South Florida

Statewide Regional Evacuation Study Program

for Broward, Miami-Dade and Monroe Counties

Prepared by:
South Florida Regional Planning Council
for the
Florida Department of Community Affairs
Division of Emergency Management

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The Statewide Regional Evacuation Study Program was completed by regional planning council staff in all eleven regions of the State. Oversight was provided by a small group in order to facilitate an overall review of the program. Subject matter expertise was provided by section leads for the major portions of the Study. It was these leaders who ensured that the accepted methodology was utilized across the State and that each section was completed in a consistent manner.

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The South Florida Regional Planning Council (SFRPC), Region 11, is one of 11 regional planning councils in Florida established under the authority of Chapter 186, Florida Statutes. Founded in 1974, its mission is to identify the long-term challenges and opportunities facing Southeast Florida and assist the Region's leaders in developing and implementing creative strategies that result in more prosperous and equitable communities, a healthier and cleaner environment, and a more vibrant economy. The South Florida Regional Planning Council serves the counties of Broward, Miami-Dade and Monroe.

There are two distinct components of the Regional Planning Council:

- The Council Governing Board, which governs the agency, is comprised of 19 local government elected officials and private citizen representatives within the region appointed by the Governor of the State of Florida.
- The staff is made up of 20 professionals who provide technical support for Council decision-making and services for local governments throughout the region.

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Statewide Regional Evacuation Study Program
List of Volumes

Volume 1 – Technical Data Report
The ***Technical Data Report (TDR)*** is the primary document of the Statewide Regional Evacuation Study Program. The TDR contains the summary analysis of all other supporting research, survey data and modeling.

Volume 2 – Regional Behavioral Analysis
The ***Regional Behavioral Analysis*** was produced by the behavioral specialist Dr. Earl J. Baker, Hazards Management Group. The report includes a summary of the behavioral survey data and analysis which includes the regional behavioral assumptions incorporated in the calculation of evacuation population, evacuation participation rate (transportation analysis) and anticipated shelter demand.

Volume 3 – Regional Behavioral Survey Report
The ***Regional Behavioral Survey Report***, produced by Kerr and Downs, Inc., provides the survey data from the 1,200 behavioral surveys conducted in South Florida in 2007 as part of the Statewide Regional Evacuation Study Program.

Volume 4 – Evacuation Transportation Analysis
The ***Regional Evacuation Transportation Analysis*** is produced by the evacuation transportation team at Wilbur Smith Associates. It includes a summary description of the evacuation transportation model, study methodologies and assumptions and growth management impact assessments on evacuation. The report includes the evacuation clearance times for the counties and the region for 2010 and 2015 under different planning and operational scenarios.

Volume 5 – Evacuation Transportation Supplemental Data Report
The Supplemental Data Report, prepared by Wilbur Smith Associates, contains the model run inputs and outputs and serves as the source data for the ***Evacuation Transportation Analysis***.

Volume 6 – Emergency Management Evacuation Tool Kit
The ***Emergency Management Tool Kit*** includes locally-selected data pertinent to each of the county emergency management agencies. It is meant to be used as a quick reference guide for operations. There is one Book for each county in the region.

Volume 7 – Storm Tide Atlas
The Storm Tide Atlas provides the storm tide boundaries based on the new SLOSH Analysis, including the boundaries of the Coastal High Hazard Area (CHHA). It is provided in several formats, including GIS files, PDF files and printed copy. There is one Book for each county in the region that has a potential for storm tide flooding.

Volume 8 – Methodology of Evacuation Transportation Modeling for the Statewide Regional Evacuation Study Program, 2010
This volume provides a detailed description of the methodologies, model assumptions and the Transportation Interface for Modeling Evacuations (TIME), developed for and utilized in the Statewide Regional Evacuation Study Program.

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Volume 1 – Technical Data Report
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PREFACE

A. About the Region

South Florida, which is made up of Monroe, Miami-Dade and Broward Counties, is the largest of the eleven planning regions in the State of Florida. It has a total area of almost 4.8 million acres (7,488 square miles), of which 4,148 square miles are land area and 3,340 square miles (44.6%) are water. It is bounded on the east by the Atlantic Ocean, on the north and west by Palm Beach County, Hendry County and Collier County, and on the south and west by the Gulf of Mexico.

South Florida is at the center of an international region that ties together the United States with Central and South America and the Caribbean. In its role as a gateway, it also links this region to Europe, Asia and Africa. Larger than 25 states, the region had a population of 4.3 million in 2009, the majority of which lives within the boundaries of 71 municipalities. In 2009, Miami-Dade was the 8th largest county in the US, with 2.4 million residents, and Broward was the 16th largest, with 1.8 million. These two counties, along with Palm Beach to the north, make up the nation's 7th largest metropolitan region, with a population of 5.5 million. In fact, South Florida's economic ties increasingly extend even further north, to Martin, St. Lucie and Indian River Counties, with residents moving across the 7-county region in their daily commutes to and from work, straining the region's transportation infrastructure.

The Atlantic Ocean to the east and the Everglades system to the west create natural boundaries for the region, which is largely built-out, so future growth increasingly will take the form of infill development and redevelopment. Even with the economic downturn, South Florida grew more rapidly (9.7%) than the nation as a whole (9.1%) during this decade. South Florida adds about 70 new residents each day, which will lead to an increase of more than half a million people in the next two decades. International migration is the most significant source of population growth in the region, accounting for more than 460,000 new residents in the current decade, while the region lost over 276,000 to domestic out-migration in the same period. In 2009, the foreign-born population in the region was 41% of the total, up from 33% in 1990 and 26% in 1980.

The ethnic and racial composition of South Florida's population continues to grow more diverse. Nearly half (46%) of the region's population today is Hispanic or Latino. This ethnic group, which can be of any race, continues to grow more diverse within, with large communities from various Central and South American nations, even as the Cuban community, the largest Hispanic group in the region, continues to grow. The Black population, which in South Florida includes not only African Americans but also large communities from the Caribbean and Latin America, represented 21% of the overall population in 2009.

Approximately 1.9 million acres of the land area (71.7%) of the three counties are designated for conservation. These areas include Everglades National Park and Big Cypress National Preserve, the Water Conservation Areas that are part of the larger Everglades system, Biscayne National Park and Dry Tortugas National Park, four national wildlife refuges (Great White Heron, National Key Deer, Key West and Crocodile Lake) and fifteen state parks, all of which help to

preserve habitat for threatened and endangered species. Monroe County includes both the mainland portion of the County and the Florida Keys, the long string of islands extending 110 miles from Key Largo southwest to the City of Key West. The County also is home to the Florida Keys National Marine Sanctuary, created to protect North America's only coral reef, the third largest coral reef system in the world.

B. Background

South Florida is one of the most hurricane vulnerable areas in the United States. During the last 50 years, the region's population more than tripled, adding 3 million new residents, with a corresponding increase in the number of people exposed to the impacts of hurricanes and other natural disasters.

In June 1983, the Jacksonville District of the United States Army Corps of Engineers (USACE) and Post, Buckley, Schuh & Jernigan, Inc. (PBS&J) published the *Lower Southeast Florida Hurricane Evacuation Study*, with funding from the USACE and the Federal Emergency Management Agency (FEMA). The study encompassed four counties from Palm Beach south to Monroe. Key elements of the methodology used in the Technical Data Report included (1) a hazards analysis; (2) a vulnerability analysis; (3) population data; (4) behavioral data; (5) shelter data; (6) gale force winds analysis; (7) shelter duration; (8) study analysis zones; (9) evacuation routes; (10) shelter assignment; (11) clearance time; (12) evacuation order time; and (13) coordination. Council staff participated as a member of the Regional Disaster Preparedness Committee. The worst probable storm tide elevations, for a Category 5 storm on the Saffir-Simpson Hurricane Wind Scale, were estimated to be in excess of 15 feet for Monroe County and Miami-Dade County, in excess of 11 feet for Broward County, and in excess of 9 feet for Palm Beach County.

The USACE and FEMA teamed up with the National Oceanic and Atmospheric Administration (NOAA), through the National Hurricane Center (NHC), and the Florida Department of Community Affairs (DCA), through its Division of Emergency Management, to complete an update to the *Lower Southeast Florida Hurricane Evacuation Study* in 1991. This update utilized information from the Sea, Lake and Overland Surges from Hurricanes (SLOSH) models for Biscayne Bay and Florida Bay, developed by the NHC. These models were not available when the original study was prepared. The study was funded by FEMA, USACE and DCA, and included extensive coordination with the emergency management directors of all four counties. The update included five major analyses (hazards, vulnerability, behavioral, shelter and transportation), along with a section on decision information, which incorporated the use of the HURREVAC model. These components of the study were combined into a Technical Assessment document for each county. In addition, a Storm Surge Atlas was published for each county. As part of the update, the USACE contracted with the Department of Psychology at the University of South Florida to prepare a study that included four sections: (1) a review of studies of actual hurricane evacuations; (2) a review of behavioral studies of reactions to hypothetical hurricanes; (3) a review of the literature regarding the responses of immigrant groups to evacuations; and (4) a behavioral study of reactions to hypothetical hurricanes of residents of Monroe County.

The *Florida Keys Hurricane Evacuation Study* was prepared by Miller Consulting, Inc., for the Florida Department of Transportation, District 6, and published in June, 2001. The study had

three specific goals: (1) develop an evacuation model that measured and analyzed the unique characteristics of the Florida Keys; (2) determine the clearance time required to evacuate the Florida Keys up to Florida City, based on existing US 1 and Card Sound Road conditions (providing input into the *Miami-Dade County Hurricane Evacuation Study* at the junction of US 1 and the Florida Turnpike); and (3) identify clearance times of various scenarios, which include existing conditions ("no build") as well as "build" alternatives. One of the products of this study was a spreadsheet model that is used to estimate clearance times under changing roadway, behavioral and demographic characteristics and assumptions in the Florida Keys.

During the early 2000s, the USACE, FEMA, the NHC, DCA and PBS&J participated in the preparation of a number of county-level updates for Miami-Dade County and Broward County. New topographic (Light Detection and Ranging – LiDAR) data and new Sea, Lake and Overland Surges from Hurricanes (SLOSH) modeling provided data that was used to update the delineation of evacuation zones by the county emergency management departments, who then contracted the preparation of updated traffic analysis to calculate new clearance times and identify congested roadways. However, there were no comprehensive regional updates to the *South Florida Regional Hurricane Evacuation Study*.

In early 2006, the Florida Department of Community Affairs contracted with the South Florida Regional Planning Council to carry out an update of the traffic component of the *South Florida Regional Hurricane Evacuation Study*. The resulting *2006 South Florida Regional Hurricane Evacuation Traffic Study* provides an integrated analysis of Monroe County, Miami-Dade County and Broward County. The accompanying user model, with the capability to analyze existing and future regional hurricane evacuation traffic dynamics, allows users to test alternative evacuation scenarios. The study charts the flow of vehicles to destinations inside and outside of the region to generate clearance times and identify South Florida roadways prone to traffic congestion. For example, it shows how Monroe County evacuation traffic interacts with Miami-Dade evacuation traffic, especially in southern Miami-Dade County, as it travels into and/or through Miami-Dade County. The study and the user model also make it possible to account for how current and future housing trends, population trends, evacuation behaviors and land development policies across the region, especially within hurricane evacuation zones, generate hurricane evacuation traffic and affect clearance times. The study included traffic modeling performed by the Florida Department of Transportation, District IV, under six baseline hurricane evacuation scenarios. An unpublished regional spreadsheet model linking the three counties, created in 2004 by PBS&J for the United States Army Corps of Engineers, was the starting point for the study and the design of the study's user model. The study also benefitted extensively from the Florida Keys model developed by Miller Consulting.

Over the years, the South Florida Regional Planning Council has produced a number of additional studies related to hurricane preparedness and response, evacuation planning and climate change:

- *South Florida Region: Hurricane Loss Study* (February, 1987)
- *South Florida Hurricane Contingency Planning Study* (June, 1987)
- *South Florida Regional Hurricane Exercise After Action Report* (December, 1987)
- *Hurricane Shelter Survey Report* (November, 1990)
- *Post-Disaster Redevelopment Planning: Model Plans for Three Florida Scenarios* (December, 1990)
- *Regional Resource and Shelter Capacity Analysis* (September, 1993)

- *Hurricane Survival Guide for Small Businesses* (September, 1995)
- *Regional Strategic Coastal Management Element for Local Government Comprehensive Plans* (September, 1995)
- *South Florida Regional Hurricane Evacuation Study: Final Report* (April, 1996)
- *Broward County Hurricane Risk Assessment Information System* (January, 1997)
- *Monroe County Inland Evacuation and Shelter Plan* (1997)
- *Hurricane Survival Guide for Small Businesses, 2nd Edition* (2000)
- *Post Disaster Redevelopment: Putting the Pieces Together* (2001)
- *Sea Level Rise Project Final Report* (September, 2005)
- *Climate Change Community Toolbox CD* (August, 2007)
- *Climate Change Impact Resiliency Study for Local Governments in Miami-Dade County* (June, 2010)

C. Objective and Scope

A major hurricane making landfall reaches beyond county lines and affects even areas not directly hit by the storm. Jurisdictions and counties can share one bay or estuary which can experience drastic storm surge. Evacuation routes can bring residents from one town or county into a completely different jurisdiction or even state. Therefore, it is important for local governments to communicate across governmental lines in order to plan for the potential impacts neighboring jurisdictions may have on safely evacuating the threatened population.

The primary purpose of this study was to coordinate a statewide, regionally consistent, comprehensive and quantitative evacuation study, primarily for hurricanes. Additional objectives were:

- Ensure consistency in evacuating population and routes with adjacent regions.
- Update and standardize the DEM facilities database to provide all counties with consistent, accurate and standardized emergency management data.
- Establish standardized analysis and methodology for use in deriving impacts and determining mitigation needs as required in Section 163.3178, Florida Statutes.

The major components of the study consist of the following:

- **Demographic and Land Use Analysis** – Describe population and demographics for the region and counties using current socioeconomic data for 2006, with projections for 2010 and 2015.
- **Hazards Analysis** – A comprehensive analysis of potential hurricane hazards in the South Florida Region utilizing new LiDAR data, new SLOSH modeling, and new surge modeling.
- **Behavioral Analysis** – A survey and analysis to determine how vulnerable evacuees may respond to a hurricane threat, as well as other hazards.
- **Vulnerability Analysis** – Identification of the vulnerable areas and population to hurricane, wind and flooding hazards.
- **Shelter Analysis** – A quantitative analysis of shelter availability, deficit, and special needs (medical and pets).

- **Transportation Analysis** – Development of hurricane evacuation clearance times for each county and storm scenario associated with the movement of the current and projected vulnerable population from specific evacuation areas to specific evacuation destinations for years 2010 and 2015.

As part of this study, an abbreviated transportation model called "TIME" was developed that can be used by local emergency management officials, city and county planning staff, state emergency preparedness officials, and others to recalculate clearance times based upon land use and transportation system changes.

The *South Florida Regional Evacuation Study* is not intended to serve as the detailed operations plan for each unit of local government in the region. Rather, it is intended to provide data to support revisions and updates to local and state plans. The implementation of any evacuation plan is a local function. Therefore, the actual deployment and assignment of manpower and equipment to carry out the evacuation is best planned for at the local level. The data provided by this report will enable the local governments of the region to update specific operating procedures for the relocation of their vulnerable populations and recovery from a hurricane strike.

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Volume 1-11
Technical Data Report

South Florida Region

Executive Summary

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EXECUTIVE SUMMARY

This Executive Summary is provided to state and local governments, volunteer organizations, the media and interested residents to highlight the results of the ***Statewide Regional Evacuation Study for the South Florida Region***, and to quantify and to illustrate the challenges of evacuation response in the South Florida Region.

A. DEMOGRAPHIC AND LAND USE ANALYSIS

South Florida is the largest of the eleven planning regions in the State of Florida, with a total area of almost 4.8 million acres (7,488 square miles), of which 4,148 square miles are land area and 3,340 square miles (44.6%) are water. It is bounded on the east by the Atlantic Ocean, on the north and west by Palm Beach County, Hendry County and Collier County, and on the south and west by the Gulf of Mexico. The region is home to a total resident population of 4.3 million in 2006, the majority of which lives within the boundaries of 71 municipalities. The unincorporated portions of the counties were home to 1.2 million residents in 2006, about 27.2% of the regional total.

An explosive growth rate had been experienced fueled by people seeking the combination of ample, quality land opportunities and consistent sun that the South Florida Region has to offer. All three counties in the region had consistently experienced increases in density (persons per square mile) since 1970. This trend has slowed since 2007 with the economic downturn and, for the first time, the region experienced a decrease in population in 2009[1].

Chapter I provides a demographic profile of the region and of each of the counties. Specific socio-economic characteristics that may have an impact on evacuation vulnerability, response and mass care were identified using Census data, including recent American Community Survey data.

Information includes:

- Overall Population
- Group Quarters Population
- Housing Units by Type
- Occupied Housing Units (Households)
- Household Size
- Seasonal Dwelling Units
- Vehicles per Household
- Age Composition
- Race / Ethnicity
- Place of Birth and Citizenship
- Linguistic Isolation
- Labor Force
- Poverty Status
- Small Area Dwelling Unit and Population Data

[1] 2009 Florida Estimates of Population, BEBR

The Future Land Use Map for South Florida is presented Chapter I, and a more detailed map is presented for each county in the corresponding appendices. There are 11 categories identified, which represent a consolidation of land use categories identified in the three county and 71 municipal government comprehensive plans in the region (see Table I-17).

- RL Residential Low (higher than AG, < 1DU)
- RM Residential Medium (more than RL, < 13DU)
- RH Residential High (more than RM)
- CONS Conservation, natural and protected
- PUB Public/Semi-Public, government, institutional
- AG Agriculture - rural land, farms (< 0.5DU)
- REC Recreation/Open Space
- COM Commercial, office, tourism, marina
- MU Mixed Use, activity centers, urban village
- WAT Water bodies
- IND Industrial, extractive, transportation

B. REGIONAL HAZARDS ANALYSIS

The Hazards Analyses is the first step in the development of the regional evacuation study. The Hazards Analysis identifies type, extent and probability of those hazards which may confront our region and necessitate a regional evacuation. The Statewide Regional Evacuation Study Program took an "all-hazards" approach to this evacuation study. The hazards which could necessitate an evacuation at a regional level were identified as (1) tropical storms and hurricanes, (2) flooding, (3) hazardous materials and (4) wildfire.

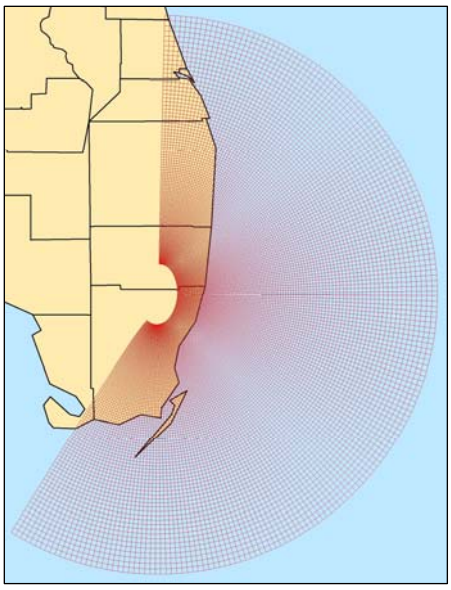
1. Tropical Storms and Hurricanes

Risks from tropical storms and hurricanes include storm surge, high winds, tornadoes and inland flooding. Storm surge, considered the most deadly hazard, was quantified using the National Oceanic and Atmospheric Administration (NOAA) numerical storm surge model, SLOSH[2]. The SLOSH modeling system consists of the model source code and model basin or grid. SLOSH model grids must be developed for each specific geographic coastal area individually incorporating the unique local bay and river configuration, water depths, bridges, roads and other physical features. In addition to open coastline heights, one of the most valuable outputs of the SLOSH model for evacuation planning is its predictions of surge heights over land which predicts the degree of propagation of the surge into inland areas.

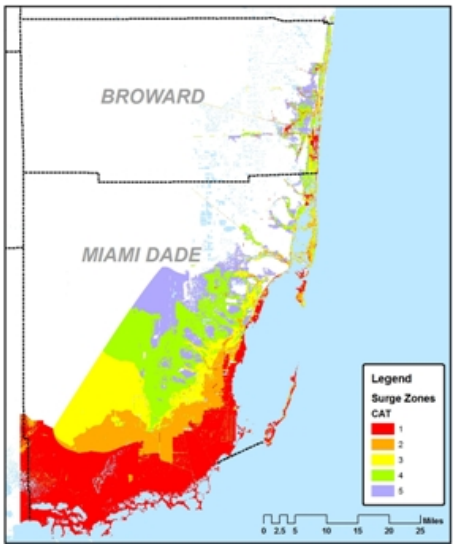
New SLOSH modeling conducted in South Florida provides the maximum amount of surge expected at thousands of points in the Biscayne Bay basin (for Broward and Miami-Dade

[2]SLOSH stands for Sea, Lake and Overland Surges from Hurricanes

Counties) and the Florida Bay basin (for Monroe County), considering different parameters of hypothetical storms and the topography and the bathymetry of the two basins.



The newest generation of the SLOSH model basin incorporated in the ***2010 Statewide Regional Evacuation Study*** reflects major improvements, including higher resolution basin data and grid configurations. Faster computer speeds allowed additional hypothetical storms to be run for creation of the MOM (maximum potential storm surge) values for each category of storm. Storm tracks were run in ten different directions. And for each set of tracks in a specific direction storms were run at forward speeds of 5, 15 and 25 mph. And, for each direction, at each speed, storms were run at two different sizes (30 statute mile radius of maximum winds and 45 statute miles radius of maximum winds). Finally, each scenario was run at both mean tide and high tide. Both tide levels are now referenced to North American Vertical Datum of 1988 (NAVD88) as opposed to the National Geodetic Vertical Datum of 1929 (NGVD29). A total of 14,700 hypothetical storms were modeled for Biscayne Bay and 13,620 for Florida Bay.



SLOSH and SLOSH related products reference storm surge heights relative to the model vertical datum, in this case NAVD88. In order to determine the inundation depth of surge flooding at a particular location the ground elevation at that location must be subtracted from the potential surge height. As part of the Statewide Regional Evacuation Study Program, all coastal areas as well as areas surrounding Lake Okeechobee were mapped using remote-sensing laser terrain mapping (LIDAR[3]) providing the most comprehensive, accurate and precise topographic data for this analysis. As a general rule, the vertical accuracy of the laser mapping is within a 15 centimeter tolerance.

The LIDAR data was incorporated into the SLOSH basin data and used to subtract the land elevation from the storm surge height to develop the storm tide limits. The result of this storm surge hazard analysis is graphically portrayed in the Storm Tide Atlas which illustrates the storm tide limits based on the maximum storm surge for landfalling categories 1, 2, 3, 4 and 5. The Atlas maps and GIS files for South Florida are available online at www.sfrpc.com/sresp.htm.

[3] Light Imaging Detection and Ranging

While all residents would be susceptible to some extent from the affects of hurricane-force winds, mobile home residents are far more vulnerable than residents in site-built homes. Mobile home and RV Park data was updated using information from the State of Florida Department of Health.

Tornadoes are another hazard of tropical storm activity. Because it is impossible to identify where a tornado imbedded in the hurricane wind bands will strike, evacuation does not consider tornado activity, per se. It is recognized, however, that mobile home residents are much more vulnerable to this severe weather event. Therefore, with the evacuation of mobile homes for hurricane winds, it is anticipated that severe injury will also be reduced from any tornado activity. In addition, the public information campaign will include a recommendation that tornado safe rooms (see www.fema.gov) be considered by residents.

While inland flooding had not been considered to be life-threatening in the past, it had, over the last twenty years, become a leading cause of hurricane-related deaths until Hurricane Katrina in 2005. The 100-year flood zone, as designated by the Federal Emergency Management Agency (FEMA) National Flood Insurance Program (NFIP), is identified and addressed separately under the Flooding Hazard.

While in Florida counties do not typically evacuate for inland flooding for a hurricane, it is recognized that this may become a major problem during a hurricane evacuation, after a tropical storm passes or after prolonged rainfall. Evacuation routes within the flood zone are identified in an effort to find alternative routes, if necessary. Public information will stress that after the storm (1) residents do NOT attempt to drive on flooded roadways and (2) children are NOT permitted to swim or play in flood waters.

2. Flooding

Both coastal and inland flooding are addressed through FEMA's NFIP. The 100-year and 500-year floodplain was identified within the region to illustrate the regional and county-level vulnerability to the flood hazard. In addition, communities with repetitive loss properties were identified by building type to provide an overall assessment of the risk. The area's risk, historical frequency and estimated population at risk were identified in the hazards and vulnerability analyses. Also identified were dams which could pose a risk to the population which lives below them.

3. Wildfires and the Urban Interface

Florida is home to millions of residents who enjoy the state's beautiful scenery and warm climate. But few people realize that these qualities also create severe wildfire conditions. Each year, thousands of acres of wildland and many homes are destroyed by fires that can erupt at any time of the year from a variety of causes, including arson, lightning and debris burning. Adding to the fire hazard is the growing number of people living in new communities built in areas that were once wildland. This growth places even greater

pressure on the state's wildland firefighters. As a result of this growth, fire protection becomes everyone's responsibility (Florida Division of Emergency Management, 2008, www.floridadisaster.org/bpr/EMTOOLS/wildfire/wildfire.htm).

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

The risk of potential wildfire to the region's population was identified using the data provided by the Florida Division of Forestry (FlamMap) and the population living in the high/very high risk areas was estimated.

4. Hazardous Materials

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

No specific emergency sequence can be isolated as the model for which to plan because each emergency could have different consequences, both in nature and degree. As an alternative to defining a specified emergency, the regional plan identifies various parameters for planning which are based upon knowledge of the possible consequences, timing, and release characteristics of a spectrum of emergencies. The ***Regional Hazardous Materials Emergency Response Plan*** then establishes the appropriate response for each level of threat. Therefore, the Statewide Regional Evacuation Study did not specifically address hazardous material incidents.

C. VULNERABILITY ANALYSIS AND POPULATION-AT-RISK

Depending upon the strength of the storm, the regional evacuation study calls for the complete evacuation of successively more surge-vulnerable zones inland in addition to all mobile home residents. Using information from the local jurisdictions, the population, dwelling unit counts and vehicle data for each zone was developed (see Chapter IV, Regional Vulnerability and Population Analysis). County/ Regional population-at-risk for the years 2010 and 2015 are presented in Tables ES-1 and ES-2 below.

Table ES-1 Population-at-Risk from Hurricanes by Evacuation Level, 2010

County and Type of Dwelling Unit	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Broward County*					
Site-built Homes	46,214		96,953	45,172	103,939
Mobile/Manuf. Homes	0		191	407	623
TOTAL	46,214		97,144	45,579	104,562
Miami-Dade County*					
Site-built Homes	148,487	153,512		144,869	
Mobile/Manuf. Homes	0	1,917		6,467	
TOTAL	148,487	155,430		151,335	
Monroe County*					
Site-built Homes	72,946				
Mobile/Manuf. Homes	12,179				
TOTAL	85,125				

Source: Volume 4-11, Table IV-1

Note: Vulnerable population determined using SRESP small area data and county provided evacuation zones. See section E for the source of the small area data. 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 D does not include vulnerable population listed for Evacuation Zone C.

**Note: Broward County has a combined A/B zone, Miami-Dade County has combined B/C and D/E zones, and all of Monroe County is considered vulnerable.*

Table ES-2 Population-at-Risk from Hurricanes by Evacuation Level, 2015

County and Type of Dwelling Unit	Evacuation Zone A	Evacuation Zone B	Evacuation Zone C	Evacuation Zone D	Evacuation Zone E
Broward County					
Site-built Homes	49,121		102,701	48,840	109,787
Mobile/Manuf. Homes	0		206	440	671
TOTAL	49,121		102,907	49,280	110,458
Miami-Dade County					
Site-built Homes	153,588	174,226		163,929	
Mobile/Manuf. Homes	0	1,958		6,574	
TOTAL	153,588	176,184		170,503	
Monroe County					
Site-built Homes	77,221				
Mobile/Manuf. Homes	12,130				
TOTAL	89,351				

Source: Volume 4-11, Table IV-2

Note: Vulnerable population determined using SRESP small area data and county provided evacuation zones. See section E for the source of the small area data. 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 D does not include vulnerable population listed for Evacuation Zone C.

**Note: Broward County has a combined A/B zone, Miami-Dade County has combined B/C and D/E zones, and all of Monroe County is considered vulnerable.*

If everyone who was ordered to evacuate did so and those who were not ordered to evacuate, secured their homes and stayed put, emergency management could use the population-at-risk statistics. This, however, is not the case.

Post-hurricane behavioral studies conducted along the Atlantic and Gulf coasts illustrate that many people ordered to evacuate will not and, conversely, people who live in site-built homes far outside the coastal areas will pack up and try to "outrun" the storm (*"shadow evacuation"*). How we quantify this behavior is key to an accurate transportation analysis. This study used the general response model (HMG, 2010) as well as the surveys conducted in 2009 (see Chapter III, Regional Behavioral Analysis Summary). Volume 2 of the Statewide Regional evacuation Study Program provides the Regional Behavioral Assumptions based upon the General Response Model and the survey results presented in Volume 3, Behavioral Survey Report

Using the behavioral assumptions discussed in Chapter III, two scenarios were developed. The **Base Planning Scenarios** assume that 100% of the population-at-risk evacuate plus the anticipated "shadow evacuation" from outside the surge vulnerable areas. The scenarios are considered the most "conservative" estimate and will be used for growth management purposes. Tables ES-3 and ES-4 present these evacuation population estimates for 2010 and 2015.

The population estimates for **Operational Scenarios** apply the participation rates presented in the regional behavioral assumptions. They do not assume that 100% of the population at risk evacuate but do include the "shadow evacuation" expected depending on the strength of the hurricane. Tables ES-5 and ES-6 present the evacuation population estimates and projections for 2010 and 2015.

Table ES-3 Hurricane Population by Evacuation Level
Base Planning Scenarios, 2010

Scenario	Level	Broward	Miami-Dade	Monroe	South Florida Region
1	A	206,928	355,090	72,390	634,408
2	B	214,031	476,223	76,936	767,190
3	C	299,975	497,973	72,868	870,816
4	D	446,746	707,145	72,868	1,226,759
5	E	638,542	905,557	72,868	1,616,967

Source: Volume 4-11, Table IV-7

Table ES-4 Hurricane Evacuation Population by Evacuation Level Base Planning Scenarios, 2015

Scenario	Level	Broward	Miami-Dade	Monroe	South Florida Region
1	A	218,416	371,443	73,947	663,806
2	B	226,001	508,106	78,770	812,877
3	C	317,053	532,700	77,142	926,895
4	D	472,792	759,854	77,142	1,309,788
5	E	675,370	965,798	77,142	1,718,310

Source: Volume 4-11, Table IV-8

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

Scenario	Level	Broward	Miami-Dade	Monroe	South Florida Region
1	A	161,746	241,939	68,116	471,801
2	B	178,775	296,346	73,884	549,005
3	C	234,502	373,313	51,007	658,822
4	D	397,033	587,866	58,295	1,043,194
5	E	585,798	839,544	65,581	1,490,923
6	A	0	241,939	68,116	310,055
7	B	178,775	0	0	178,775
8a	C	0	0	51,007	51,007
8b	C	0	0	72,868	72,868
9	D	0	587,866	0	587,866
10	E	585,798	0	0	585,798

Source: Volume 4-11, Table IV-20

Table ES-6 Hurricane Evacuation Population by Evacuation Level Operational Scenarios, 2015

Scenario	Level	Broward	Miami-Dade	Monroe	South Florida Region
11	A	170,279	254,775	69,693	494,747
12	B	188,437	313,091	75,732	577,260
13	C	247,443	397,844	53,999	699,286
14	D	419,667	628,690	61,713	1,110,070
15	E	619,333	893,260	69,428	1,582,021
16	A	0	254,775	69,693	324,468
17	B	226,001	508,106	0	734,107
18	C	247,443	0	0	247,443
19	D	0	0	61,713	61,713
20	E	0	893,260	0	893,260

Source: Volume 4-11, Table IV-21

Chapter IV also presents the vulnerability of critical facilities within the region to (1) tropical storms and hurricanes; (2) flooding (100-year and 500-year); and wildfire (high and very high). The County Appendices provide more detailed data and maps for selected critical facilities including health care facilities (hospitals, nursing homes, etc.), assisted living facilities (ALFs), fire and police stations, and other identified facilities.

D. PUBLIC SHELTER DEMAND

As part of the regional evacuation study, the anticipated demand for public shelter was quantified. The public shelter inventories and the capacities within each county were identified and a comparison was made to determine the status within both the county and the region.

The general response model, post-hurricane behavioral surveys of residents in the South Florida Region and past experience was used to determine public shelter demand. The number of evacuees who choose public shelter as their evacuation destination is based on demographic characteristics of the population including income and age, risk area and housing (mobile home vs. site built homes). The planning assumptions regarding anticipated shelter use were presented in the Regional Behavioral Analysis (see Appendices III-A, III-B and III-C), and were applied to the projected Hurricane Evacuation Population estimates for both the Base Planning Scenarios as well as the Operational Scenarios.

As discussed in Chapter IV, the Base Planning Scenarios assume 100% compliance of the vulnerable populations (surge-vulnerable and mobile home residents) plus the “shadow evacuation”. The Operational Scenarios use the participation rates from the behavioral analysis to determine the evacuation rates.

Table ES-7 Public Shelter Demand for Hurricane Evacuation Base Scenarios, 2010

	Scenario 1 Evacuation Level A	Scenario 2 Evacuation Level B	Scenario 3 Evacuation Level C	Scenario 4 Evacuation Level D	Scenario 5 Evacuation Level E
Monroe - Key West	860	890	592	1,480	1,480
Monroe - Lower Keys	294	307	278	694	694
Monroe - Middle Keys	457	470	244	244	244
Monroe - Upper Keys	736	779	444	444	444
Monroe County - Total	2,348	2,446	1,558	2,862	2,862
Miami-Dade County	22,762	27,659	29,419	46,163	61,894
Broward County	9,502	9,809	13,786	19,529	27,184

Source: Volume 4-11, Table IV-11.

Table ES-8 Public Shelter Demand for Hurricane Evacuation Base Scenarios, 2015

	Scenario 6 Evacuation Level A	Scenario 7 Evacuation Level B	Scenario 8 Evacuation Level C	Scenario 9 Evacuation Level D	Scenario 10 Evacuation Level E
Monroe - Key West	870	901	616	1,541	1,541
Monroe - Lower Keys	302	318	302	755	755
Monroe - Middle Keys	463	475	257	257	257
Monroe - Upper Keys	744	792	474	474	474
Monroe County - Total	2,377	2,486	1,648	3,027	3,027
Miami-Dade County	23,033	28,170	30,116	48,035	64,247
Broward County	9,894	10,216	14,350	20,365	28,338

Source: Volume 4-11, Table IV-11.

Table ES-9 Public Shelter Demand for Hurricane Evacuation Operational Scenarios 2010

	Scenario 1 Evacuation Level A	Scenario 2 Evacuation Level B	Scenario 3 Evacuation Level C	Scenario 4 Evacuation Level D	Scenario 5 Evacuation Level E	
Monroe - Key West	810	855	414	1,184	1,332	
Monroe - Lower Keys	246	272	194	555	623	
Monroe - Middle Keys	409	437	172	196	220	
Monroe - Upper Keys	640	712	311	355	400	
Monroe County - Total	2,105	2,276	1,092	2,290	2,575	
Miami-Dade County	16,162	18,924	23,282	38,587	57,916	
Broward County	7,555	8,268	10,706	17,281	24,809	
	Scenario 6 Evacuation Level A	**Scenario 7 Evacuation Level B**	**Scenario 8a Evacuation Level C**	**Scenario 8b Evacuation Level C**	**Scenario 9 Evacuation Level D**	**Scenario 10 Evacuation Level E**
Monroe - Key West	810	0	414	592	0	0
Monroe - Lower Keys	246	0	194	278	0	0
Monroe - Middle Keys	409	0	172	244	0	0
Monroe - Upper Keys	640	0	311	444	0	0
Monroe County - Total	2,105	0	1,092	1,558	0	0
Miami-Dade County	16,162	0	0	0	38,587	0
Broward County	0	8,268	0	0	0	24,809

Source: Volume 4-11, Table IV-24.

Table ES-10 Public Shelter Demand for Hurricane Evacuation Operational Scenarios 2015

	Scenario 11 Evacuation Level A	Scenario 12 Evacuation Level B	Scenario 13 Evacuation Level C	Scenario 14 Evacuation Level D	Scenario 15 Evacuation Level E
Monroe - Key West	820	864	431	1,232	1,386
Monroe - Lower Keys	255	283	211	605	679
Monroe - Middle Keys	414	440	179	205	231
Monroe - Upper Keys	651	725	331	379	427
Monroe County - Total	2,140	2,313	1,153	2,422	2,723
Miami-Dade County	16,550	19,333	23,913	39,993	60,045
Broward County	7,842	8,593	11,130	17,997	25,848
	Scenario 16 Evacuation Level A	**Scenario 17 Evacuation Level B**	**Scenario 18 Evacuation Level C**	**Scenario 19 Evacuation Level D**	**Scenario 20 Evacuation Level E**
Monroe - Key West	820	0	0	1,232	0
Monroe - Lower Keys	255	0	0	605	0
Monroe - Middle Keys	414	0	0	205	0
Monroe - Upper Keys	651	0	0	379	0
Monroe County - Total	2,140	0	0	2,422	0
Miami-Dade County	16,550	28,170	0	0	60,045
Broward County	0	10,216	11,130	0	0

Source: Volume 4-11, Table IV-24.

Using the behavioral assumptions based on the General Response Model has a significant impact on the potential shelter demand calculations. As noted in Chapter III, Regional Behavioral Analysis, the use of public shelters for residents in site built homes ranges from 5% - 10% depending on age and income. Traditionally, a public shelter use rate of between 10%-25% was used for planning purposes. However, the trend for less reliance on public shelters has been recognized in past evacuations throughout the Gulf and Atlantic states.

Recognizing the trend toward a reduced reliance on public shelters, the emergency management community remains concerned that the assumption of a reduction in anticipated need does not take into consideration that many vulnerable residents will choose not to evacuate until there is no longer sufficient time to reach other destinations. This could logically result in a surge of evacuees to the public shelters in the closing hours of the evacuation. In addition if a major hurricane were to impact the region, there would be less capacity in public shelters for those residents who have no home to which to return.

In terms of community resiliency, without the requirement of EHPA standards, new schools may not be built to standards which would insure the schools would survive the hit of major hurricane. In addition the need for more special needs shelters must also be addressed in both State and local plans.

Therefore, local emergency management may use different assumptions for both public and special needs shelters within the operational plans as reflected in the County Comprehensive Emergency Management Plans (CEMPs).

E. EVACUATION TRANSPORTATION ANALYSIS

The evacuation transportation analysis discussed in Chapter VI documents the methodology, analysis, and results of the transportation component of the Statewide Regional Evacuation Study Program (SRESP). Among the many analyses required for the SRESP study, transportation analysis is probably one of the most important components in the process. By bringing together storm intensity, transportation network, shelters, and evacuation population, transportation analysis explicitly links people's behavioral responses to the regional evacuation infrastructure and helps formulate effective and responsive evacuation policy options. Due to the complex calculations involved and numerous evacuation scenarios that need to be evaluated, the best way to conduct the transportation analysis is through the use of computerized transportation simulation programs, or transportation models.

The development of the transportation methodology and framework required coordination and input from all eleven regional planning councils in Florida, along with the Division of Emergency Management, Department of Transportation, Department of Community Affairs, and local county emergency management teams. At the statewide level, the transportation consultant, Wilbur Smith Associates, participated in SRESP Work Group Meetings which were typically held on a monthly basis to discuss the development of the transportation methodology and receive feedback and input from the State agencies and RPCs.

At the local and regional level, Wilbur Smith Associates conducted a series of four regional meetings to coordinate with and receive input from local county emergency management, the regional planning council, local transportation planning agencies and groups, as well as other interested agencies.

1. Transportation Methodology

The methodology used in the South Florida Regional Planning Council Evacuation Transportation Analysis is identical to the methodology used for all eleven Regional Planning Councils and includes the following components:

- Behavioral Assumptions
- Zone System and Highway Network
- Background Traffic
- Evacuation Traffic
- Dynamic Traffic Assignment

The regional model developed for the South Florida Region used a series of input data provided by the RPC, including the following:

- Regional Model Network
- Regional Zone System
- Regional Demographic Characteristics

2. Clearance Times

Based on the analysis, the Clearance Times for the Base Planning Scenario and Operational Scenarios for 2010 and 2015 are provided below.

- **Clearance Time to Shelter:** The time necessary to safely evacuate vulnerable residents and visitors to a "point of safety" within the county based on a specific hazard, behavioral assumptions and evacuation scenario. Calculated from the point in time when the evacuation order is given to the point in time when the last vehicle reaches a point of safety within the county.
- **In-County Clearance Time:** The time required from the point an evacuation order is given until the last evacuee can either leave the evacuation zone or arrive at safe shelter within the County. This does not include those evacuees leaving the County, on their own.
- **Out of County Clearance Time:** The time necessary to safely evacuate vulnerable residents and visitors to a "point of safety" within the county based on a specific hazard, behavioral assumptions and evacuation scenario. Calculated from the point an evacuation order is given to the point in time when the last vehicle assigned an external destination exits the county.
- **Regional Clearance Time**: The time necessary to safely evacuate vulnerable residents and visitors to a "point of safety" within the (RPC) region based on a specific hazard, behavioral assumptions and evacuation scenario. Calculated from the point in time when the evacuation order is given to the point in time when the last vehicle assigned an external destination exits the region.

Table ES-11 – 2010 Clearance Times for Base Scenarios

	Evacuation Level A Base Scenario 1	Evacuation Level B Base Scenario 2	Evacuation Level C Base Scenario 3	Evacuation Level D Base Scenario 4	Evacuation Level E Base Scenario 5
Clearance Time to Shelter					
Key West	3.0	2.5	N/A	N/A	N/A
Lower Keys	N/A	N/A	N/A	N/A	N/A
Middle Keys	N/A	N/A	N/A	N/A	N/A
Upper Keys	N/A	N/A	N/A	N/A	N/A
Monroe County	3.0	2.5	N/A	N/A	N/A
Miami-Dade County	13.0	13.0	13.0	13.0	13.5
Broward County	12.5	12.5	13.0	19.0	30.0
In-County Clearance Time					
Key West	12.5	12.5	15.5	15.5	15.5
Lower Keys	17.5	18.5	22.5	22.5	22.5
Middle Keys	22.0	23.0	27.5	27.5	27.5
Upper Keys	24.0	26.0	31.0	31.0	31.0
Monroe County	24.0	26.0	31.0	31.0	31.0
Miami-Dade County	13.0	26.5	31.0	31.0	31.0
Broward County	12.5	12.5	13.5	20.0	31.0
Out of County Clearance Time					
Key West	12.5	12.5	15.0	15.0	15.0
Lower Keys	17.0	18.0	22.0	22.0	22.0
Middle Keys	21.5	22.5	27.0	27.0	27.0
Upper Keys	24.0	25.5	30.5	30.5	30.5
Monroe County	24.0	25.5	30.5	30.5	30.5
Miami-Dade County	25.5	27.0	31.5	31.5	32.0
Broward County	26.0	27.5	32.0	32.0	39.5
Regional Clearance Time					
South Florida Region	26.0	27.5	32.0	32.0	39.5

Note: In-county clearance times are generally not less than the response curve unless in-county or to shelter population numbers are very low. The base scenarios use a 12 hour response curve. Also, in-county clearance times for Miami-Dade County are typically equal to or above Monroe County out of county clearance times for all level B or higher scenarios that include Monroe County evacuating. By definition, in-county clearance time includes out-of-county trips from other counties that pass through evacuation zones in the evacuating county, including Miami-Dade's combined B/C evacuation zone located where US 1 enters from Monroe County.

Table ES-12 – 2015 Clearance Times for Base Scenarios

	Evacuation Level A Base Scenario 6	Evacuation Level B Base Scenario 7	Evacuation Level C Base Scenario 8	Evacuation Level D Base Scenario 9	Evacuation Level E Base Scenario 10
Clearance Time to Shelter					
Key West	4.0	3.0	N/A	N/A	N/A
Lower Keys	N/A	N/A	N/A	N/A	N/A
Middle Keys	N/A	N/A	N/A	N/A	N/A
Upper Keys	N/A	N/A	N/A	N/A	N/A
Monroe County	4.0	3.0	N/A	N/A	N/A
Miami-Dade County	13.0	13.0	13.0	13.0	14.5
Broward County	12.5	12.5	13.0	21.0	45.0
In-County Clearance Time					
Key West	12.5	12.5	16.5	16.5	16.5
Lower Keys	17.5	18.5	24.0	24.0	24.0
Middle Keys	22.5	23.5	29.0	29.0	29.0
Upper Keys	25.0	27.0	32.5	32.5	32.5
Monroe County	25.0	27.0	32.5	32.5	32.5
Miami-Dade County	13.0	27.0	32.5	32.5	32.5
Broward County	12.5	12.5	13.0	21.0	45.0
Out of County Clearance Time					
Key West	12.5	12.5	16.0	16.0	16.0
Lower Keys	17.0	18.0	23.5	23.5	23.5
Middle Keys	22.0	23.0	28.5	28.5	28.5
Upper Keys	24.5	26.5	32.0	32.0	32.0
Monroe County	24.5	26.5	32.0	32.0	32.0
Miami-Dade County	26.0	27.5	33.0	33.0	35.0
Broward County	26.5	28.0	33.5	33.5	46.0
Regional Clearance Time					
South Florida Region	26.5	28.0	33.5	33.5	46.0

Note: In-county clearance times are generally not less than the response curve unless in-county or to shelter population numbers are very low. The base scenarios use a 12 hour response curve. Also, in-county clearance times for Miami-Dade County are typically equal to or above Monroe County out of county clearance times for all level B or higher scenarios that include Monroe County evacuating. By definition, in-county clearance time includes out-of-county trips from other counties that pass through evacuation zones in the evacuating county, including Miami-Dade's combined B/C evacuation zone located where US 1 enters from Monroe County.

Table ES-13 – 2010 Clearance Times for Operational Scenarios

	Evacuation Level A Operational Scenario 1	Evacuation Level B Operational Scenario 2	Evacuation Level C Operational Scenario 3	Evacuation Level D Operational Scenario 4	Evacuation Level E Operational Scenario 5
Clearance Time to Shelter					
Key West	5.5	4.5	N/A	N/A	N/A
Lower Keys	N/A	N/A	N/A	N/A	N/A
Middle Keys	N/A	N/A	N/A	N/A	N/A
Upper Keys	N/A	N/A	N/A	N/A	N/A
Monroe County	5.5	4.5	N/A	N/A	N/A
Miami-Dade County	9.5	13.0	10.0	13.0	23.5
Broward County	9.5	12.5	9.5	20.5	23.5
In-County Clearance Time					
Key West	9.5	12.5	10.0	13.0	13.5
Lower Keys	16.0	17.5	16.5	19.0	21.0
Middle Keys	19.5	22.0	20.0	22.5	25.0
Upper Keys	22.5	25.0	22.5	25.5	28.0
Monroe County	22.5	25.0	22.5	25.5	28.0
Miami-Dade County	9.5	36.5	33.5	36.5	47.0
Broward County	9.5	12.5	9.5	20.5	42.0
Out of County Clearance Time					
Key West	9.5	12.5	9.5	12.5	13.0
Lower Keys	15.5	17.0	16.0	18.5	20.5
Middle Keys	19.5	21.5	19.5	22.0	24.5
Upper Keys	22.5	24.5	22.0	25.0	27.5
Monroe County	22.5	24.5	22.0	25.0	27.5
Miami-Dade County	34.0	37.0	34.0	40.5	49.5
Broward County	34.5	36.5	45.5	65.0	46.5
Regional Clearance Time					
South Florida Region	35.5	38.0	46.5	66.5	49.5

Notes: For scenarios 1, 2, 3, 4, and 5, regional clearance time is larger than the highest out-of-county clearance time from any of the counties in the region due to the 24-hour phasing used as part of the scenario.

In-county clearance times are generally not less than the response curve unless in-county or to shelter population numbers are very low. In-county clearance time for Broward County in scenarios 1, 2, and 3 illustrate this, as these scenarios used a 9-hour, 12-hour, and 9-hour response curve, respectively.

In-county clearance times for Miami-Dade County are typically equal to or above Monroe County out-of-county clearance times for scenarios that include Monroe County evacuating. By definition, in-county clearance time includes out-of-county trips from other counties that pass through evacuation zones in the evacuating county, including Miami-Dade's combined B/C evacuation zone located where US 1 enters from Monroe County.

Out-of-county clearance time for Broward County in Scenario 4 is significantly larger than the out-of-county clearance time for Broward County in Scenario 5 due to the phasing used in Scenario 5, where Collier and Monroe Counties evacuate 24 hours prior to the remaining counties.

Table ES-13 – 2010 Clearance Times for Operational Scenarios (continued)

	Evacuation Level A Operational Scenario 6	Evacuation Level B Operational Scenario 7	Evacuation Level C Operational Scenario 8a	Evacuation Level D Operational Scenario 8b	Evacuation Level E Operational Scenario 9	Evacuation Level E Operational Scenario 10
Clearance Time to Shelter						
Key West	5.0	N/A	N/A	N/A	N/A	N/A
Lower Keys	N/A	N/A	N/A	N/A	N/A	N/A
Middle Keys	N/A	N/A	N/A	N/A	N/A	N/A
Upper Keys	N/A	N/A	N/A	N/A	N/A	N/A
Monroe County	5.0	N/A	N/A	N/A	N/A	N/A
Miami-Dade County	9.5	N/A	N/A	N/A	10.0	N/A
Broward County	N/A	9.5	N/A	N/A	N/A	9.5
In-County Clearance Time						
Key West	9.5	N/A	12.5	15.0	N/A	N/A
Lower Keys	16.0	N/A	16.5	22.0	N/A	N/A
Middle Keys	19.5	N/A	20.0	27.0	N/A	N/A
Upper Keys	22.5	N/A	22.5	30.5	N/A	N/A
Monroe County	22.5	N/A	22.5	30.5	N/A	N/A
Miami-Dade County	9.5	N/A	N/A	N/A	10.0	N/A
Broward County	5.5	9.5	N/A	N/A	N/A	9.5
Out of County Clearance Time						
Key West	9.5	N/A	12.5	15.0	N/A	N/A
Lower Keys	15.5	N/A	16.5	22.0	N/A	N/A
Middle Keys	19.5	N/A	20.0	27.0	N/A	N/A
Upper Keys	22.5	N/A	22.5	30.5	N/A	N/A
Monroe County	22.5	N/A	22.5	30.5	N/A	N/A
Miami-Dade County	23.5	9.5	23.5	31.5	10.5	11.0
Broward County	24.0	10.0	22.5	30.5	13.0	24.0
Regional Clearance Time						
South Florida	24.0	10.0	23.5	31.5	13.0	24.0

Table ES-14 – 2015 Clearance Times for Operational Scenarios

	Evacuation Level A Operational Scenario 11	Evacuation Level B Operational Scenario 12	Evacuation Level C Operational Scenario 13	Evacuation Level D Operational Scenario 14	Evacuation Level E Operational Scenario 15
Clearance Time to Shelter					
Key West	5.5	4.0	N/A	N/A	N/A
Lower Keys	N/A	N/A	N/A	N/A	N/A
Middle Keys	N/A	N/A	N/A	N/A	N/A
Upper Keys	N/A	N/A	N/A	N/A	N/A
Monroe County	5.5	4.0	N/A	N/A	N/A
Miami-Dade County	10.0	13.0	13.0	10.0	13.0
Broward County	9.5	12.5	12.5	22.5	46.0
In-County Clearance Time					
Key West	10.0	12.5	13.0	12.0	14.5
Lower Keys	16.5	18.0	17.5	19.5	22.0
Middle Keys	20.0	22.5	21.0	23.5	26.0
Upper Keys	23.0	26.0	24.0	26.0	29.5
Monroe County	23.0	26.0	24.0	26.0	29.5
Miami-Dade County	10.0	26.0	36.5	26.5	29.5
Broward County	9.5	12.5	12.5	22.5	47.0
Out of County Clearance Time					
Key West	10.0	12.5	12.5	11.5	14.0
Lower Keys	16.0	17.5	17.0	19.0	21.5
Middle Keys	20.0	22.0	20.5	23.0	25.5
Upper Keys	23.0	25.5	23.5	25.5	29.0
Monroe County	23.0	25.5	23.5	25.5	29.0
Miami-Dade County	24.0	26.5	37.0	27.0	44.5
Broward County	24.5	27.0	43.0	46.5	47.0
Regional Clearance Time					
South Florida Region	24.5	27.0	44.5	46.5	47.0

Notes: For scenario 13, regional clearance time is larger than the highest out-of-county clearance time from any of the counties in the region due to the 24-hour phasing used as part of the scenario.

In-county clearance times are generally not less than the response curve unless in-county or to shelter population numbers are very low. In-county clearance time for Broward County in scenarios 11, 12, and 13 illustrate this, as these scenarios used a 9-hour, 12-hour, and 12-hour response curve, respectively.

In-county clearance times for Miami-Dade County are typically equal to or above Monroe County out-of-county clearance times for scenarios that include Monroe County evacuating. By definition, in-county clearance time includes out-of-county trips from other counties that pass through evacuation zones in the evacuating county, including Miami-Dade's combined B/C evacuation zone located where US 1 enters from Monroe County.

Table ES-14 – 2015 Clearance Times for Operational Scenarios (continued)

	Evacuation Level A Operational Scenario 16	Evacuation Level B Operational Scenario 17	Evacuation Level C Operational Scenario 18	Evacuation Level D Operational Scenario 19	Evacuation Level E Operational Scenario 20
Clearance Time to Shelter					
Key West	4.0	N/A	N/A	N/A	N/A
Lower Keys	N/A	N/A	N/A	N/A	N/A
Middle Keys	N/A	N/A	N/A	N/A	N/A
Upper Keys	N/A	N/A	N/A	N/A	N/A
Monroe County	4.0	N/A	N/A	N/A	N/A
Miami-Dade County	13.0	10.0	N/A	N/A	13.0
Broward County	N/A	9.5	12.5	N/A	N/A
In-County Clearance Time					
Key West	12.5	N/A	N/A	19.0	N/A
Lower Keys	17.0	N/A	N/A	20.5	N/A
Middle Keys	21.0	N/A	N/A	24.0	N/A
Upper Keys	24.0	N/A	N/A	27.0	N/A
Monroe County	24.0	N/A	N/A	27.0	N/A
Miami-Dade County	13.0	10.5	N/A	N/A	13.5
Broward County	N/A	9.5	12.5	N/A	N/A
Out of County Clearance Time					
Key West	12.5	8.5	N/A	18.5	N/A
Lower Keys	16.5	9.5	N/A	20.0	N/A
Middle Keys	20.5	9.5	N/A	23.5	N/A
Upper Keys	23.5	10.0	N/A	26.5	N/A
Monroe County	23.5	10.0	N/A	26.5	N/A
Miami-Dade County	24.5	10.5	12.5	27.5	13.5
Broward County	25.0	25.5	13.0	26.5	17.0
Regional Clearance Time					
South Florida Region	25.0	25.5	13.0	27.5	17.0

3. TIME User Interface

Wilbur Smith Associates developed the Transportation Interface for Modeling Evacuations (TIME) to make it easier for RPC staff and transportation planners to use the model and implement the evacuation methodology. The TIME interface is based on an ArcGIS platform and is essentially a condensed transportation model, which provides a user friendly means of modifying input variables that would change the clearance times for various evacuation scenarios.

The evacuation model variables include a set of distinguishing characteristics that could apply to evacuation scenarios as selection criteria. These following variables may be selected using the TIME interface and allow the user to retrieve the best results from various evacuation alternatives:

- Analysis time period;
- Highway network;
- Behavioral response;
- One-way evacuation operations;
- University population;
- Tourist occupancy rates;
- Shelters;
- Counties evacuating;
- Evacuation level;
- Response curve hours; and,
- Evacuation Phasing.

It is anticipated that the regional planning council and local governments will be able to use the TIME User Interface to simulate additional scenarios varying behavioral assumptions, reflecting proposed growth in coastal areas, new transportation improvements, etc.

F. GLOSSARY

The Glossary at the back of the Technical Data Report contains the definitions of the terms used throughout the document. In many cases, it represents the legal consensus of the definition of terms in statute pertaining to growth management. The Statewide Regional Evacuation Study Program represents a consistent and coordinated approach to provide tools for both the emergency management as well as the planning community in the State of Florida.

G. CONCLUSIONS AND RECOMMENDATIONS

Obviously, the implementation of a successful hurricane evacuation in the South Florida Region will be complex and challenging. It will require a team effort – not just on the part of the emergency management and response personnel, but of the entire community. We have come to a point in this metropolitan coastal region that complacency and apathy will have dire consequences.

The *South Florida Region Hurricane Evacuation Study* illustrates that there have been improvements in hurricane evacuation planning, including increased public shelter capacity, assistance for the transit dependent, alternatives for evacuees with pets, special needs shelters, route improvements and growth management mitigation strategies helping to reduce the population-at-risk. However, there remain serious challenges in this region if we are to avoid the loss of life and property and human suffering witnessed in the 2005 hurricane season in Mississippi, Louisiana and Texas.

Over the past 30 years, South Florida Regional Planning Council (SFRPC), the State of Florida, County Emergency Management agencies, the American Red Cross and many other agencies have worked together to prepare regionally for a disaster – not just the inevitable strike of a hurricane but the impacts of flooding, hazardous material incidents and terrorist attack.

Recent events have tragically demonstrated the power of nature and the horrific results if government and citizens fail to respond appropriately. As public servants and elected officials, it is imperative to address the concerns of our citizens and leaders regarding our ability to manage a major disaster.

1. Public Education

Our citizens' knowledge and understanding of personal risk and appropriate evacuation response remains a serious challenge. The behavioral surveys indicated that many residents – even those in the most surge-vulnerable areas and mobile homes – believe their home would be safe in a major hurricane, do not have a family disaster plan, and many will not evacuate regardless of the intensity of the storm or government actions. This fact means that those who choose to stay behind in mobile homes and areas vulnerable to storm surge and velocity wave action might not survive a storm.

In turn, many residents – well inland of storm surge and in site-built homes – responded that they will try to evacuate, many out of the region or state. Because of the "shadow evacuation," resulting clearance times are exceedingly high necessitating the planning of refuge shelters along critical evacuation routes, reverse laning of Interstate systems and the potential of evacuation problems seen in Houston, Texas, with Hurricane Rita (2005).

In order to elicit an immediate evacuation response, the population-at-risk must be clearly and conclusively convinced that (1) they are indeed residing in a vulnerable area and (2) that a decision not to leave could well mean their loss of life or injury. Post-hurricane studies have shown that the most vital piece of information is the information received from the emergency management personnel and local officials. For the most part, people will respond based upon the urgency and seriousness of the threat as conveyed by the emergency response personnel.

Three key messages have been identified:

- Know your risk (evacuation zone/ mobile homes)

- Make a family plan.
- Obtain emergency supplies for at least 3-5 days.

The accurate formulation and comprehensive dissemination of these critical pieces of information to the public in a simple and understandable form is essential for implementation of an effective hurricane evacuation plan.

Hopefully, irrational emergency decision-making on the part of the population can be decreased if they determine their vulnerability to a hurricane before the emergency occurs. Residents in the South Florida region are encouraged to become familiar with the county plans for evacuation and to make their "family plans" and business plans ahead of time. The State of Florida has partnered with the Florida Broadcasting Association to encourage the "culture of preparedness" including PSAs and billboards. Partnering at the local level is also needed.

Additional notification procedures (of evacuation level) is implemented and repeated throughout the season. The local governments in the region do have programs which provide these services to their residents so it is unclear why so many residents do not know their evacuation level or understand their risk.

- Notification on utility bills (zone designation)
- Notification on tax bills (zone designation)
- Special mailings and deliveries
- Interactive Web sites (zone look up)
- Citizen Information lines (zone look up)

Perhaps the answer lies in a continued strengthen initiative to partner with all levels of government, the private sector, civic and business associations and non-profit/volunteer agencies and the media to "get the word out" about preparedness and mitigation. Businesses have been increasingly active in developing continuity plans and providing information to their employees. Churches and civic associations, neighborhood associations, crime watch and Community Emergency Response Teams (CERT) can provide direct contact and face-to-face communication.

2. Special Needs

Providing shelter for residents with special needs is a critical issue. Partners including the Departhment of Health, home health agencies, hospitals and skilled nursing facilities, to name just a few, must work with local agencies to (1) register and determine the appropriate level of care and appropriate shelter alternative for each resident and (2) provide the facility, staff, equipment and supplies and transportation assistance in an effective manner in a disaster situation.

Again, we need to develop strong partnerships with those entities in the community that work with our citizens with special needs on a daily basis to ensure they receive the information and support they need before, during and after a disaster.

3. Mitigation Message

As identified, the results of the ***Statewide Regional Evacuation Study for the South Florida Region*** highlight the challenges of the emergency management community in a metropolitan coastal area such as South Florida. If people do not respond correctly when an evacuation order is given, there will be serious implications on the entire emergency response. For example, if residents who live in low-lying surge vulnerable areas or mobile homes do not evacuate, they are putting their safety at risk. Conversely, if residents who live in site-built homes outside the surge-vulnerable areas try to evacuate in significant numbers – as they did during the 1999 Hurricane Floyd evacuation and for Hurricane Rita in 2005 – the resulting traffic congestion may prevent anyone from reaching safety.

The answer is comprehensive consistent public education which focuses on encouraging our residents to do the following (1) know their risk, and (2) plan ahead. Again, key messages include:

- Individual Responsibility – Be disaster resilient. Know your risk, plan ahead and obtain needed supplies.
- Encourage residents to *"Flee from Flood; Hide from Wind".* Obviously, coastal residents in surge vulnerable areas and mobile home residents must evacuate; however, the key message is to seek refuge within "tens of miles, not hundreds of miles."
- Strongly encourage all residents who live in site-built homes outside the surge vulnerable areas to call and invite friends or relatives who must evacuate to come and stay with them if there is a hurricane threat. Once they have committed by inviting their friends or relatives, we will also encourage residents to prepare their homes and mitigate for the potential winds, i.e. window and door protection, braced gable end roofs, and garage doors.

- It is assumed if inland residents take action to protect their homes from wind, they will be less likely to try to "outrun" a hurricane.

4. The Coastal High Hazard Area (CHHA)

In 2006 the Florida Legislature passed a bill changing the definition of the coastal high hazard area (CHHA) from the evacuation zone to the "area defined by the SLOSH model to be inundated from a category one hurricane." This change was welcome as the definition was more defensible tying the land use regulations to a scientific model rather than the zone delineated by roadways and familiar landmarks. However, the limitations of the model must be recognized by the local governments now responsible for its regulation.

As discussed, the SLOSH model does not address wave height and other local processes. It also does not incorporate the danger of isolation in areas surrounded by storm surge with limited access such as barrier islands. These two issues are of serious concern and it is recommended that local governments address them within their comprehensive plans and land development regulations.

H. Use of SRES Data in Growth Management

While this study is primarily designed for the local emergency management agencies to utilize in the preparation of emergency response, evacuation, sheltering and mitigation plans, Section 163.3178 of the Florida Statutes directs growth management planners to this study to identify exceedances when determining the impacts of growth on the safety of the public. Therefore, this study is also designed with many features to address growth management issues. Key items included are Coastal High Hazard Areas (CHHA), clearance times, shelter capacity, and tools for determining impacts of growth.

1. Storm Tide Limits and the Coastal High Hazard Area

The Statewide Regional Evacuation Study (SRES) contains data which is directly referenced in growth management legislation in the State of Florida and coastal/conservation elements of the Local Government Comprehensive Plans. The ***Storm Tide Atlas*** (Volume 7) and the storm tide limits it portrays for each county define the Coastal High Hazard Area (CHHA)[4]. Section 163.3178(9)(c), Florida Statutes, requires local governments to amend their future land use map and coastal management element to include the new definition of the Coastal High Hazard Area and to depict the CHHA on the county's Future Land Use Map.

[4] Section 163.3178(2) (h), F.S. "the area below the elevation of the Category 1 storm surge line as established by a Sea, Lake and Overland Surges from Hurricanes (SLOSH) computerized storm surge model."

As indicated in the Hazards Analysis chapter (*Volume 1 – Technical Data Report, Chapter II*), the ultimate amount of storm surge at any given coastal location is determined by a number of factors. It has been demonstrated that storm parameters including the wind speed and profiles, angle of approach, size of radii of maximum winds and the forward speed of the system will have a complex and inter-related affect on the amount of surge at a particular site. For example, Hurricane Ike which struck the Galveston area in 2008 was classified as a Category 2 hurricane on the Saffir Simpson Hurricane Wind Scale yet it produced a 24 – 26 foot storm surge (often associated with a Category 5 Hurricane) due to its large wind field (radius of maximum winds) and angle of approach.

2. Storm Tide Limits and Evacuation Zones

Emergency management officials use many factors in determining county evacuation zones, with storm tide limits being a major component. However, it is important to note that the storm tide boundaries are not the only data used in this determination. Local officials use their knowledge of the area and other data such as: areas of repetitive loss, surge depth, freshwater flooding, isolation issues, and debris hazards, and typically choose known landmarks to identify boundaries for public warning and information.

As a result, the evacuation zones largely correspond to the storm tide limits of the category 1–5 hurricanes on the Saffir-Simpson Wind Scale. However, the degree to which any specific zone corresponds to storm tide limits is directly related to the affect other data factors have on the final determination of county evacuation zones by local officials. These factors may lead local officials to consolidate zones, add additional zones, expand or contract zones to ensure those threatened by the hazards are appropriately included.

The 2010 SRES introduces alphabetic evacuation zones/levels (A-E) across the State for the first time. A map (Figure IV-2) of these zones is located in *Chapter IV – Regional Vulnerability and Population Analysis*, found in Volume 1-11 of the Study. For purposes of growth management planning, the reference to areas to be evacuated from a category 1 hurricane should use evacuation zone/level A, reference to evacuation areas to be evacuated in advance of a category 2 hurricane should use evacuation zone/level B, and reference to areas to be evacuated from a category 3 hurricane should use evacuation zone/level C. Similarly, in policies that refer to evacuation areas from a category 4 or 5 hurricane, evacuation zones/levels D or E should be used respectively. Where there are consolidated zones or evacuation levels, please refer to the detailed reference information (*Chapter IV: Regional Population and Vulnerability Analysis* of *Volume 1-11*).

3. Transportation

Two types of scenarios (Base Scenarios and Operational Scenarios) were defined in the *Evacuation Transportation Analysis (Volume 4-11*) for use in the Regional Evacuation Model to derive the evacuating population, evacuation vehicles, clearance times and critical congested roadways. Most pertinent to Growth Management are the base scenarios, which were developed to estimate a worst case scenario in which 100% of the vulnerable population (those found in evacuation zones) evacuate, plus the addition of "shadow evacuation". The standard assumptions utilized as the baseline were identified by the Division of Community Planning (DCP) as best suited for use in growth management analysis. The Base Scenarios (Table VI-9, Chapter VI: Regional Evacuation Transportation Analysis in Volume 1-11) are provided to supply the anticipated time needed to evacuate all vulnerable populations (clearance times are found in Tables VI-11 and VI-12, *Chapter VI:*

Regional Evacuation Transportation Analysis in *Volume 1-11*). The Base Scenarios also supply the baseline data for planning purposes (maximum evacuation population found in Tables VI-15 and VI-16, *Chapter VI: Regional Evacuation Transportation Analysis* in *Volume 1-11*). This allows for the evaluation of growth management strategies and provides a consistent statewide measure for clearance time calculations.

The ability to alter scenarios is also available, allowing a planner to increase or decrease population, roadway capacities, shelter availability and more; then measure the variations to determine impacts of population, land use or infrastructure changes. The Transportation Interface for Modeling Evacuations (TIME) is the tool developed to allow users to run further scenarios. Built on the Cube Voyager and Cube Avenue software, this interface is a user-friendly interface which provides the ability to run variations on the transportation scenario, without being transportation planners. If needed, a transportation planner familiar with the model's underlying software can provide a more complex analysis.

4. Definitions

In addition to the data provided, the SRES also defines terms (*Volume 1-11 – Technical Data Report, Glossary*) that are referenced in Florida legislation including various Evacuation Clearance Times (Clearance Time to Shelter, In-County Clearance Time, Out-of-County Clearance Time and Regional Clearance Time). These clearance time definitions better clarify the criterion in determining the compliance of Comprehensive Plan Amendments with State coastal high hazard provisions as prescribed in Section 163.3178(9), Florida Statutes. Using the uniform assumptions from the Base Scenarios, the SRES supplies the information to provide a consistent statewide methodology to assess current conditions as well as quantify impacts that may need to be mitigated.

5. Sheltering

As indicated in the Hurricane Preparedness Policy Rule (Rule 9J-2.0256 (4), F.A.C.), shelter space surplus and deficits are utilized to determine impacts of Developments of Regional Impacts (DRI). *Chapter V – Regional Shelter Analysis* of *Volume 1-11* provides general information on sheltering (general population, special needs and pet friendly), listings of all county shelters and their capacity as well as specific public shelter demand (Tables V-9 through V-12). Shelter surplus and deficits are outlined in these tables as well.

Important to note: shelters listed in the study are divided in two categories, 'primary' and 'other' shelters. Primary shelters are ARC 4496 compatible and may meet other requirements as well (Enhanced Hurricane Protection Areas). It is these primary shelters in which the assessment of a County's shelter deficit is based upon. Each study may list 'other shelter resources' that are within each County, but these shelters may or may not be utilized during an event.