Volume 1-10
Treasure Coast Region
Technical Data Report

CHAPTER IV

REGIONAL POPULATION AND VULNERABILITY ANALYSIS

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IV. REGIONAL VULNERABILITY AND POPULATION ANALYSES

A. Introduction

In the previous chapter the ***hazards analysis*** was presented. The hazards analysis is the first step in effective evacuation planning – going through the process of identifying the hazards that face the community and the level of risk they represent[1]. Once the potential hazards and impacts have been identified, a vulnerability analysis can be conducted to provide information on the location and extent of risk and vulnerability. The ***vulnerability analysis*** is the susceptibility of people, property, environment and social and economic activity to injury or damage and the degree to which they are at risk[2].

"Risk is the probability of a hazard occurrence and vulnerability is the susceptibility of people and property to injury or damage. Risk and vulnerability mapping is simply a procedure for locating areas with different degrees of hazard probability and susceptibility."[3] Through the hazards analysis, specific hazards were recognized as having the potential to initiate a regional or multi-jurisdictional evacuation. These included tropical storms or hurricanes, flooding, hazardous materials incidents and wildfires. Therefore, the next step is the vulnerability analysis and risk mapping of these specific hazards.

B. Risk And Vulnerability Assessment

The vulnerable areas within each county can be mapped by risk to determine the potential impact to the population, property, critical facilities and the environment. This was accomplished using the hazards analysis data for each hazard facing the community which was determined to have the potential to initiate a regional evacuation; including tropical storms and hurricanes, flooding, and wildfires.

The SLOSH Model Maximum of Maximums (MOMs) storm surge runs were utilized to determine the evacuation levels for each category of storm and tropical storm scenarios. The vulnerability analysis for flooding used the FEMA National Flood Insurance Rate Maps (FIRMs) to present the

[1] ICMA, *Emergency Management: Principles and Practice for Local Government*, Drabek, Hoetmer, editors, 1991, pg 80.
[2] Pg. 144.
[3] Pg. 143.

velocity and 100-year flood zones. The vulnerability to hazardous materials relied on the *Regional Hazardous Materials Emergency Response Plan* (2009) and the County Hazardous Material Facility Hazards Analyses to present a compilation of all vulnerability assessments. The wildfire risk was identified by the Department of Forestry's assessment of the urban wildland interface. The risk and vulnerability assessment for each specific hazard will be discussed in further detail.

C. Population Estimates and Projections

1. Small Area Data: Traffic Analysis Zones (TAZs)

The most recent **z-data**, the socio-economic data which provides the number of households, population and vehicle projections by **Traffic Analysis Zone** (TAZ), were obtained from the Florida Department of Transportation (FDOT) District IV and the Metropolitan Planning Organizations (MPO) for Indian River, Martin, Palm Beach and St. Lucie counties. Data was provided for the base year of 2006 with projections for 2010 and 2015.

The z-data provided the number of **permanent occupied dwelling units** (single family and multi-family) and **permanent population** and the percentage of vacant and seasonal units. Using this percentage and subtracting the percentage of vacant units, an estimate of the seasonal **dwelling units** and **seasonal population** was determined. In addition, in all counties the anticipated hotel/motel visitors were incorporated in the evacuation population. This data was interpolated to generate estimates for 2010 and 2015.

The number of mobile home and recreational vehicle spaces within each evacuation zone was derived from an inventory of mobile home and recreational vehicle (RV) parks from the Florida Department of Health enhanced with the property appraiser parcel data and Census data (American Community Survey, 2008) a meetings with local governments . This listing was geo-coded using the GIS and aerial photography.

For purposes of this study, seasonal factors as determined by the 2000 Census by housing type augmented with the American Community Survey data of 2008 were applied to determine the number of residents and visitors at different times during the hurricane season. This seasonal fluctuation results in two estimates of population-at-risk - a high and low - for each county evacuation scenario. The high seasonal occupancy factor was used in the Base Planning Scenarios. The summer seasonal rate was used in the Operational Planning Scenarios.

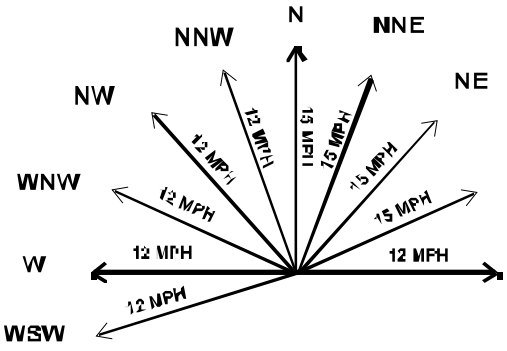
2. Traffic Evacuation Zones (TEZs)

The Small Area Data, Traffic Analysis Zones (TAZs), provide the first level of vulnerability and population analysis. In order to facilitate the evacuation transportation analysis, it was necessary to aggregate the small area data into larger zones. The Treasure Coast Regional Evacuation Transportation Model incorporates the four counties within the Treasure Coast Region as well as adjacent counties which serve as external destination assignments. Created for the purposes of the Evacuation Transportation Model, Traffic

Evacuation Zones (TEZs) form the basic unit of evaluation in the modeling process. The TEZs represent geographic areas and contain the demographic information crucial to modeling evacuation traffic. Each TEZ includes one or more Small Area Data Zone. The Traffic Evacuation Zones offer the model a balance between specificity in traffic assignment and model flexibility and economy. A regional map of the TEZs is presented on Figure IV-1. County TEZ Maps are presented in the Appendices IV-A, IV-B, IV-C, and IV-D. The TEZs are discussed further in Chapter VI, Evacuation Transportation Analysis.

D. Hurricane Vulnerability

1. Hurricane Evacuation Levels



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 that depict the possible flooding. One useful composite is the MEOW (Maximum Envelopes of Water) that 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 Maximum Envelopes of Water (MEOWs).

In order to determine a scenario that confronts county hurricane threats 24-48 hours before a storm is expected, a further compositing of the MEOWs into Maximums of the Maximums (MOMs) is usually required.

The MOM (Maximum of the MEOWs) combines all the MEOWs of a particular category. The 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).

The MOM surge tide heights, which were furnished by the National Hurricane Center, 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.

The range of maximum surge heights (high and low) for each county in the region based upon the model is provided for each category of storm on Table IV-1. **It should be noted again that these surge heights represent the maximum surge height recorded in the county including inland and Lagoon areas where the surge can be magnified dependent upon storm parameters.**

Table IV-1 Potential Storm Tide Height(s) by County

(In Feet above NAVD88)

*Storm Strength	Indian River	Martin (Coastal)	Martin (Lake)	Palm Beach (Coastal)	Palm Beach (Lake)	St. Lucie
Category 1	1.6 – 4.1	2.0 – 4.2	9.1 – 26.1	1.3 – 4.0	8.9 – 24.4	1.6 – 4.5
Category 2	3.4 – 7.1	3.4 – 6.3	9.5 – 26.8	1.6 – 5.9	8.9 – 27.7	3.3 – 6.9
Category 3	6.1 – 10.6	5.6 – 9.8	9.9 – 29.6	1.9 – 8.2	8.9 – 32.3	5.8 – 10.3
Category 4	10.0 – 14.4	7.2 – 12.8	10.1 – 31.3	2.2 – 11.5	8.9 – 36.4	6.5 – 13.9
Category 5	15.0 – 18.1	10.0 – 15.7	10.3 – 32.2	2.4 – 14.3	8.9 – 38.4	8.2 – 16.2

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

2. Delineation of Hurricane Evacuation Zones

As in the original study one of the keys for effective implementation of the study is the delineation of evacuation zones throughout the region. The delineation of evacuation zones is an essential part of any hurricane evacuation plan for two reasons. First, the creation of zones allows for the assignment of population and vehicles for the transportation analysis. Secondly, the creation of zones allows preparedness and response officials to identify areas predicted to receive a common level of storm surge and areas that should use the same major evacuation route.

The **storm tide limits** were determined using the maximum surge from landfalling hurricanes (Categories 1, 2, 3, 4 and 5). County emergency management agencies delineate the **evacuation zones** based on the storm tide limits. However, in order to relay this information to the public in a meaningful way, the emergency management agencies use roadways, waterways and familiar landmarks combined with parcel data as the boundaries for the evacuation areas. This is a very painstaking and deliberate process. It requires knowledge of the area, the land use and population density. Judgments must be made about the potential for isolation in areas that may not receive storm surge yet are surrounded by areas which will. Potential freshwater flooding is also a consideration in some cases.

The more detailed storm tide limits coupled with the desire to minimize any potential "over-evacuation" resulted in tighter more detailed evacuation areas in all four counties in the region. This is especially true where the laser terrain mapping or survey data provided very detailed topographic data and where, in such a densely populated county, over-evacuation could affect thousands of residents.

Conversely, the inability to forecast exact hurricane track, intensity, size and forward speed as well as the limitation of the SLOSH model, encourage many county emergency management officials to simplify the evacuation zone patterns. This more flexible concept allows a more generalized zone scheme that may be easier to convey to the public. County Evacuation Zones in the Region are presented on Figure IV-2. The Evacuation Zones are also presented in the County Appendices.

3. Hurricane Wind Vulnerability: Manufactured Housing

Mobile homes and recreational vehicles are extremely vulnerable to hurricane force winds and severe weather. Statistics document that mobile homes and RVs receive a disproportionate share of the damage from severe weather, and residents are far more likely to be injured or killed in these structures compared to site built homes.[4] Because of this vulnerability hurricane evacuation plans in Florida have called for the evacuation of all areas subject to potential storm surge (coastal flooding) and the complete evacuation of all mobile home/RV residents no matter where they are located within the county.

In the 1930s the beauty of America and the draw of the open road attracted campers and their families to "travel trailers." Later the product and its name evolved into "trailers," and still later "mobile homes[5]." The changes were far more than changes in nomenclature. In 1976 the Department of Housing and Urban Development (HUD) established construction and safety standards for mobile homes, which for many people were now being used as permanent residences. In 1999 HUD added new anchor, strapping, and tie-down regulations to make manufactured homes safer[6].

[4] For example, in February 1998, a tornado destroyed many site-built homes, mobile homes and RVs in the Kissimmee and Orlando central Florida area. There were 42 people killed: 34 resided in mobile homes, 7 in RVs and 1 was in an automobile. No one living in a site-built home died; although there was **more** traditional concrete block and stick-built homes destroyed (385) than mobile homes (373) yet without any fatalities.

[5] *Mobile home* is actually a term that was used for manufactured homes produced prior to June 15, 1976, when HUD began to administer the federal code which governs the construction of all manufactured homes. Note: Modular homes where the walls are constructed off-site but assembled on site and affixed to a permanent foundation are now evaluated and inspected against the Florida Building Code. They are built to the same construction standards as site-built structures in the community and are not subject to evacuation orders for wind only.

[6] Stronger wall sheathing, headers above windows and multiple studs at windows and doors meet post-1994 requirements and add strength to the structural envelope. The result is a home better able to withstand the buffeting

In the 2004 hurricane season it seemed new manufactured homes held up relatively well, even when compared to site-built homes. Since 1999, manufactured homes have been built and installed to tougher standards but not equivalent to the most recent codes for site-built structures. As required by HUD all manufactured homes sold in Florida's coastal counties since 1994 are engineered to withstand sustained winds of 110 mph and 3-second gusts of 130 to 150 mph. http://www.builtstronger.com/history.html

This is good news for state and local mitigation efforts and public safety and it is evidence that we are moving in the right direction; however, it does not alleviate the concern regarding evacuation. While the manufactured home industry may have a case regarding the benefit of stricter standards, they need to present it to the Florida Building Code officials. Manufactured homes are not currently evaluated against the Florida Building Code; so no matter how strong the industry says they are built, they are not evaluated using the same construction standards as site-built homes. While it is clear that those homes built and installed after 1999 are more hurricane resistant, they must be measured against the same construction standards as site-built homes. Otherwise, there is no way to confirm how well they will perform.

There are several additional factors to consider:

- Unless a structure is permanently attached to a foundation, there is no way to assume that the structure will remain "tied down" in hurricane force winds. With Florida's climate, salt air and sandy soils, tie-down systems would not be expected to perform optimally without constant vigilance.
- Currently, most mobile homes in the region were built prior to 1999 and do not meet current standards for wind load or anchoring systems.
- Additions, such as carports, siding and cladding, and attached storage units did not perform well in hurricane conditions even on newer units.
- Newer manufactured homes would be at risk from flying debris from older units within the same mobile home park.
- It would be difficult, at best, to implement evacuation orders based on the age and maintenance of individual units.

Therefore, no change in evacuation strategy is identified in this report. In addition to residents vulnerable to storm surge, those residents vulnerable to hurricane force winds (74+ mph) must be evacuated in advance of the hurricane. Basically, residents of buildings without traditional structural foundations are more vulnerable to such wind speeds. In the Treasure Coast Region, this includes residents of substandard housing, mobile homes and visitors in recreational vehicles and travel trailers. Since hurricane force winds can extend inland many miles, all mobile home residents and travel trailer/RV visitors must be evacuated, regardless of their location in the region.

To update the mobile home population a list of mobile home/ RV parks was obtained from the Florida Department of Health and cross researched through the local county property appraiser offices. This list was geo-coded using the geographic information

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of high wind and the impact of wind-borne missiles than the pre-1994 manufactured housing. http://www.fmha.org/hurricane.html

system (GIS). County maps identifying the locations of mobile home parks are included in the Appendices (Appendices IV-A, IV-B, IV-C, and IV-D). This database provided an accurate up-to-date inventory of mobile home/ RV spaces within licensed parks. However, it was necessary to supplement this data in Indian River, Martin, Palm Beach and St. Lucie Counties with (updated) mobile home counts from the property appraiser's offices and the Census in order to derive an estimated number of occupied residential mobile homes outside of designated parks. (Note: Most mobile homes / RVs are located within the licensed parks given the urban nature of the region.) The estimated and projected mobile home populations were incorporated in the evacuation population analyses.

Table IV-2 Mobile Home/ RV Parks in the Treasure Coast Region (2009)

County	# of MH/RV Parks	# of Mobile Homes Spaces	# of RV Unit Spaces	Sum # of Spaces
Indian River	53	5,830	854	6,684
Martin	44	4,332	643	4,975
Palm Beach	122	15,055	2,064	17,119
St. Lucie	36	8,345	963	9,308
Region	255	33,562	4,524	38,086

Source: Florida Department of Health, 2009

4. Wind Vulnerability of Site-Built Residential and Commercial Structures

The existing regional hurricane evacuation studies have focused on the storm surge hazard with detailed evacuation areas based on the potential coastal flooding. Historically, the storm surge hazard has caused nine out of ten hurricane-related deaths. An equally important goal is the evacuation of mobile home/ RV residents regardless of their location due to their life-threatening vulnerability to hurricane force winds. However, hurricane force winds can cause significant injuries and property loss even in conventional site-built structures -- commercial and residential.

The winds of a major hurricane (winds exceeding 120 mph) will have an impact on the safety of **ALL** Treasure Coast residents as demonstrated by past storm events including Hugo (1989), Opal (1985), Andrew (1992) and Wilma (2005). There is evidence to support the fact that winds are significantly reduced as the hurricane crosses the coastline. However, the reduction of wind fields and wind speeds to safe limits depends a great deal on the individual parameters of the storm (strength, size, forward speed,

etc.), the geography of the area, and the type/ construction of the buildings in harm's way.

Much of the wind damage in hurricanes Andrew, Hugo and Wilma were not confined to waterfront properties. Andrew literally destroyed many single-family site-built homes 10-20 miles inland. Hugo caused serious wind damage as far inland as Raleigh, North Carolina. Wilma caused significant wind damage as it exited the east coast of Florida.

Results of the recent experiences of hurricanes Charley, Frances, Jeanne and Wilma indicate that because of the uncertainties of the hurricane and the dangers of the major storm winds, it is imperative that emergency managers:

(1) strongly encourage all residents who are not ordered to evacuate to secure their homes before the storm arrival;

(2) recommend evacuation policies which address the closure of high-rise buildings with large expanses of glass (even those outside surge vulnerable zones);

(3) local governments, in cooperation with school boards, American Red Cross and the private sector should continue to support policies and funding mechanisms to implement the statewide program to upgrade primary and special needs shelters, health care buildings and other critical facilities. This would include window and door protection, generators, roof/truss improvements, etc.

The new Florida Building Code addresses “fortified criteria” designed to make new construction more hurricane-resistant. Ultimately, this will have a positive impact on future storm losses; however, currently, we must rely on retrofit of the more than 1 million existing homes.

Code plus improvements, as defined in the ”Blueprint for Safety” developed by the Florida Alliance for Safe Homes (FLASH) in coordination with the Home Builders’ Association, covers both new construction and retrofit of existing structures.
The major components of this program are:

- Window protection which meets the Dade County protocol as defined in the Florida Building Code
- Roof and truss connections; reinforcement of gable ends
- Wall and roof connections
- Roof covering
- Garage door and entry door protection
- Safe rooms (FEMA standards)

Through the **Local Mitigation Strategies** and public information campaigns, state and local governments and the Treasure Coast Regional Planning Council are working to encourage residents and businesses to mitigate potential wind and flood losses at the local level. This is no easy task; however, implementing the LMS is a priority in the Treasure Coast Region and efforts to bring together the public and the private sectors are underway to address these major issues.

5. Population-at-Risk

In order to quantify the hurricane evacuation times as well as hurricane response and recovery needs, it is essential to know how many persons must be evacuated from the hazards associated with a tropical storm or hurricane -- the **population-at-risk**. First, it is necessary to enumerate the entire population residing within the areas predicted by the SLOSH model to require total evacuation from storm tide flooding under the five evacuation levels (Evacuation levels A, B, C, D, and E). As discussed in Chapter I and II, these evacuation levels correspond to the maximum storm tide flooding from each category of landfalling hurricane on the Saffir-Simpson Hurricane Scale (Category 1, 2, 3, 4 and 5). The Evacuation Zones or areas are defined by the county emergency management agencies based on the expected inundation areas and definable boundaries.

Second, it is also necessary to quantify all mobile homes and RVs throughout the region -- even in areas not vulnerable to storm tide. These structures are particularly vulnerable to property damage and their inhabitants vulnerable to potential injury and loss of life due to hurricane force winds.

While it is clear that we are in a period of more active and intense tropical activity, this also reflects the exponential growth in population and property at risk. A study (Pielke and Landsea, 1999) of coastal development warned *that more and more Americans have put themselves and their property at risk by flocking to vulnerable coastal locations.* There is 400 times the number of people in Florida today as there was at the turn of the century. The population-at-risk by hurricane evacuation level for the years 2010 and 2015 are presented on Tables IV-3 and IV-6.

6. Evacuation Population

The population-at-risk is the number of persons residing in evacuation areas or mobile home residents who would be directly affected by a future evacuation order. In every evacuation, however, a percentage of persons who live outside of the surge-vulnerable areas and who do not live in mobile homes or substandard housing will evacuate. Whether this is the result of confusion, a desire to be extra cautious or the desire to avoid the impacts of storm aftermath (loss of power and/or utilities), this phenomenon, termed ***shadow evacuation*** was documented in the Treasure Coast Region during the post Hurricane Charley, Frances, and Jeanne surveys as well as in other post-storm surveys conducted in other parts of the country over the last few decades (Hazard Management Group (HMG), (2009).

In addition, there will also be a percentage of persons inside the evacuation areas who will NOT evacuate and, to a certain degree, a percentage of persons who live in mobile homes who will not evacuate. After the destruction in South Florida following Hurricane Andrew, it was expected that more people would evacuate than ever before. Regardless, it is expected that there will be difference in the population-at-risk and the actual **evacuation population.**

In the Evacuation Behavioral Analysis, planning assumptions were identified to assist in the development of the anticipated Evacuation Population under different storm scenarios.

Evacuation participation rates are influenced by the perceived risk and location of the residents. Evacuation rates and shelter use are also influenced by age and income that, in the Treasure Coast Region, are significant factors. These assumptions are discussed in more detail in Chapter III **Behavioral Analysis Summary**.

Two sets of behavioral assumptions were made in the Statewide Regional Evacuation Study (SRES) to determine the Evacuation Populations. The first is considered the ***Base Scenario***, which represents 100% participation of the population-at-risk plus "*shadow evacuation*". The Base Scenario is considered the "planning scenario", a more conservative estimate that will be used for growth management planning purposes. The second set of assumptions is termed the ***Operational Scenario***. The county planning assumptions as presented in Chapter III and in more detail in Volume 2 of the SRES, were used in the calculations for the evacuation population under the Operational Scenario. Other differences in the two scenarios are presented in Chapter VI: Regional Evacuation Transportation Analysis.

The evacuation population by evacuation level for the region for the Base Planning Scenario is presented for the years 2010 and 2015on Tables IV-4 and IV-7, respectively.

The evacuation population by evacuation level for the region for the Operational Scenario is presented for the years 2010 and 2015 on Tables IV-5 and IV-8 respectively.

It should be noted the 2010 regional evacuation study update modeled the population-at-risk ("Perfect Response" Scenario) for each of the hurricane evacuation levels plus a "shadow evacuation rate." These sets of assumptions will be used to develop the scenario used for growth management planning.

As indicated, a "real world" response would most likely reflect less than 100% evacuation from surge vulnerable areas and mobile homes and a significant "shadow evacuation." These sets of assumptions are used to develop the operational scenarios. However, even a small percentage of a very large population has a significant impact on the population estimates and the resulting evacuation population. The difference between the population at risk and the evacuation population can be as much as 20-40%. Both evacuation population estimates were incorporated into the model to conduct the transportation analysis and determine evacuation times. (See Chapter VI Transportation Analysis for model assumptions and impacts.)

Table IV-3 Population-at-Risk from Hurricanes by Evacuation Level, 2010

	Indian River	Martin	Palm Beach	St. Lucie	Treasure Coast Region
A	18,135	6,966	76,080	8,701	109,882
B	20,758	2,242	9,234	2,548	34,782
C	907	6,370	23,070	2,996	33,343
D	3,081 total represented as one zone	8,308	26,826	1,522	39,737
E		24,861	42,338	1,879	72,159

Table IV-4 Hurricane Population by Evacuation Level, Base Planning Scenario 2010

	Indian River	Martin	Palm Beach	St. Lucie	Treasure Coast Region
A	43,125	29,916	186,934	38,730	298,705
B	61,768	38,236	193,682	53,892	347,578
C	63,096	45,275	280,426	56,241	445,038
D	73,720	63,486	356,645	82,768	576,619
E	78,149	85,665	444,686	96,935	705,435

Table IV-5 Hurricane Evacuation Population by Evacuation Level, Operational Scenarios, 2010

	Indian River	Martin	Palm Beach	St. Lucie	Treasure Coast Region
A	28,899	21,601	133,202	28,697	212,399
B	41,010	30,428	143,310	44,706	259,454
C	47,940	36,539	231,371	48,341	364,191
D	63,686	54,311	317,686	76,930	512,613
E	72,925	70,176	402,125	92,676	637,902

Table IV-6 Population-at-Risk from Hurricanes by Evacuation Level, 2015

	Indian River	Martin	Palm Beach	St. Lucie	Treasure Coast Region
A	19,576	7,270	82,261	9,003	118,110
B	22,286	2,337	9,983	2,635	37,241
C	979	6,596	24,943	3,148	35,666
D	3,283 Zones combined	8,593	29,005	1,596	42,477
E		25,850	45,777	1,978	76,888

Table IV-7 Hurricane Evacuation Population by Evacuation Level, Base Planning Scenarios, 2015

	Indian River	Martin	Palm Beach	St. Lucie	Treasure Coast Region
A	45,383	30,964	201,769	41,259	319,375
B	65,447	39,952	209,023	58,651	373,073
C	66,878	47,259	302,717	61,129	477,983
D	78,338	66,833	385,061	92,000	622,232
E	83,119	90,244	480,110	108,370	761,843

Table IV-8 Hurricane Evacuation Population by Evacuation Level, Operational Scenarios, 2015

	Indian River	Martin	Palm Beach	St. Lucie	Treasure Coast Region
A	30,443	22,495	143,673	31,075	227,686
B	43,365	31,956	154,560	49,285	279,166
C	50,729	38,260	249,681	53,012	391,682
D	67,661	57,373	342,946	85,997	553,977
E	77,584	74,166	434,096	103,972	689,818

7. Property at Risk

Seven of the top ten most destructive U.S. hurricanes have made landfall in the past five years, including Katrina (2005), Charley (2004), Ivan (2004), Wilma (2005), Frances (2004), Jeanne (2004) and Allison (2001). Six of these seven made landfall in the state of Florida.

Table IV-9 The 30 Costliest Tropical Cyclones to Strike the U.S. Mainland

(Damages are listed in US dollars and are not adjusted for inflation.)				
Rank	**Hurricane**	**Year**	**Category**	**Damage**
1	Katrina (FL, MS, LA)	2005	4	81,000,000,000
2	Andrew (SE FL, SE LA)	1992	5	26,500,000,000
3	Wilma (FL)	2005	2	20,600,000,000
4	Charley (SW FL)	2004	4	15,000,000,000
5	Ivan (AL/NW FL)	2004	3	14,200,000,000
6	Rita (SW LA, N TX)	2005	3	11,300,000,000
7	Frances (FL)	2004	2	8,900,000,000
8	Hugo (SC)	1989	4	7,000,000,000
9	Jeanne (FL)	2004	3	6,900,000,000
10	Allison (N TX)	2001	TS[a]	5,000,000,000
11	Floyd (Mid-Atlantic & NE U.S.)	1999	2	4,500,000,000
12	Isabel (Mid-Atlantic)	2003	2	3,370,000,000
13	Fran (NC)	1996	3	3,200,000,000
14	Opal (NW FL, AL)	1995	3	3,000,000,000
15	Frederic (AL, MS)	1979	3	2,300,000,000
16	Dennis (NW FL)	2005	3	2,230,000,000
17	Agnes (FL, NE U.S.)	1972	1	2,100,000,000
18	Alicia (N TX)	1983	3	2,000,000,000
19	Bob (NC, NE U.S.)	1991	2	1,500,000,000
20	Juan (LA)	1985	1	1,500,000,000
21	Camille (MS, SE LA, VA)	1969	5	1,420,700,000
22	Betsy (SE FL, SE LA)	1965	3	1,420,500,000
23	Elena (MS, AL, NW FL)	1985	3	1,250,000,000
24	Georges (FL Keys, MS, AL)	1998	2	1,155,000,000
25	Gloria (Eastern US)	1985	3	900,000,000
26	Lili (SC LA)	2002	1	860,000,000

(Damages are listed in US dollars and are not adjusted for inflation.)				
Rank	**Hurricane**	**Year**	**Category**	**Damage**
27	Diane (NE U.S.)	1955	1	831,700,000
28	Bonnie (NC, VA)	1998	2	720,000,000
29	Erin (NW FL)	1998	2	700,000,000
30	Allison (N TX)	1989	TS	500,000,000
30	Alberto (NW FL, GA, AL)	1994	TS	500,000,000
30	Ernesto (FL, NC,VA)	2006	TS	500,000,000
30	Frances (TX)	1998	TS	500,000,000

ADDENDUM (Rank is independent of other events in group)

19	Georges (USVI, PR)	1998	3	1,800,000,000
19	Iniki (Kaukai, HI)	1992	3	1,800,000,000
19	Marilyn (USVI, PR)	1995	2	1,500,000,000
25	Hugo (USVI, PR)	1989	4	1,000,000,000
30	Hortense (PR)	1996	1	500,000,000

Source: NOAA online web site at www.nhc.noaa.gov

E. Flood Evacuation Levels

1. Delineation of Flood Evacuation Zones

In order to determine the vulnerability of the flood prone areas, the digital Q3 Flood Data[7] (100-year flood zones) was used. This allows the data to be presented in a consistent format with other hazards.

2. Population-at-Risk

The population–at-risk was determined using the small area data (TAZs) to estimate the population within the flood zones within each TAZ. Estimates and projections of the population-at-risk for flood for 2010 and 2015 are presented on Table IV-11.

3. Critical Facilities

As indicated previously, the Critical Facility Inventory (CFI) includes a Vulnerability Assessment from (1) Hurricanes and Tropical Storms, (2) the 100-year flood plain, and (3) Wildfire. Refer to Appendices for vulnerability of specific county critical facilities.

Table IV-10 Population-at-Risk from Flooding, 2010 - 2015

[7] The digital Q3 Flood Data product is a digital representation of certain features of FEMA's FIRM product, intended for use with desk-top mapping and GIS technology. The digital Q3 Flood Data are created by scanning (producing raster or grid data files) the effective FIRM paper maps and vectorizing (converting to lines and areas) select data features into a countywide format. The digital Q3 Flood Data are designed to serve FEMA's needs for disaster response activities, National Flood Insurance Program activities, risk assessment, and floodplain management. The data are expected to be used for a variety of planning applications including broad-based review for floodplain management, land-use planning, commercial siting analysis, insurance target marketing, natural resource/environmental analyses, and real estate development and targeting.

The digital Q3 Flood Data are designed to provide guidance and a general proximity of the location of Special Flood Hazard Areas. The digital Q3 Flood Data cannot be used to determine absolute delineation of flood risk boundaries, but instead should be seen as portraying zones of uncertainty and possible risks associated with flood inundation. Users must apply considerable care and judgment in the application of this product.

	Site Built Population 2010	Mobile Home Population 2010	Site Built Population 2015	Mobile Home Population 2015
Indian River County				
100-YEAR FLOODPLAIN	97,233	7,328	7,328	104,976
500-YEAR FLOODPLAIN	2,881	217	217	3,111
Martin County				
100-YEAR FLOODPLAIN	6,741	99	99	7,312
500-YEAR FLOODPLAIN	111,553	1,633	1,633	121,016
Palm Beach County				
100-YEAR FLOODPLAIN	109,175	2,309	2,309	116,425
500-YEAR FLOODPLAIN	806,131	17,052	17,052	859,660
St. Lucie County				
100-YEAR FLOODPLAIN	21,171	989	989	24,600
500-YEAR FLOODPLAIN	3,829	179	179	4,449

F. Hazardous Materials

1. Delineation of Hazardous Material Vulnerability Zones (HMVZ)

In order to determine the vulnerability of the county to potential hazardous material incidents, it is necessary to determine the HMVZs[8] of each of the Section 302 Facilities (Facilities which use/store Extremely Hazardous Materials). Through the LEPC and the County Hazardous Material Section of the Emergency Management office, detailed vulnerability areas can be determined in real time using the specific chemical, amount of release, wind direction and wind speed. Due to the specificity of each hazardous material release, it was not possible to determine the HMVZ or population exposure for the county.

2. Population-at-Risk

Due to the specificity of each hazardous material release, it was not possible to determine the HMVZ or population exposure for the county.

3. Critical Facilities

As part of the determination of the HMVZ, critical facilities including hospitals, nursing homes and schools affected are determined at the time of the incident.

[8] Hazardous Material Vulnerability Zones

G. Wildfire Evacuation Levels

1. Delineation of Wildland-Urban Interface (WUI)

In order to determine the vulnerability of the counties to potential wildfire, the assessment from the Florida Division of Forestry (DOF) risk maps[9] for wildfire was used to identify areas susceptible to fires.

2. Population-at-Risk

The population–at-risk was calculated using the small area data (TAZs) to determine the population within the Wildland Interface, if identified, within each TAZ, The estimates for the population-at-risk for the Wildland Interface within each county for 2010 and 2015 are presented on Table IV-12.

3. Critical Facilities

As indicated previously, the Critical Facility Inventory (CFI) includes a Vulnerability Assessment from (1) Hurricanes and Tropical Storms, (2) the 100-year flood plain and (3) Wildfire.

Table IV-11 Population-at-Risk from Wildfire, 2010 – 2015

Risk	Site Built Residents 2010	Site Built Residents 2015	Mobile Home Population 2010	Mobile Home Population 2015
Indian River County				
HIGH	4,971.20	5,367.07	374.67	374.67
VERY HIGH	2,347.82	2,534.79	176.95	176.95
Martin County				
HIGH	16,391.74	17,782.31	240.02	240.02
VERY HIGH	5,166.10	5,604.36	75.65	75.65
Palm Beach County				
HIGH	35,390.01	37,740.00	748.61	748.61
VERY HIGH	51,736.56	55,172.00	1,094.39	1,094.39
St. Lucie County				
HIGH	21,008.13	24,410.58	981.49	981.49
VERY HIGH	7,303.56	8,486.43	341.22	341.22

[9] 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).

H. Critical Facilities

The identification of critical and sensitive facilities is an important factor for emergency management planning. The Critical Facilities Inventory is maintained by state and local emergency management agencies and updated to ensure that preparedness and protective actions can be focused to provide efficient evacuation, sheltering and recovery operations.

Typically critical facilities include transportation facilities, including roadways, bus depots, ports, airports; communications facilities; utilities such as power plants, water treatment plants and water distribution systems; wastewater treatment plants and lift stations; health care facilities such as hospitals, nursing homes, hospice and dialysis facilities; assisted living and residential treatment facilities; schools and day cares; correctional facilities and sheriff/police stations; fire stations; and county and municipal buildings. Volunteer and relief agencies, potential staging areas, recovery centers and points of distribution (PODs) were also included in the critical facilities inventories.

The county inventory was obtained, updated and coded by type of facility. Facilities were coded as follows:

Table IV-12 Critical Facility Types and Codes

TYPE OF CRITICAL FACILITY	CRITICAL CODE
Health Care Facilities	
Assisted Living	
Assisted Living Facilities/ Adult Family Care Homes	AL
Long Term Care	
Skilled Nursing Facilities	NH
Intermediate Care Facilities	HI
Transitional Living Facilities	HT
Hospitals	
Hospitals	HO
Residential Treatment Facilities	RT
Laboratory	
End Stage Renal Disease Facilities	RD
Hospices	HS
Critical Response Facilities	
Law Enforcement	HP, LE
Fire Department	FD
EMS	EM
EOCs	EC
PODs	POD
Relief Agencies	RA
Disaster Field Offices	DF

TYPE OF CRITICAL FACILITY	CRITICAL CODE
Potential Staging /Temporary Housing Areas	SA
Military Resources	MB
Community Resources	
Designated Shelters	SH
Churches	CH
Community Centers	CC
Post Offices	PO
Public Buildings	PB
Schools	SC
Correctional Facility	CF
Animal Related	AN
Transportation	
Transportation – Marine	T2
Transportation – Bridge	T2
Transportation – Traffic Control	T3
Transportation – Port	T4
Transportation – Mass Transit	T5
Transportation – Airport	T6
Transportation – Heliport/Helipad	T7
Transportation – Evac Intersection	T9
Communication	
Phone/ Satellite/ Cellular Towers, etc.	CO
Electrical Systems	
Power Plants/ Utility Infrastructure/ Staging Areas, etc.	EL
Private Resources	
Ice	IC
Supplies	SP
Medicine	ME
Private Facility	PR
Infrastructure	
Solid Waste Facilities	SW
Landfill Active	LA
Landfill Inactive	LI
Sewage Treatment / Pump Stations	ST
Stormwater / Drainage Facilities	DF
Water Treatment Plants/ Facilities / Wells	WT
Manufactured Housing	
Mobile Home Parks/ Subdivisions	MH
Hazardous Materials	
Hazardous Materials - General	HZ
Hazardous Materials – 302 facilities	HZ1
Hazardous Materials - 313 facilities	HZ2
Hazardous Materials – 302/313 facilities	HZ3
Hazardous Materials – 112R facilities	HZ4
Hazardous Materials – 302/112R facilities	HZ5
Hazardous Materials – 311 facilities	HZ6
Hazardous Materials – 304 facilities	HZ7
Miscellaneous	
Fuel Storage	FS

TYPE OF CRITICAL FACILITY	CRITICAL CODE
Garage Facility	GA
Tall Structure	TS
Miscellaneous	XX

Source: Health Care – AHCA online at www.fdhc.state.fl.us
Mobile Homes – FDOH online at www.fdoh.state.fl.us
Schools – FDOE online at www.fdoe.state.fl.us
Shelters and PODs – County Emergency Management Agencies, August 2009
Hazardous Materials – HMIS, August 2009

These facilities were geo-coded and the risk assessment was conducted to determine potential vulnerability to storm surge flooding, coastal and inland flooding and wildfire. The electronic database was provided to the State Division of Emergency Management and the County Emergency Management for official use only (FOUO). The lists and vulnerability assessments of selected facilities with the corresponding maps are provided in the back of this report (See Appendix IV-A, B, C and D).

1. Hospitals and Skilled Nursing Facilities

Particular attention was paid to health care facilities due to their potential need for evacuation support and the special needs of their patients.

In the Treasure Coast Region there are 30 hospitals and 78 skilled nursing facilities many of which may require complete patient evacuation from storm surge. The effects of a hurricane's hazards on these residents would be greatly compounded by their lack of mobility and need for continuity of care.

Past experience of medical facility evacuations has pointed out that a medical facility which can serve as an emergency shelter for even twice its normal patient capacity is still more capable of providing the necessary medical care to those sheltered patients than would a public shelter such as a school building. This is due to the medical manpower and equipment already in place in the host facility. As a result, low-lying vulnerable medical facilities are now encouraged by local officials to make individual hurricane contingency plans to evacuate to a similar facility located outside of areas vulnerable to storm surge instead of to a designated public shelter. The surge vulnerability results are essential for this facility-to-facility concept of planning not only to help determine the need for evacuation, but also for the selection of non-vulnerable host shelter facilities for the reception of the evacuated facility's patients.

Chapter 400, Florida Statutes and Chapter 10-D29, Florida Administrative Code, (FAC), mandate and provide guidance in the development of evacuation plans for nursing homes. The procedures to be followed include the designation of a host facility and a written agreement from the host facility, as well as the evacuation transportation providers. Chapter 10-D29 also requires nursing homes to exercise

both the internal (fire, etc.) evacuation and external (hurricane, tornado, flooding, etc.) evacuation plans annually. The county emergency management agencies must review the disaster plans before a license is granted by the state[10]. In addition, the county emergency management agencies provide training and assistance in the development and maintenance of the nursing home plans.

Table IV-13 Health Care Facilities on the Treasure Coast

Type of Facility	Indian River	Martin	Palm Beach	St. Lucie	Region
Assisted Living					
Assisted Living Facility / Adult Care Homes	17	10	110	56	193
Long Term Care					
Skilled Nursing Facilities	6	7	56	9	78
Intermediate Care Facilities	0	1	1	2	4
Hospitals					
Hospitals	3	2	18	7	30
Residential Treatment Facilities	0	0	5	1	6
Laboratory					
End-Stage Renal Disease Facilities	3	1	24	4	32
Home Care					
Hospices	1	1	3	0	5

2. Assisted Living Facilities (ALFs), Residential Treatment Facilities

In addition to the medical facilities there are over 193 licensed assisted living facilities (ALFs) and Adult Care Homes (ACH) in the Treasure Coast region. ALFs and ACHs are living arrangements where adults live together to receive room, meals, and help with their daily living. ALFs and ACHs are not nursing homes.

ALFs offer a variety of personal services like supervision of medications, or assistance with daily tasks such as bathing, dressing, etc. Recent administrative changes will allow some ALFs to provide limited nursing services such as injections, prescriptions, dressing changes, etc.

The majority of ALFs were built as private homes and care for four or five residents. In addition to one and two story dwellings, some ALFs are located in high rise buildings, or multi-unit buildings. Three groups of people live in ALFs: the elderly, the physically disabled, and the mentally disabled. ALFs may also

[10] The state Agency for Health Care Administration (AHCA) administers Florida's $16 billion Medicaid program, licenses and regulates more than 32,000 health care facilities and 37 health maintenance organizations, and publishes health care data and statistics.

distinguish residents according to specific health problems. For example, providing they can care for themselves, some homes will accept people with Alzheimer's disease, diabetes, incontinence of bowel or bladder and those who require oxygen. While residents of ALFs do not require the constant attention necessary in nursing homes, in a stressful situation such as an emergency evacuation or public shelter stay, residents will need support and continued assistance.

Chapter 10-A5, FAC, requires that ALFs have an evacuation plan (both internal and external) with written agreements with other similar host facilities if evacuation is necessary. The Florida State Department of Health and the Department of Elder Affairs provide guidance in disaster planning for ALFs. In addition many of the county departments of emergency management provide training and assistance in the development and maintenance of the hurricane evacuation plans. County ALF facilities serving fifty or more residents and the predicted storm surge under each evacuation level also are presented in the Appendices to this chapter.

3. End Stage Renal Dialysis Centers

Patients on dialysis face increased risks and challenges in disaster situations. Their treatment requires electrical power and a source of pure water. The Florida Agency for Health Care Administration (AHCA) requires that their providers identify their patients on dialysis and ensure they are dialyzed at their assigned centers within 24 hours of a hurricane warning. They are encouraged to make sure they have an emergency contact number for the dialysis centers, place their patients on their “disaster diets” and provide a list of all dialysis centers in the state as well as patient treatment sheets. After the storm, patients are directed to call the dialysis center to determine if it is operational. If it is not, they are to the call the emergency contact for the facility. If these contacts fail, patients are to call Network 7 at 1-800-826-3773. Health care providers are instructed not to assume that local hospitals will be able to handle their patients’ needs. They are also responsible to provide receiving facilities with the appropriate needs, supplies and sufficient staff. (See ***Guidance to Health Care Providers***, AHCA, July 6, 2006)

4. Home Health Care

New legislation in 2006 has identified the challenges to providing continuity of care especially in a hurricane evacuation. The legislation has assigned responsibility to home health care providers to identify their vulnerable patients, assist them in finding appropriate shelter for the storm depending on their clients’ needs and appropriate level of care and to provide sufficient staff and supplies to the receiving facilities.

Each county has established special needs shelters for those residents on the special needs registries as well as plans for transportation of those residents and their care providers. Home health agencies are now required to work with the

county emergency management agencies and health departments and to augment staff at those shelters if required.

5. Critical Infrastructure (Water Systems, Waste Water Systems, Power, Communications and Transportation)

The Critical Facilities Inventory also includes a listing of critical facilities/infrastructure necessary for response and recovery. County emergency management worked with providers including local government, utility companies, phone and cellular companies and transportation entities in the region.

6. Response and Recovery Facilities

State and county emergency management agencies have pre-identified potential sites for Points of Distribution of emergency supplies in the community as well as potential Staging Areas and Recovery Sites. These facilities are included in the Critical Facilities Inventories and are mapped. In addition certain community resources such as community/recreation centers and churches were included. This preliminary information will be evaluated looking at key factors such as hazard vulnerability, neighborhood access, and income levels. (See maps in Appendix IV-A, B, C, and D)

7. Other Critical Facilities

The Inventory also includes the most current listing of hazardous material (Section 302) facilities, mobile home and RV parks, as well as both public and private resources.

Figure IV-1 Traffic Evacuation Zones (TEZs) - Treasure Coast Region

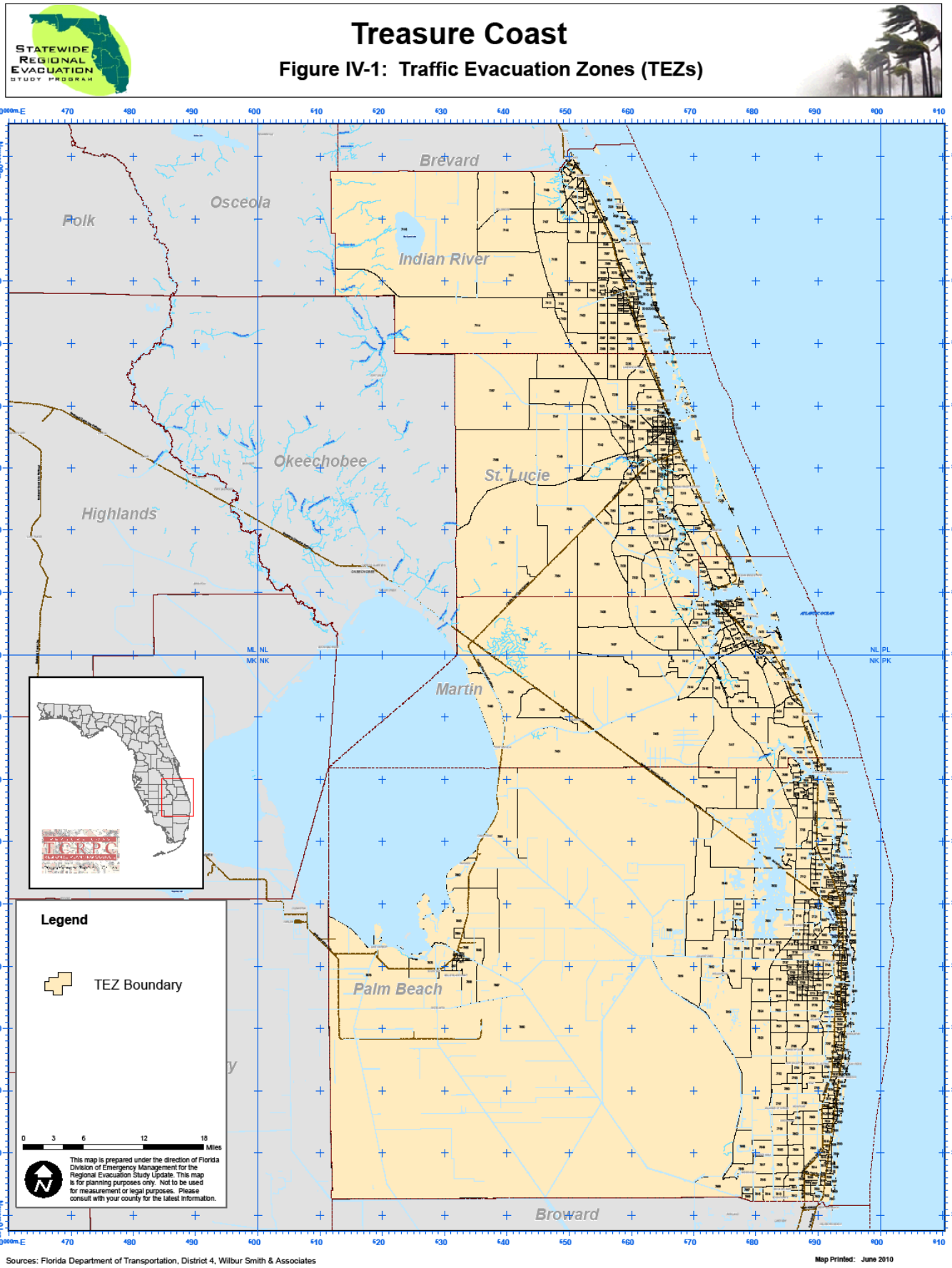

Figure IV-2 Hurricane Evacuation Zones - Treasure Coast Region

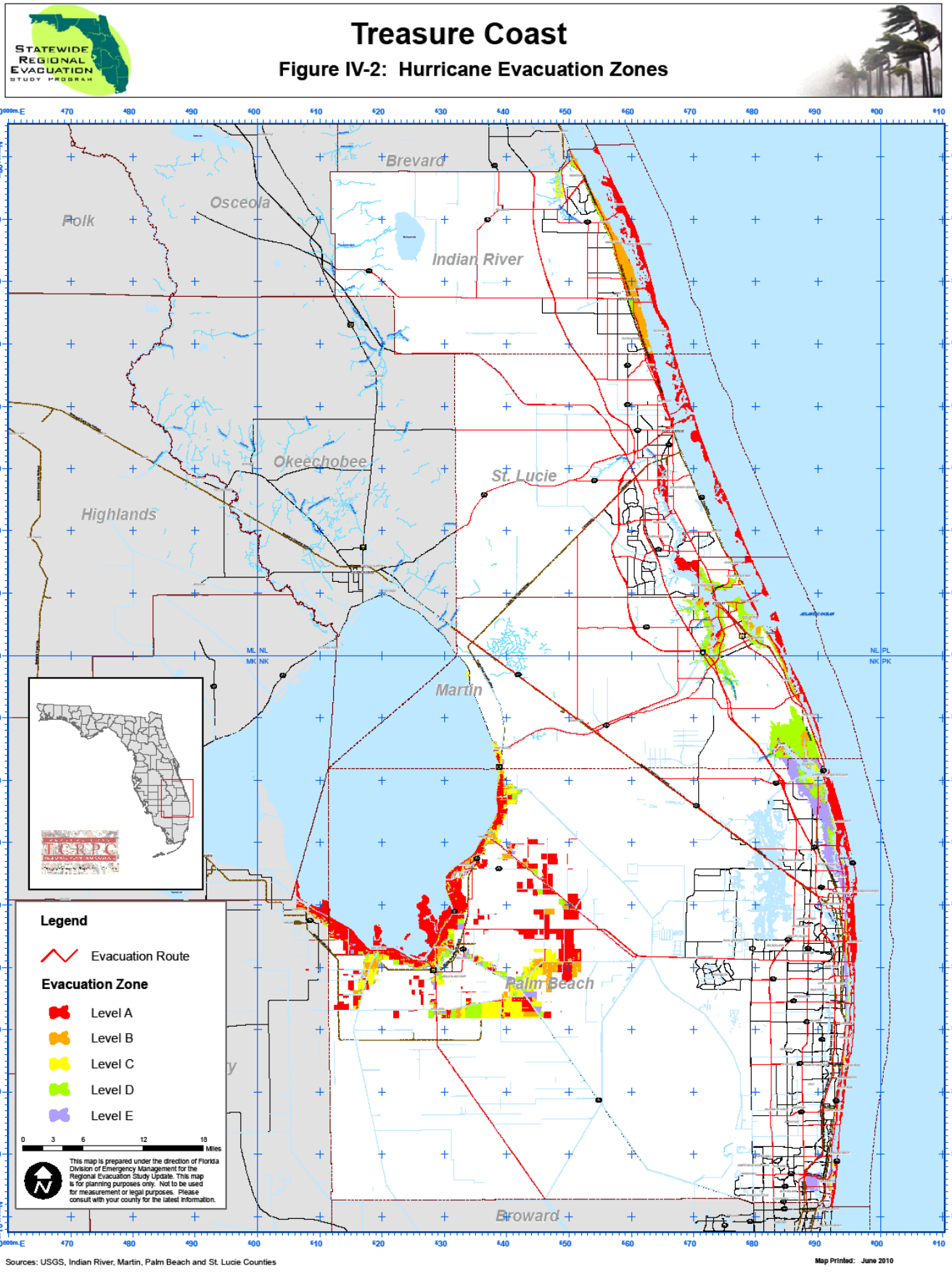

Figure IV-3 Treasure Coast Region 100-Year Flood Plain

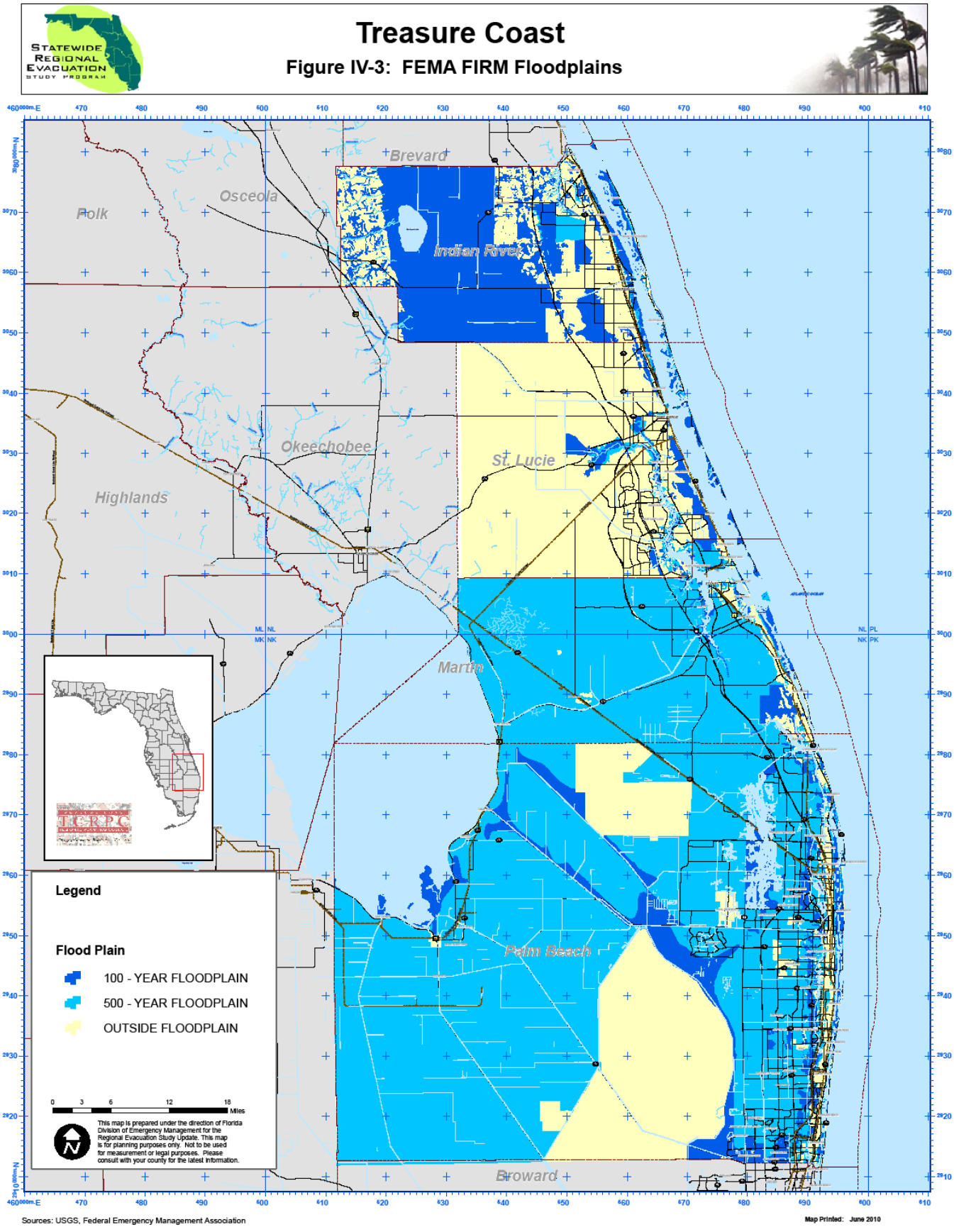

Figure IV-4 Wildland-Urban Interface Evacuation Areas - Treasure Coast Region