Florida Statewide Regional Evacuation Study Program

Regional Population and Vulnerability Analysis

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Southwest Florida Region
Technical Data Report

CHAPTER IV

REGIONAL VULNERABILITY AND POPULATION 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

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

analysis for flooding used the FEMA National Flood Insurance Rate Maps (FIRMs) to present the 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 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 VII for the counties of Charlotte, Collier, Glades, Hendry, Lee and Sarasota Counties and the Lee County Metropolitan Planning Organization (MPO). 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). 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 Southwest Florida Regional Evacuation Transportation Model incorporates the six counties within the Southwest Florida 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.

3. Traffic Evacuation Areas (TEAs)

There are approximately 2000 TEZs in the Southwest Florida Region. In order to present the multi-hazard vulnerability analyses and population data in a meaningful way, the TEZs were further aggregated into **Traffic Evacuation Areas (TEAs)** in the Southwest Florida Region. The designation of the TEAs assisted in presenting this information by further delineating the county by geographic or environmental boundaries, transportation networks and demographic characteristics.

Existing local emergency management plans were also utilized in the designation of evacuation analysis zones to include Recovery and/or Debris Management Areas or local planning districts.

The TEAs were built on and are consistent with the small area data (TAZs or Census Block Groups) and the Traffic Evacuation Zones (TEZs) (See Evacuation Transportation Analysis).

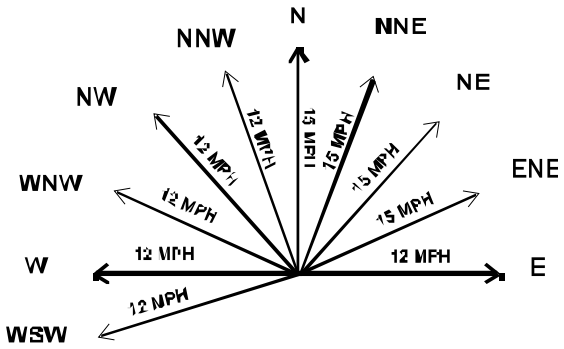
In consultation with the local emergency management agencies and local and state planners, Geographic Information System (GIS) tools were utilized to divide each county in the region into appropriate Traffic Evacuation Areas (TEAs).

In the Southwest Florida Region, the TEAs were drawn using the following considerations:

- Jurisdictional Boundaries
- SLOSH Zones
- Neighborhoods and Communities / Census Places
- Transportation Networks and Regional Evacuation Routes
- 2001 Regional Hurricane Evacuation Study Evacuation Zones
- Traffic Evacuation Zones (TEZs)

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

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 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 heights for the four coastal counties and two Lake Okeechobee counties were furnished by the National Hurricane Center and have 2 values, mean tide and high tide and 16' and 20' lake levels, respectively. 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 and 16' and 20') for each coastal and inland 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 back bay 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	Charlotte	Collier	Lee	Sarasota	Lake O 16ft	Lake O 20ft
TS	Up to 5.2	Up to 5.8	Up to 6.1	Up to 5.6	NA	NA
1	Up to 7	Up to 8.2	Up to 8.7	Up to 6.9	Up to 21.1	Up to 25
2	Up to 17	Up to 14.1	Up to 15.5	Up to 15.4	Up to 26.6	Up to 30.6
3	Up to 26	Up to 19.5	Up to 23	Up to 26	Up to 33.2	Up to 35.5
4	Up to 32.3	Up to 24.5	Up to 27.6	Up to 33.2	Up to 36.4	Up to 37.2
5	Up to 37.7	Up to 41.9	Up to 41.7	Up to 35.4	Up to 38.9	Up to 40

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

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 land falling hurricanes (Categories 1,2,3,4 and 5). County emergency management agency delineates 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 agency's 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 which 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. In Southwest Florida, a program was developed using the property appraiser database and the GIS. Where storm surge from a hypothetical hurricane is predicted to inundate a parcel, that parcel is included in

the evacuation area for that evacuation level. This parcel by parcel delineation results in a very detailed evacuation zone map and is challenging for public information and evacuation implementation. This approach reduces the "over-evacuation" 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 which may be easier to convey to the public. County Evacuation Zones are presented on Figures IV-4a, 4b, 4c, and 4d, 4e and 4f.

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,

[4] For example, in February 1998, a tornado destroyed many site-built homes, mobile homes and RVs in the Kissimmee/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.

strapping, and tie down regulations to make manufactured homes safer[6]. In the year 2000, one out of six new, single-family housing starts was a manufactured home. www.builtstronger.com/history.html

In the 2004 hurricane season, new manufactured homes held up relatively well, even when compared to site-built homes. According to a Florida Department of Highway Safety and Motor Vehicles, Division of Motor Vehicles, Bureau of Mobile Home and RV Construction study of how well various ages of mobile homes in Lee and Charlotte County withstood the 140 mph winds of Hurricane Charley, the new homes, built since HUD changed its building code in July 1994, performed (without exception) admirably. 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)

Furthermore, the State Bureau of Mobile Home and RV Construction surveyed 11,800 manufactured homes among 77 parks in seven counties, including hard hit Charlotte and DeSoto Counties. Of the manufactured homes installed according to Rule 15-C the most stringent tie-down regulation in the country—the Bureau could not find a single home that had been moved from its foundation. And RADCO, an independent engineering firm, revealed that manufactured homes produced and installed in accordance with the current Federal Standards successfully withstood the effects of Hurricane Charley. (http://www.builtstronger.com/myths.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.

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

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 Southwest Florida 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. This list was geo-coded using the Geographic Information System (GIS). County maps identifying the locations of mobile home parks are included in the Appendices (Appendices IV- A, IV-B, IV-C, IV-D, IV-E and IV-F). This data base provided an accurate up-to-date inventory of mobile home/ RV spaces within licensed parks. However, it was necessary to supplement this data in all the counties within the region (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 Southwest Florida Region (2009)

County	# of MH/RV Parks	# of Mobile Homes Spaces	# of RV Unit Spaces	Sum # of Spaces
Charlotte	45	6,915	2,297	9,212
Collier	69	4,061	3,561	7,705
Glades	35	258	2,317	2,645
Hendry	29	1,222	1,282	2,513
Lee	143	16,859	10,690	27,765
Sarasota	80	15,654	3,756	19,439
Region	401	74,284	44,050	119,119

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** Southwest Florida 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 was 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's arrival;

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

(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 new program were:

- 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 Southwest Florida 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 Southwest Florida 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 surge 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 surge flooding from each category of land falling 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 agency 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 surge. 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. In the Southwest Florida Region the population has grown from 160,000 in 1921 (when the last major hurricane made landfall in the region) to 1,555,562 today.

The population-at-risk from hurricane evacuation level for the Years 2010 and 2015 are presented on Tables IV-3 and IV6.

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 Southwest Florida Region during the post Hurricane Georges, 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. The post 2004 and 2005 season survey seems to contradict this assumption -- at least in the Southwest Florida area which has been spared a hurricane strike for so many years.

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 which, in the Southwest Florida 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 a 20% "*shadow evacuation*". The Base Scenario is considered the "planning scenario", a more conservative estimate which 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 2015 on 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 conservative "shadow evacuation rate." The vulnerable shadow population is calculated using a combination of rates from the behavioral study for site built homes. Mobile homes are not included as vulnerable shadow population because they are all considered vulnerable and are on the vulnerable population tables. Vulnerable shadow population is calculated using the site built homes that are not vulnerable in other parts of the county. The calculation uses several of the shadow evacuation rates from the behavioral study. Here is an example:

2010 Charlotte County – Level C Vulnerable Shadow Population = (site built population in evacuation zone D)*(shadow evacuation rate for Cat 3 storm for evacuation zone D) plus (site built population in evacuation zone E)*(shadow evacuation rate for Cat 3 storm for evacuation zone E) plus (site built population in inland portion of the county)*(shadow evacuation rate for Cat 3 storm for inland portion of the county).

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%. The 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

County	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Charlotte County	48,322	92,994	29,118	5,195	249
Collier County	89,754	130,924	76,200	9,155	3,874
Glades County	604	643	674	1,185	408
Hendry County	2,268	307	274	70	0
Lee County	112,663	262,232	137,540	40,707	47,096
Sarasota County	29,683	55,240	114,718	68,787	39,251
Southwest Florida Region	283,294	542,340	358,524	125,099	90,878

Note: Vulnerable population determined using SRESP behavioral data and county provided evacuation zones. Vulnerable population numbers are not inclusive, meaning population numbers listed for a higher zone are not included in the lower zone. For example, vulnerable population listed for Evacuation Zone B does not include vulnerable population listed for Evacuation Zone A.

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

County	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Charlotte County	89,731	155,193	177,604	180,115	180,275
Collier County	159,885	259,887	321,015	328,205	329,479
Glades County	6,668	7,114	7,765	8,335	8,644
Hendry County	21,529	22,752	25,008	26,083	27,116
Lee County	266,761	451,504	561,508	600,955	626,078
Sarasota County	108,516	154,378	262,304	323,399	349,525
Southwest Florida Region	653,090	1,050,828	1,355,204	1,467,092	1,521,117

Note: Vulnerable shadow population included as determined using SRESP behavioral data and county provided evacuation zones.

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

County	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Charlotte County	0	87,258	103,585	128,494	151,442
Collier County	111,736	111,736	211,630	255,267	278,344
Glades County	3,826	3,826	4,912	5,986	6,829
Hendry County	13,003	13,003	16,784	20,722	23,567
Lee County	199,274	258,261	372,654	453,170	516,398
Sarasota County	0	105,251	105,251	187,361	317,297
Southwest Florida Region	327,839	579,335	814,816	1,051,000	1,293,877

Note: Vulnerable shadow population included as determined using SRESP behavioral data and county provided evacuation zones.

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

County	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Charlotte County	77,504	86,602	23,330	4,560	179
Collier County	149,477	102,661	73,799	12,997	3,344
Glades County	777	664	748	1,142	380
Hendry County	2,317	312	237	66	0
Lee County	104,882	224,145	180,355	70,628	77,885
Sarasota County	22,776	53,328	143,032	98,270	30,997
Southwest Florida Region	357,733	467,712	421,501	187,663	112,785

Note: Vulnerable population determined using SRESP behavioral data and county provided evacuation zones. Vulnerable population numbers are not inclusive, meaning population numbers listed for a higher zone are not included in the lower zone. For example, vulnerable population listed for Evacuation Zone B does not include vulnerable population listed for Evacuation Zone A.

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

County	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Charlotte County	116,378	177,271	195,622	197,388	197,497
Collier County	211,604	291,724	352,439	361,749	362,702
Glades County	7,310	7,767	8,483	9,028	9,330
Hendry County	23,715	24,998	27,344	28,477	29,570
Lee County	271,069	429,482	580,133	646,743	687,293
Sarasota County	113,409	157,352	290,143	368,155	389,878
Southwest Florida Region	743,485	1,088,594	1,454,164	1,611,540	1,676,270

Note: Vulnerable shadow population included as determined using SRESP behavioral data and county provided evacuation zones.

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

County	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Charlotte County	67,044	99,253	115,622	143,058	115,622
Collier County	0	184,227	184,227	236,992	184,227
Glades County	4,124	4,124	5,295	6,452	7,357
Hendry County	0	14,276	18,415	22,670	25,774
Lee County	206,538	263,502	397,107	492,156	397,107
Sarasota County	88,149	88,149	207,608	295,190	207,608
Southwest Florida Region	365,855	653,531	928,274	1,196,518	937,695

Note: Vulnerable shadow population included as determined using SRESP behavioral data and county provided evacuation zones.

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
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 Traffic Evacuation Areas (TEAs) were overlaid on the digital Q3 Flood Data[7] (100-year flood zones). 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 determine the population within the flood zones within each TAZ, aggregated to the Traffic Evacuation Areas (TEAs). The estimates for the population-at-risk for flood zones within each County TEA for 2010 and 2015 are presented on Table IV-10.

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.

[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.

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

County	Total County Population 2010	Estimated Population in 100 Year Floodplain 2010	Total County Population 2015	Estimated Population in 100 Year Floodplain 2015
Charlotte	181,227	177,530	198,395	193,703
Collier	337,916	169,979	368,898	224,482
Glades	10,670	10,670	11,481	11,481
Hendry	40,231	40,231	43,443	43,443
Lee	640,930	430,938	704,197	434,117
Sarasota	422,779	281,697	461,035	283,629
Southwest Florida Region	1,633,753	1,111,045	1,787,449	1,190,855

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 within the Traffic Evacuation 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, then aggregated up to the Traffic Evacuation Areas (TEAs). The estimates for the population-at-risk for the Wildland Interface within each county TEA 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.

[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).

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

County	Total Estimated County Population	Estimated Population in Wildfire/Urban Interface	Total Estimated County Population	Projected Population in Wildfire/Urban Interface
	2010	2010	2015	2015
Charlotte	181,237	161,646	198,395	185,118
Collier	337,916	324248	368,898	347,851
Glades	10,670	10,670	11,481	11,481
Hendry	40,231	37,197	43,443	40,036
Lee	640,930	472,730	704,197	604,040
Sarasota	422,779	293,594	461,035	355,545
Southwest Florida Region	1,633,763	1,300,085	1,787,449	1,544,071

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
Home Care	
Home Health Agencies	Offices provided in table format
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
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

TYPE OF CRITICAL FACILITY	CRITICAL CODE
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
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 Southwest Florida Region there are 20 hospitals, 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 agency provides training and assistance in the development and maintenance of the nursing home plans.

[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.

Table IV -13: Health Care Facilities in Southwest Florida

Type of Facility	Charlotte	Collier	Glades	Hendry	Lee	Sarasota	Region
Assisted Living							
Assisted Living Facilities/ Adult Family Care Homes	38	20	0	1	55	76	190
Long Term Care							
Skilled Nursing Facilities	0	0	0	0	0	0	0
Intermediate Care Facilities	0	0	0	0	5	1	6
Hospitals							
Hospitals	3	5	0	1	5	6	20
Residential Treatment Facilities	0	0	0	0	1	1	2
Laboratory							
End Stage Renal Disease Facilities	3	7	0	1	9	4	24
Home Care							
Home Health Agencies	17	31	0	0	55	54	157
Hospices	0	1	0	0	1	1	3

Source: Agency for Health Care Administration (AHCA) - Online: Florida Health Finder: http://www.floridahealthfinder.gov/FacilityLocator/FacilitySearch.aspx

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

In addition to the medical facilities there are 190 licensed assisted living facilities (ALFs) in the Southwest Florida Region. ALFs are living arrangements where adults live together to receive room, meals, and help with their daily living. ALFs 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 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 Table 1 of Appendix IV.

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

On any given day in the Southwest Florida Region, it is estimated that approximately 100,000 residents are receiving some type of home health care. Those 100,000 residents will not be the same residents next month. 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, D, E and F).

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) in the Southwest Florida Region

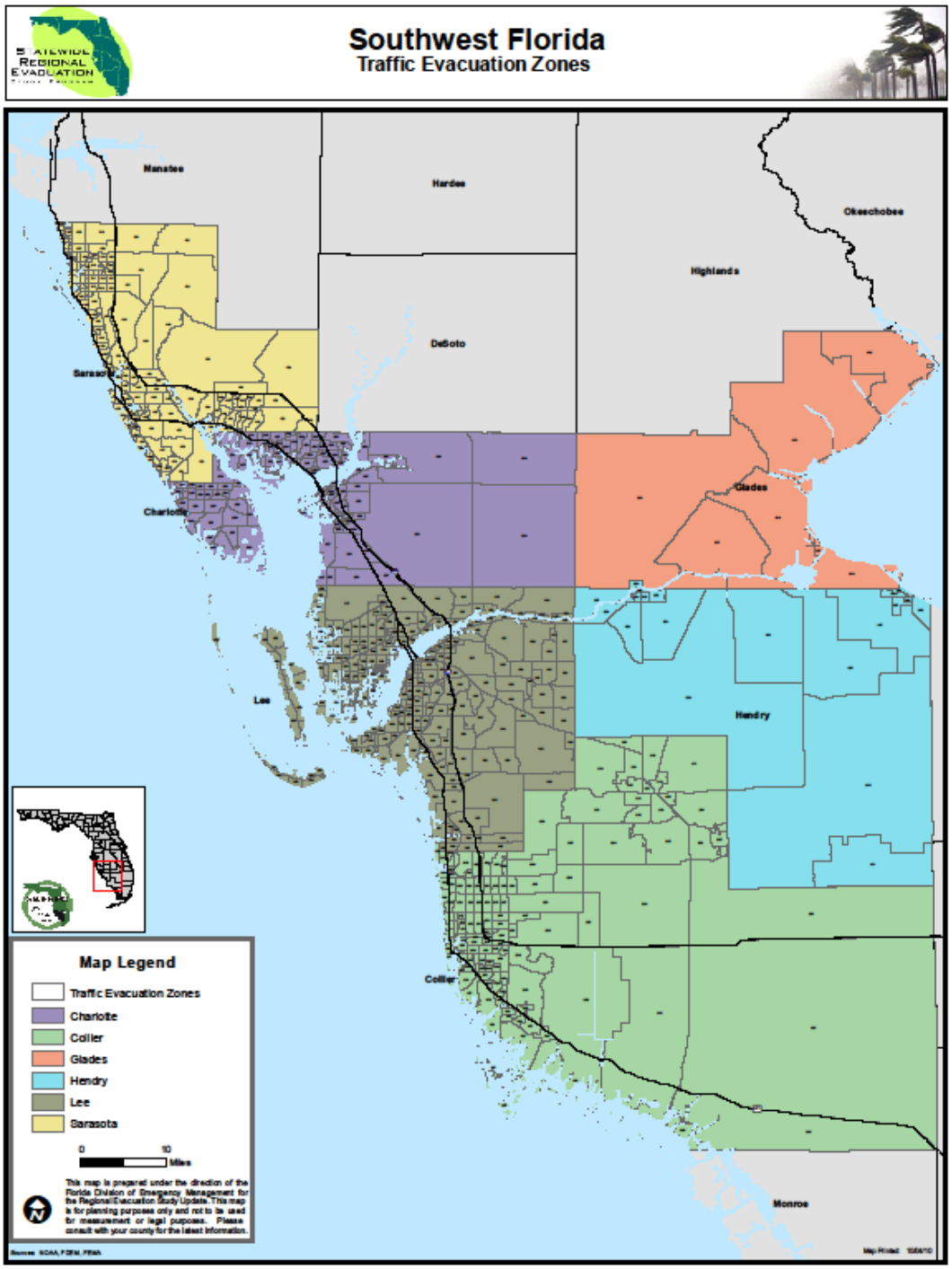


Figure IV-2: Hurricane Evacuation Zones

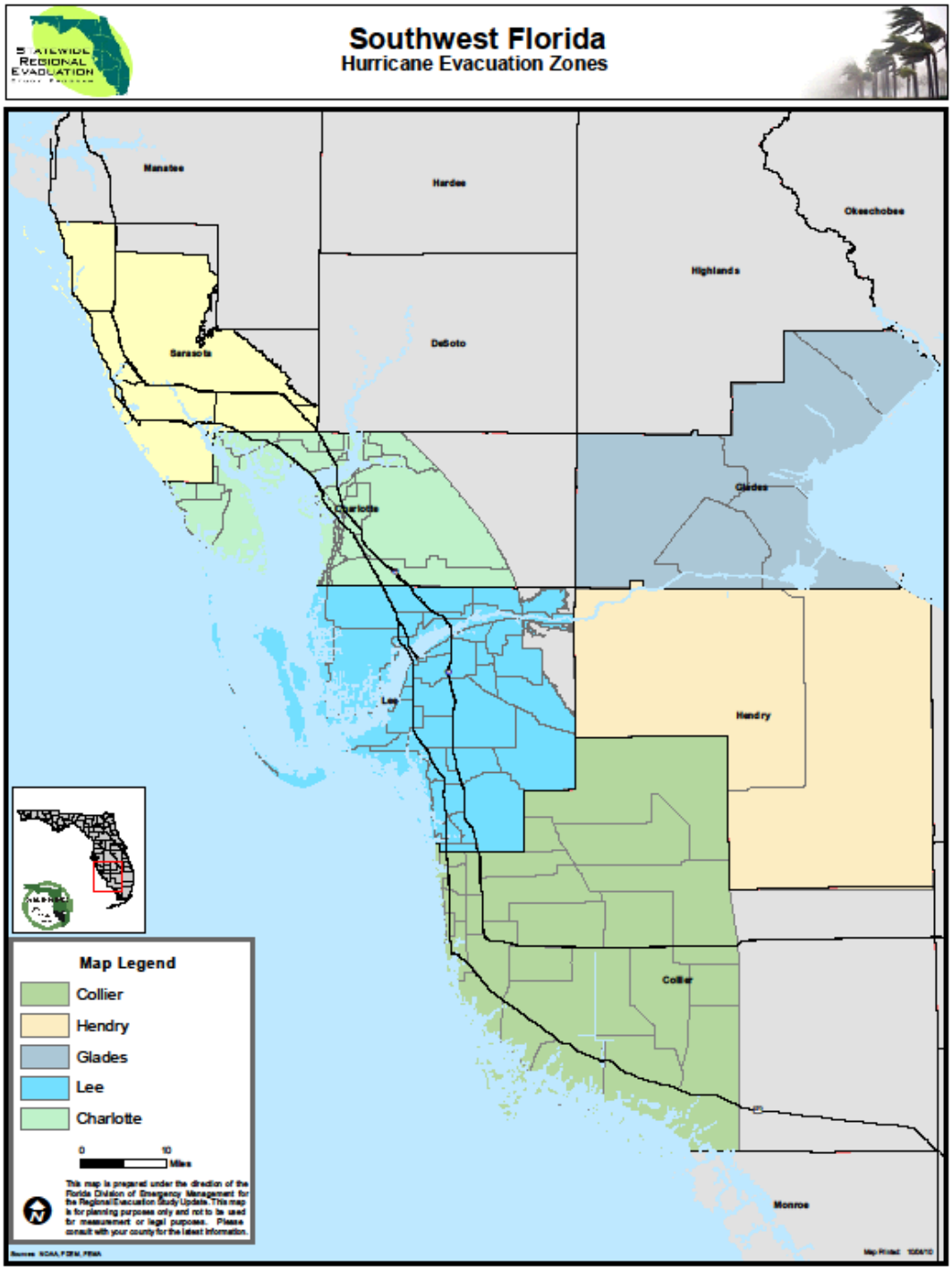


Figure IV-3: Flood Zones

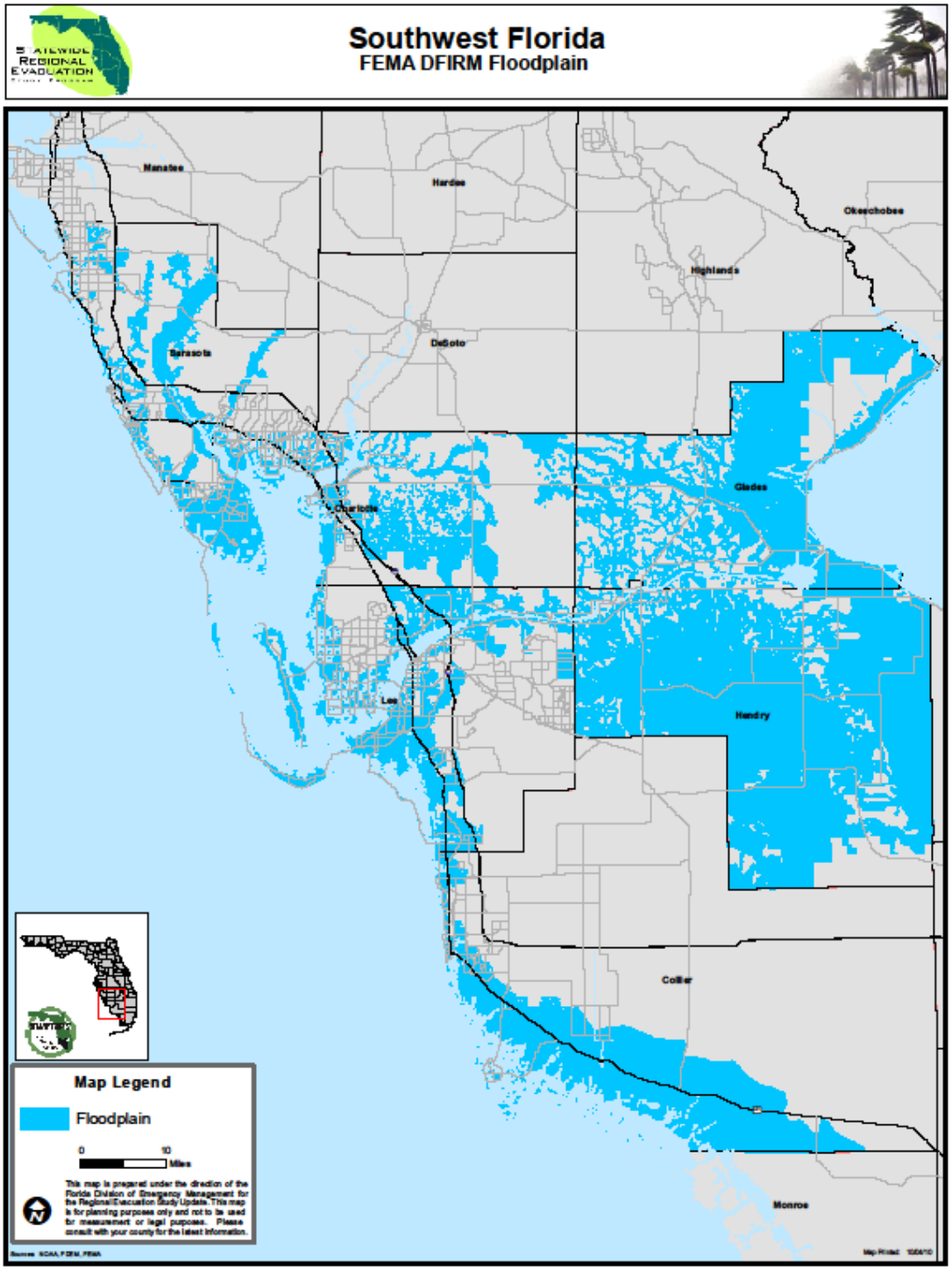
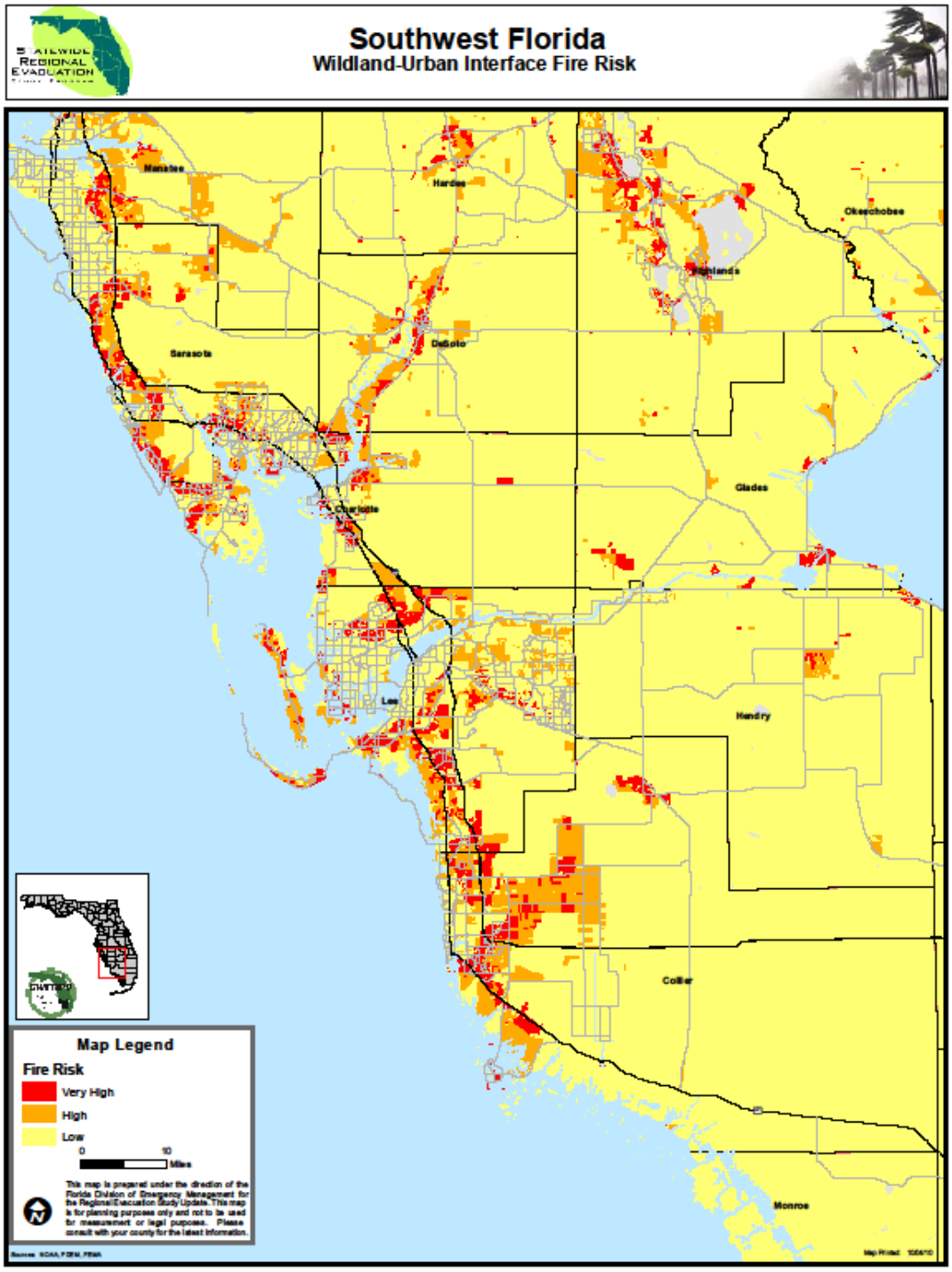


Figure IV-4: Wildland-Urban Interface Fire Risk



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