Florida, eastward to Live Oak.

June 2007 – The Florida Division of Forestry produced the map below to show the active wildfires in the state. There were 17 wildfires burning with over 300 acres and a much larger number of smaller fires.

3. Wildland-Urban Interface (WUI)

The Florida Division of Forestry (DOF) provides risk maps for wildfire. The web-based risk system produces maps for Level of Concern (LOC), Fuels, Wildland Fire Susceptibility Index (WFSI), and the likelihood of the number of fires per 1000 acres per year (FOA). Unfortunately, the website does not offer a vulnerability output in terms of dollars lost and the data was last updated in 2005. Data layers are in the process of being updated and for the release of DOF's new web-based mapping risk assessment program, due out in late 2009 or early 2010.

a. Methodology

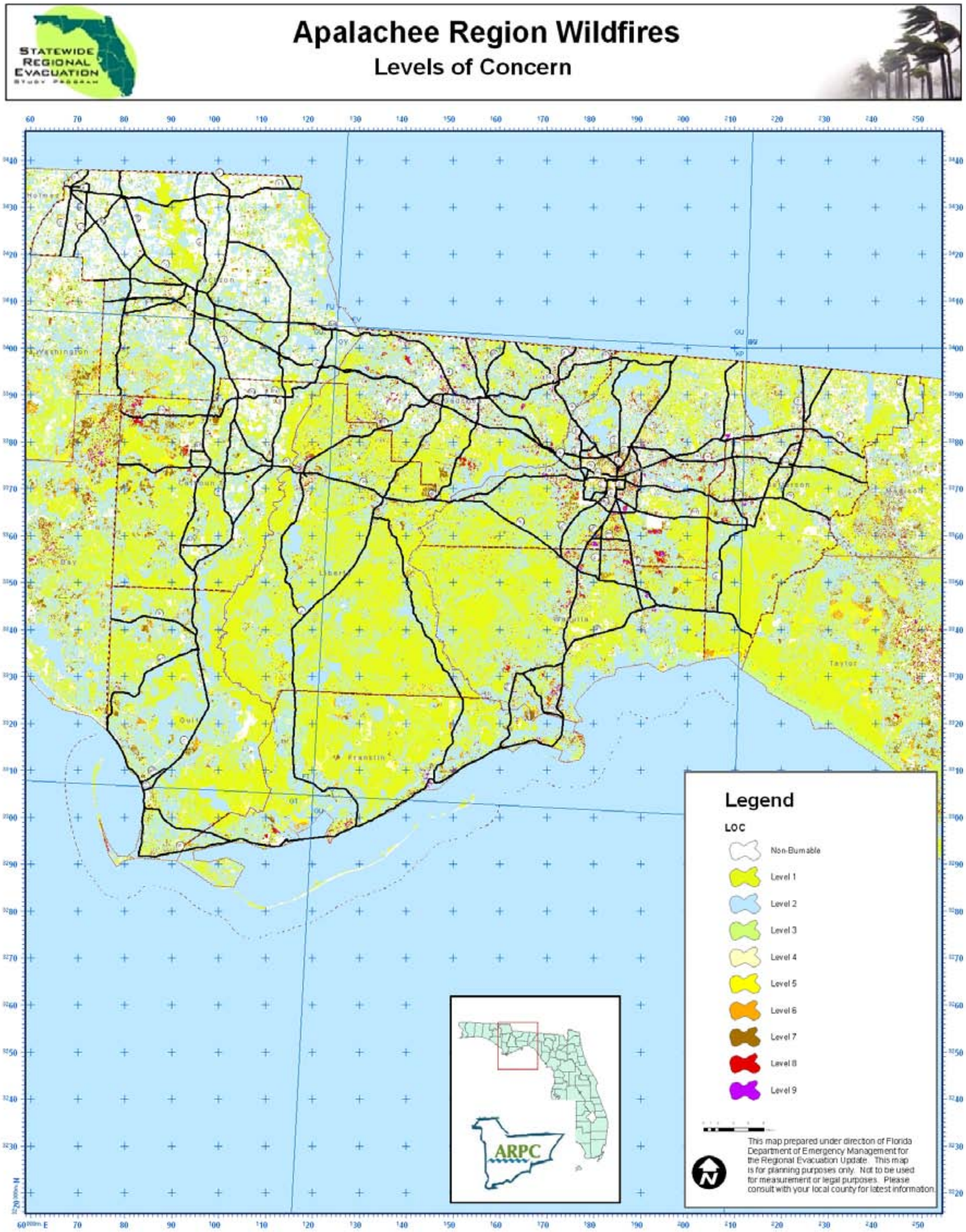
The Wildland Fire Risk Assessment System (FRAS) combines indices of Wildland Fire Susceptibility and Fire Effects to generate a "Level of Concern" map. Data layers used to develop the Wildland Fire Susceptibility Index include: fuel and crown closure classifications and non-burnable areas from Landsat TM data, and topographic and fire weather data from existing data sets.

The Fire Effects Index uses data layers derived from a variety of existing data sets. These data included location of critical facilities, forest plantations, utility corridors, urban interface areas, roads, and firefighting resource locations; as well as, suppression cost--based on soil and fuel types. The Levels of Concern (LOC) were computed by multiplying the Wildland Fire Susceptibility Indices by the Fire Effects Indices. The LOC values were then assigned to nine categories of risk and mapped for each Florida Division of Forestry District.

Another component of FRAS is the Fire Response Accessibility Index (FRAI). The FRAI is a relative measure of travel time from the nearest fire station to reach a particular mapped cell. Values are assigned into one of six categories of time ranging from class 1 (greater than 120 minutes) to class 6 (0-14 minutes). Accessibility is based on the location of roads and wildland firefighting resource dispatch stations. The Fire Response Accessibility Index is coupled with the Levels of Concern data on District maps. The fire behavior model, FlamMap is used in FRAS. FlamMap calculates the behavior of a fire occurring in each 30x30 meter cell under defined weather conditions given topographic, fuels, and crown closure data.

Figure II- 17 illustrates the risk for wildfire within the region using the data provided by the Florida Division of Forestry.

Figure II-17
Apalachee Bay Region Levels of Concern



E. Hazardous Materials Incidents

1. Overview

A hazardous material is generally considered as any item or agent (biological, chemical, physical) which has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors. Almost every community deals with hazardous materials on a daily basis through transport, use, storage and/or disposal. The benefits that hazardous materials bring into our lives through their designed uses have become vital to our standard of living. Although major hazardous materials emergencies are extremely rare, there always remains a chance that one will occur. In the State of Florida, the county emergency management agencies plan for hazardous material incidents and coordinate regionally for response through the Local Emergency Planning Committees (LEPCs).

2. History of the Local Emergency Planning Committees (LEPCs)

Public awareness of the potential danger from accidental releases of hazardous materials has increased over the years due to significant chemical accidents that have occurred around the world. Two major accidents, including a significant release in Bhopal, India in 1984 which killed thousands and a more localized event in Institute, West Virginia became the impetus for eventual legislative reform. In response to mounting public concern to the dangers of hazardous materials, EPA began its Chemical Emergency Preparedness Program (CEPP) in 1985. CEPP was a voluntary program to encourage state and local authorities to identify hazards within their jurisdictions and to plan for potential hazardous materials releases. This local planning complemented emergency response planning carried out at the national and regional levels by the National Response Team and Regional Response Teams organized by EPA, the U.S. Coast Guard, and the National Oceanic and Atmospheric Administration (NOAA).

The following year Congress enacted many of the elements of CEPP in the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA), also known as Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This law required states to establish State Emergency Response Commissions and Local Emergency Planning Committees to develop emergency response plans for each community. EPCRA also required facilities to make information available to the public on the hazardous chemicals they have on site. EPCRA's reporting requirements foster a valuable dialogue between industry and local communities on hazards to help citizens become more informed about the presence of hazardous chemicals that might affect public health and the environment. According to the Occupational Safety and Health Administration (OSHA) requirements, workers on site also have a right to know about the hazardous chemicals to which they could be exposed.

In Florida the Local Emergency Planning Committees are organized in conjunction with the eleven Regional Planning Councils which provide staff support with funding from the

Florida Division of Emergency Management. The LEPCs assist with the implementation of the EPCRA provisions through hazardous materials planning, training, outreach and exercises. The District II LEPC, which includes the counties of Calhoun, Franklin, Gadsden, Gulf, Jackson, Jefferson, Liberty, Leon and Wakulla counties and their respective municipalities, meets quarterly beginning in January of each year. LEPC membership consists of local professionals representing occupational categories such as firefighting, law enforcement, emergency management, health, and/or transportation.

LEPC members are appointed by the State Emergency Response Commission for Hazardous Materials (SERC), a policy board appointed by the Governor, which administers the hazardous materials laws for the U.S. Environmental Protection Agency (EPA) at the Florida level and at the local level, through the 11 LEPCs statewide. The Chairman of the SERC is the Secretary of the Department of Community Affairs and the Alternate Chairman is the Director of DEM.

3. LEPC Mission Statement

To partner with citizens, facilities, and local emergency management officials to protect communities from the adverse effects of hazardous materials in District II.

To support this goal, the LEPC is committed to the following objectives:

a. The LEPC shall prepare regional hazardous materials emergency plans which indicate the facilities that store, use, or produce hazardous substances at or above established threshold amounts and that are located in the region;

- Data collected is used by the 11 LEPCs for plans used in responding to and recovering from a release or spill of hazardous or toxic substances. These plans are reviewed and updated by the LEPC annually and are approved by DEM on behalf of the SERC.

b. The LEPC shall serve as the repository for regional reports filed under EPCRA;

- In the past, more than 600 facilities within the District 2 LEPC region have reported their chemical inventories of both hazardous and extremely hazardous substances under Sections 311/312 of EPCRA and these reports are available for public review at the LEPC office.

c. The LEPC shall direct regional implementation activities and perform associated outreach functions to increase awareness and understanding of and compliance with the EPCRA as well as the Risk Management Program (RMP).

d. The LEPC shall play an active role in risk communication, public education, industry outreach, mitigation, and emergency planning associated with the Clean Air Act and Risk Management Planning.

4. Section 302 Fixed Facility Hazards Analysis

Any facility, public or private, that has at any given time during the year, extremely hazardous materials at or above established threshold amounts is required to report annually. These facilities are termed 'Section 302' facilities relating to the clause in EPCRA which pertains to Extremely Hazardous Substances facilities. A hazards analysis on the facility is usually performed by the county in which the facility is located. See Figure II-18 for maps showing the general location of Section 302 facilities in the region.

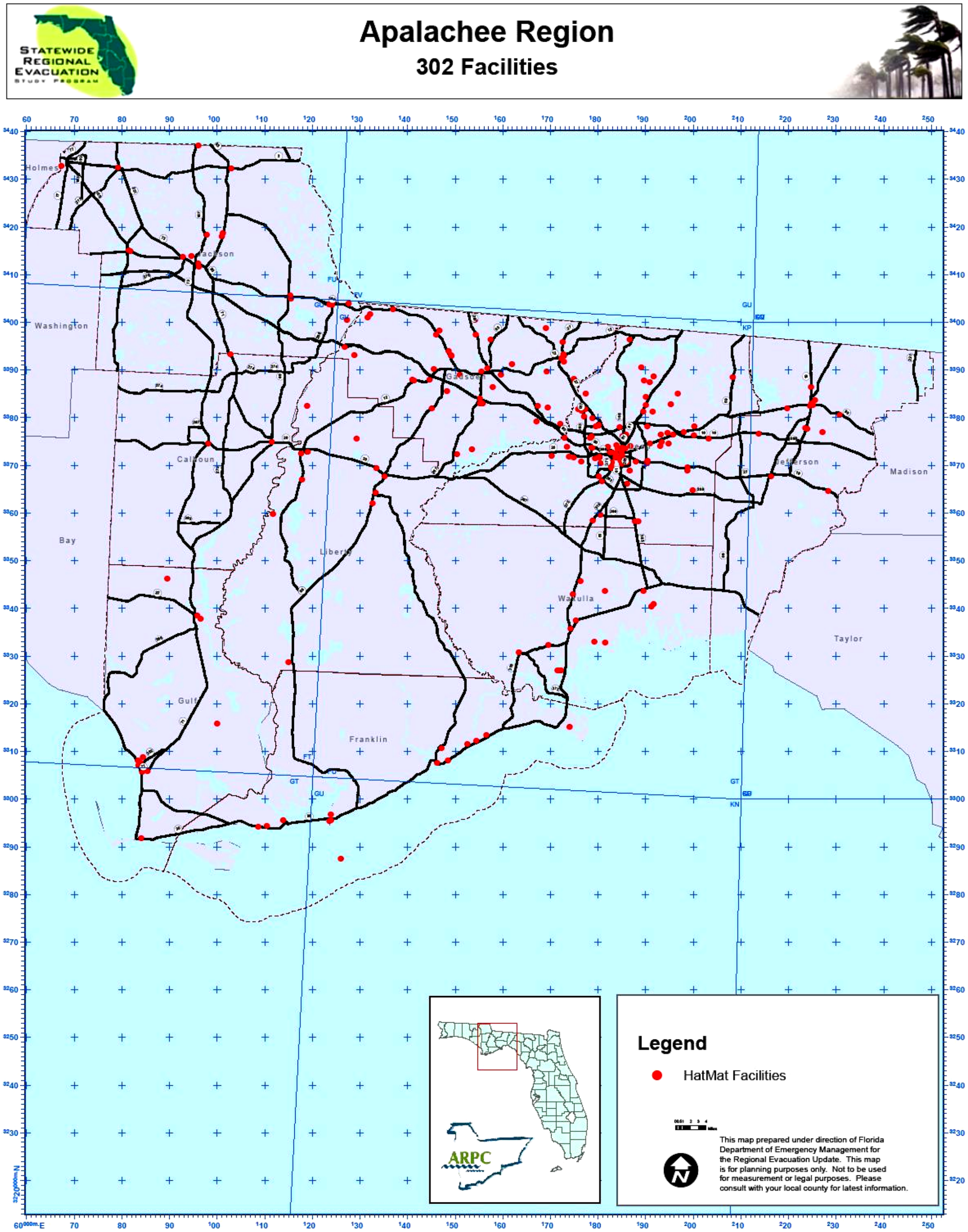
The hazard analysis looks at the amounts of materials present, the risk to the surrounding community and public facilities vulnerable to a potential release such as schools, hospitals, etc. Evacuation routes are determined based on a vulnerable zone radius from a "worst-case" release scenario. In addition, site plans are created to show first responders exactly where the hazardous materials are stored within the facility. The data is entered in a database suite called Computer Aided Management of Emergency Operations (CAMEO). The CAMEO system is a combination of three programs which work independently or in conjunction to give hazardous materials planners and first responders the tools to plan for and respond to hazardous materials releases.

The number of hazardous materials facilities continues to gradually increase as awareness of the law reaches various segments of the public and private sector. Over the years however, EPCRA has been successful in reducing the number of facilities possessing extremely hazardous substances (EHSs) by encouraging the use of safer, alternative products which do not require reporting fees. Within District II, there are 210 Section 302 (EHS) facilities reporting in 2008 and 447 facilities reporting under Sections 311/312.

The hazards analyses summaries for all Section 302 facilities within the District II LEPC area are compiled annually in the update of the Regional Hazardous Materials Emergency Plan as required by the EPCRA provisions. The plan is available upon request through the LEPC staff contact at the Apalachee Regional Planning Council.

In 2008, the District II region had approximately 200 registered Section 302 facilities. These facilities possess less than one percent of the total Section 302 chemicals by weight and volume in the State of Florida. District II had the third lowest number (91) of hazardous material incidents for 2007. However, the majority of these reported incidents were transportation-related and not fixed-facility releases. The top ten reported Section 302 chemicals for 2008 in District II are as follows:

Figure II-18
Section 302 Facilities in the Apalachee Bay Region



Sources: County Planning Department

Table II-14
Top Ten Section 302 Chemicals in the Apalachee Bay Region

Chemical	2008 Maximum Inventory (lbs)	2006 Maximum Inventory (lbs)	Change from 2006	Percent of State-Wide Inventory
Sulfuric Acid	1,809,999	3,109,755	(-) 1,299,756	0. 44%
Chlorine	183,975	182,675	(+) 1,300	0. 89%
Ammonia	176,211	40,221	(+) 135,990	0.054%
Nitric Acid	154,438	154,438	0	0.56%
Phorate	34,400	30,250	(+) 4,150	Not Available
Sulfur Dioxide	14,550	7,050	(+) 7,500	0.54%
Cyclohexanamine	12,000	22,440	(-) 10,440	Not Available
Hydrogen Fluoride	10,000	9,500	(+) 500	Not Available
Aldicarb	9,620	28,850	(-) 19,230	0.42%
Paraquat Dichloride	4,018	Not Available	Not Available	Not Available

Source: SERC for Hazardous Materials, *2006 and 2008 Annual Report*

5. Regional Hazardous Materials Commodity Flow Study

The Section 302 Facility Hazards Analysis discussed in the previous section identifies hazardous materials at fixed facilities, but does not address potential hazards arising from the transportation hazardous materials. LEPCs often perform Regional Hazardous Materials Commodity Flow studies to determine what hazardous materials are being transported through their respective regions. The District II LEPC performed a Regional Hazardous Materials Commodity Flow Study in 2009.

In August of 2009, the District II Local Emergency Planning Committee (LEPC) conducted a transportation flow study of the hazardous materials transported through the region by roadway and rail. Survey data collection occurred over a two-month period throughout the region. Although the original Hazardous Materials Emergency Preparedness (HMEP) scope of work for the project called only for a highway placard survey, the District II LEPC included an analysis of rail data provided by CSX Transportation.

Highway Placard Survey

For the highway placard survey, data was collected and analyzed from over 160 trucks carrying hazardous materials on Interstate 10 and US 90 (East-West routes), and US-19, US-319 and US-231 (North-South routes). During the data collection, it became evident that Interstate 10 is the major corridor by which hazardous materials are transported within the District II region.

It is important to note that the survey represents approximately 75% accuracy of the hazardous materials moving on highways throughout the District II region. Beyond general recording error and survey limitations, there are two reasons for this lack of accuracy. Primarily, trucks are only required to display placards if the hazardous materials meet or exceed the established transport thresholds. A truck carrying hazardous materials cargo may not necessarily display a placard when the cargo is below the federal threshold.

Secondly, trucks are only required to display the placard for the most dangerous hazardous material on board. In these instances, the survey does not reflect the entire hazardous materials inventory for the truck surveyed. Although there may be a variety of hazardous materials loaded together, they are regulated for compatibility under CFR 49, § 177.848 and they generally meet all the packaging criteria in § 172.101

Finally, the placard does not always reveal specific information about the corresponding hazardous material. For example, one placard (1993) indicates any of the following: combustible liquid, cleaning liquid compound, tree/weed killing compound, diesel fuel, flammable liquid not otherwise specified, fuel oil, etc. Unfortunately, there is no way to confirm the actual hazardous material cargo other than reviewing the shipping papers. To compensate for this uncertainty, the survey results were aggregated by the U.S. Department of Transportation's 2008 Emergency Response Guidebook (ERG) general hazards categories.

Analysis of the Transportation of Hazardous Materials by Rail

A hazardous materials density study was performed by CSX Transportation to identify the hazardous materials most frequently transported through the District. CSX rail traverses the region through Gadsden, Jackson, Jefferson, and Leon Counties. The study excludes intermodal shipments (trailer or container on flat cars). Intermodal hazardous materials shipments are non-bulk and less than 55 gallon/package formats. Unlike the Highway Placard Survey, CSX Transportation can accurately track the amounts of hazardous materials cargo by computer.

The table below is a comparison between the Highway Placard Survey and the CSX Density Study. This table allows for a comparison of the most commonly transported hazardous materials by rail and highway and includes the corresponding 2008 ERG Guide Number.

Top 5 Highway & Rail Comparison Summary

Rank	General Hazards Category (Highway Placard Survey)	Guide #	General Hazards Category (CSX Density Study)	Guide #
1.	Flammable Liquids (Non-Polar/Water-Immiscible)	128	Flammable Solids	133
2.	Gases - Flammable (Including Refrigerated Liquids)	115	Substances (Low to Moderate Hazard)	171
3.	Flammable Liquids (Polar/Water-Miscible)	127	Substances - Toxic and/or Corrosive (Non-Combustible)	154
4.	Gases - Inert (Including Refrigerated Liquids)	120	Oxidizers	140
5.	Substances - Toxic and/or Corrosive (Non-Combustible)	154	Gases - Flammable (Including Refrigerated Liquids)	115

The matching shaded areas denote shared general hazard categories for both the Highway Placard Survey and the CSX Density Study.

The comparison reveals that both *Gases – Flammable (Including Refrigerated Liquids)* and *Substances – Toxic and/or Corrosive (Non-Combustible)* are listed in the 'Top 5' for the Highway Placard Survey and the CSX Density Study.

For additional information, please request a copy of the 2009 Hazardous Materials Commodity Flow Study from the District II Local Emergency Planning Committee staff contact.

F. Terrorism and Domestic Security

1. Overview

Terrorism is the use of force or violence against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion, or ransom.

Terrorists often use threats to:

- Create fear among the public.
- Try to convince citizens that their government is powerless to prevent terrorism.
- Get immediate publicity for their causes.

Acts of terrorism include threats of terrorism; assassinations; kidnappings; hijackings; bomb scares and bombings; cyber attacks (computer-based); and the use of chemical, biological, nuclear and radiological weapons.
High-risk targets for acts of terrorism include military and civilian government facilities, international airports, large cities, and high-profile landmarks. Terrorists might also target large public gatherings, water and food supplies, utilities, and corporate centers. Further, terrorists are capable of spreading fear by sending explosives or chemical and biological agents through the mail.

a. Explosions

Terrorists have frequently used explosive devices as one of their most common weapons. Terrorists do not have to look far to find out how to make explosive devices; the information is readily available in books and other information sources. The materials needed for an explosive device can be found in many places including variety, hardware, and auto supply stores. Explosive devices are highly portable using vehicles and humans as a means of transport. They are easily detonated from remote locations or by suicide bombers.

Conventional bombs have been used to damage and destroy financial, political, social, and religious institutions. Attacks have occurred in public places and on city streets with thousands of people around the world injured and killed.

b. Biological Threats

Biological agents are organisms or toxins that can kill or incapacitate people, livestock, and crops. The three basic groups of biological agents that would likely be used as weapons are bacteria, viruses, and toxins. Most biological agents are difficult to grow and maintain. Many break down quickly when exposed to sunlight and other environmental factors, while others, such as anthrax spores, are very long lived. Biological agents can be dispersed by spraying them into the air, by infecting animals that carry the disease to humans and by contaminating food and water. Delivery methods include:

- Aerosols - biological agents are dispersed into the air, forming a fine mist that may drift for miles. Inhaling the agent may cause disease in people or animals.

- Animals - some diseases are spread by insects and animals, such as fleas, mice, flies, mosquitoes, and livestock.

- Food and water contamination - some pathogenic organisms and toxins may persist in food and water supplies. Most microbes can be killed, and toxins deactivated, by cooking food and boiling water. Most microbes are killed by boiling water for one minute, but some require longer.

- Person-to-person - spread of a few infectious agents is also possible. Humans have been the source of infection for smallpox, plague, and the Lassa viruses.

c. Chemical Threats

Chemical agents are poisonous vapors, aerosols, liquids, and solids that have toxic effects on people, animals, or plants. They can be released by bombs or sprayed from aircraft, boats, and vehicles. Some chemical agents may be odorless and tasteless rendering them difficult to detect. They can have an immediate effect (a few seconds to a few minutes) or a delayed effect (2 to 48 hours). While potentially lethal; chemical agents are difficult to deliver in lethal concentrations and difficult to manufacture. Out of doors, the agents often dissipate rapidly.

A chemical attack could come without warning. Signs of a chemical release include people having difficulty breathing; experiencing eye irritation; losing coordination; becoming nauseated; or having a burning sensation in the nose, throat, and lungs. Also, the presence of many dead insects or birds may indicate a chemical agent release.

d. Nuclear Blast

A nuclear blast is an explosion with intense light and heat, a damaging pressure wave, and widespread radioactive material that can contaminate the air, water and ground surfaces for miles around. A nuclear device can range from a weapon carried by an intercontinental missile launched by a hostile nation or terrorist organization, to a small portable nuclear devise transported by an individual. All nuclear devices cause deadly effects when exploded, including blinding light, intense heat (thermal radiation), initial nuclear radiation, blast, fires started by the heat pulse, and secondary fires caused by the destruction.

(1) Hazards of Nuclear Devices

The extent, nature, and arrival time of these hazards are difficult to predict. The geographical dispersion of hazard effects will be defined by the following:

- Size of the device. A more powerful bomb will produce more distant effects.
- Height above the ground the device was detonated. This will determine the extent of blast effects.
- Nature of the surface beneath the explosion. Some materials are more likely to become radioactive and airborne than others. Flat areas are more susceptible to blast effects.
- Existing meteorological conditions. Wind speed and direction will affect arrival time of fallout; precipitation may wash fallout from the atmosphere.

(2) Radioactive Fallout

Even if individuals are not close enough to the nuclear blast to be affected by the direct impacts, they may be affected by radioactive fallout. Any nuclear blast results in some fallout. Blasts that occur near the earth's surface create much greater amounts of fallout than blasts that occur at higher altitudes. This is because the tremendous heat produced from a nuclear blast causes an up-draft of air that forms the familiar mushroom cloud. When a blast occurs near the earth's surface, millions of vaporized dirt particles also are drawn into the cloud. As the heat diminishes, radioactive materials that have vaporized condense on the particles and fall back to Earth. The phenomenon is called radioactive fallout. This fallout material decays over a long period of time and is the main source of residual nuclear radiation.

Fallout from a nuclear explosion may be carried by wind currents for hundreds of miles if the right conditions exist. Effects from even a small portable device exploded at ground level can be potentially deadly. Nuclear radiation cannot be seen, smelled, or otherwise detected by normal senses. Radiation can only be detected by radiation monitoring devices. This makes radiological emergencies different from other types of emergencies, such as floods or hurricanes. Monitoring can project the fallout arrival times; however, any increase in surface build-up of gritty dust and dirt should be a warning for taking protective measures. In addition to other effects, a nuclear weapon detonated in or above the earth's atmosphere can create an electromagnetic pulse (EMP), a high-density electrical field. An EMP acts like a stroke of lightning but is stronger, faster, and shorter. An EMP can seriously damage electronic devices connected to power sources or antennas. This includes communication systems, computers, electrical appliances, and automobile or aircraft ignition systems. The damage could range from a minor interruption to actual burnout of components. Most electronic equipment within 1,000 miles of a high-altitude nuclear detonation could be affected. Battery-powered radios with short antennas generally would not be affected. Although an EMP is unlikely to harm most people, it could harm those with pacemakers or other implanted electronic devices.

e. Radiological Dispersion Device

Terrorist use of an RDD—often called “dirty nuke” or “dirty bomb”, is considered far more likely than use of a nuclear explosive device. An RDD combines a conventional explosive device, such as a bomb, with radioactive material. It is designed to scatter dangerous and sub-lethal amounts of radioactive material over a general area. Such RDDs appeal to terrorists because they require limited technical knowledge to build and deploy compared to a nuclear device. Also, the radioactive materials in RDDs are widely used in medicine, agriculture, industry, and research, and are easier to obtain than weapons grade uranium or plutonium.

The primary purpose of terrorist use of an RDD is to cause psychological fear and economic disruption. Some devices could cause fatalities from exposure to radioactive materials. Depending on the speed at which the area of the RDD detonation was evacuated or how successful people were at sheltering-in-place, the number of deaths and injuries from an RDD might not be substantially greater than from a conventional bomb explosion.

The size of the affected area and the level of destruction caused by an RDD would depend on the sophistication and size of the conventional bomb, the type of radioactive material used, the quality and quantity of the radioactive material, and the local meteorological conditions—primarily wind and precipitation. The area affected could be placed off-limits to the public for several months during cleanup efforts.

2. The Regional Domestic Security Task Forces (RDSTFs)

Following the events of September 11, 2001, seven Regional Domestic Security Task Forces were formed. These regions follow the Florida Department of Law Enforcement (FDLE) operational regions within the State. The North Florida RDSTF (Region 2) consists of 13 counties, six of which, Franklin, Gadsden, Jefferson, Leon, Liberty and Wakulla, are geographically part of the Apalachee Bay Region.

The goal of the RDSTF is to provide a regional response to a terrorist incident that may occur within the State. Addressing security issues at a regional level allows for “economies of scale” for resources. It provides a structure which allows resources to be used regionally rather than locally enabling smaller counties with limited resources, to draw from those counties that do.

3. History of Events

There have been no terrorist events in recent history in the Apalachee Bay Region.

4. Vulnerability Assessments

The RDSTFs are in the process of identifying critical infrastructure and key resources (CI/KR) as defined by Department of Homeland Security (DHS) in the National Infrastructure Protection Plan (NIPP). This information will allow for county and regional profiles to be developed outlining risk versus vulnerabilities. Once complied, the region will use a tiering methodology developed by DHS and modified to support regional needs to prioritize the identified CI/KR and vulnerability assessment will be completed to support mitigation efforts.

Similar to hazardous material incidents, no specific emergency sequence can be isolated as the model for which to plan for evacuation caused by a terrorist event. As an alternative to defining a specified emergency, the regional and county plans identify various parameters for planning which are based upon knowledge of the possible consequences, timing, and target characteristics of a spectrum of emergencies. The plan then establishes the appropriate response for each level of threat. Therefore, the Apalachee Bay Region Evacuation Study will not address terrorism incidents.

G. Nuclear Power Plant Incidents

Florida is home to five commercial nuclear reactors located at three sites. Two additional reactors are located in Alabama near the State line.

- Crystal River Nuclear Power Plant (NW of CR)
- St. Lucie Nuclear Power Plant (SE of FT. Pierce)
- Turkey Point Nuclear Power Plant (S of Miami)
- Farley Nuclear Power Plant (SE of Dothan, Alabama)

The Radiological Emergencies Program housed at DEM has the overall responsibility for coordination of the response to a nuclear power plant emergency by federal, state and local agencies. The Division also has the overall authority and responsibility for updating and coordinating the plans with other response organizations.

The Nuclear/Radiological Incident Annex provides an organized and integrated capability for a timely, coordinated response by Federal agencies to terrorist incidents involving nuclear or radioactive materials (Incidents of National Significance), and accidents or incidents involving such material that may or may not rise to the level of an Incident of National Significance. DHS is responsible for overall coordination of all actual and potential Incidents of National Significance, including terrorist incidents involving nuclear materials.
Therefore, the Apalachee Bay Regional Evacuation Study will not address nuclear power plant incidents.

H. Tsunami

Tsunamis, also called seismic sea waves or, incorrectly, tidal waves, generally are caused by earthquakes, less commonly by submarine landslides, infrequently by submarine volcanic eruptions and very rarely by a large meteorite impact in the ocean. Submarine volcanic eruptions have the potential to produce truly awesome tsunami waves.

The possibility of a tsunami impacting the Atlantic or Gulf Coasts of Florida is considered to be remote. This is because most tsunamis are associated with major earthquakes. The Atlantic Ocean basin is not ringed by large faults as is the Pacific, which is associated both with earthquakes and tsunamis. It is thought that rare underwater landslides would pose a greater risk in the Atlantic Ocean. The Caribbean region has a history of both earthquakes and tsunamis. They do not appear to have impacted Florida's coastlines. However because of the horrific tsunami that impacted South East Asia in December 2004 and in recognition of the fact that a tsunami occurrence is possible, the Federal government has decided to expand its warning system to include the Atlantic and Gulf Coasts of the United States. There is no history of significant tsunami activity in the region.

Since it is impossible to predict the exact location, timing or extent of a tsunami event, the tsunami hazards was not specifically addressed in the Apalachee Bay Regional Evacuation Study.