



**ATKINS**

# Proposed I-73 and SELL Corridors Hurricane Evacuation Analysis

## Technical Memorandum

**Study Report**

**July 2012**

**Plan Design Enable**

An abstract graphic in the bottom right corner consisting of overlapping geometric shapes in blue, beige, and grey.

# **Proposed I-73 and SELL Corridors Hurricane Evacuation Analysis**

## **Technical Memorandum**

Prepared by

**ATKINS**

Prepared for

**Myrtle Beach Area Chamber of Commerce**

**Study Report**

**July 2012**



## Table of Contents

I. Introduction .....	1
II. Analysis Tasks .....	3
III. Study Limitations.....	4
IV. System Level Modeling .....	4
Evacuation Zones .....	5
Socioeconomic / Land Use Data.....	6
Evacuation Behavioral Assumptions.....	7
Route Assumptions.....	8
V. Study Findings .....	8
Proposed I-73 Corridor Evacuation Time Impacts.....	10
Proposed SELL Corridor Evacuation Time Impacts.....	10
Proposed I-73 and SELL Joint Corridor Evacuation Time Impacts .....	11

## List of Figures

Figure 1: Traffic Evacuation Zones – Horry County .....	5
Figure 2: Traffic Evacuation Zones – Georgetown County .....	6

## List of Tables

Table 1: Clearance Time Comparison .....	9
--	---



## I. Introduction

Recognizing the recently completed Federal Emergency Management Agency (FEMA)/U.S. Army Corps of Engineers (USACE) Hurricane Evacuation Study work for Horry County and the northern conglomerate counties of South Carolina, the Myrtle Beach Area Chamber of Commerce decided to have an analysis performed which would quantify the level of clearance time impacts if the I-73 corridor and/or Southern Evacuation Lifeline (SELL) project corridor was constructed. Wishing to be totally consistent with professionally accepted/historical South Carolina hurricane evacuation studies, analysis inputs, methodologies, and South Carolina Department of Transportation (SCDOT)/nationally recognized consultant expertise, the Chamber retained Atkins North America (formerly known as PBS&J) to perform a basic analysis to show clearance time impacts of either or both corridors coming to fruition.

Atkins North America has accomplished fourteen different hurricane evacuation related studies in the area since the mid 1980's including all three regional FEMA/USACE transportation clearance time studies, several post storm evacuation assessments (Hugo, Bertha, Fran, and Floyd), contraflow studies for various route segments, and a variety of corridor alignment studies. The firm's lead hurricane evacuation expert, Mr. Donald Lewis, recently developed a presentation for the 2012 National Hurricane Conference in which he ranked the Myrtle Beach area in the top ten most difficult evacuation areas in the country for a major hurricane with a peak tourist occupancy. Mr. Lewis is a past winner of the conference's Neil Frank Award which is their highest annual award for recognizing national contributions to emergency management planning and has done the clearance time studies for nearly every hurricane vulnerable county in the coastal United States.

Related studies in which Atkins has been directly involved include:

- South Carolina Hurricane Evacuation Study—Transportation Analysis (1986)
- Hurricane Hugo Post Storm Evacuation Analysis (1989)
- Hurricanes Bertha/Fran Post Storm Study (1996)
- Hurricane Floyd Post Storm Evacuation Analysis (1999)
- NC Hurricane Evacuation Restudy—Transportation Analysis (1999)
- South Carolina Hurricane Evacuation Restudy—Transportation Analysis (2000)
- US 17/US 521 Contraflow Analysis—Georgetown County (2001)
- South Carolina 2000 Census Update of Abbreviated Traffic Model (2002)





- Brunswick County Progress Energy Nuclear Power Plant Evacuation Analysis (2002)
- Horry County Southern Connector Evacuation Route Analysis (2003)
- North Carolina Department of Transportation (NCDOT) Statewide Hurricane Evacuation Model (2005)
- I-73 Hurricane Evacuation Alternative Alignments Analysis (2005)
- Southern Evacuation Lifeline (SELL) Hurricane Evacuation Analysis (2007)
- Hurricane Evacuation Route Clearance Time Analysis for US 21, US 278, and SC 544 Contra-flow Operations (2007)
- Northern Conglomerate Transportation Analysis—South Carolina Hurricane Evacuation Study Analysis (2012)

State and local emergency management officials have used the study data and evacuation time calculations from these studies to further develop their decision making tools/protocols and route planning. Previous storms have proven the validity of the study data and the study products are relied upon by emergency management officials. The post storm evacuation assessments which Atkins has been involved in for the study area have provided many opportunities to learn from actual events. Traffic counts collected during evacuations in South Carolina and the behavioral data collected immediately after actual evacuations in the state greatly helped subsequent analyses including this effort. The post storm analysis for the Floyd event highlighted the need for viable reverse lane plans for key evacuation routes.



## II. Analysis Tasks

New demographic data, hazard/evacuation areas, behavioral assumptions, roadway geometrics, and the latest state/local traffic control plans were used to analyze an assumed final/preferred alignment alternative for both I-73 and the SELL project. The analysis used information from the recently completed FEMA/USACE hurricane evacuation study transportation analysis which Atkins performed and delivered to Horry County Emergency Management.

The analysis included the following components:

- 1) Using key components of the newly completed FEMA/USACE hurricane evacuation study transportation analysis for the area, analyze the no build alternative for the current base year and future year planning horizon (2030).
- 2) Analyze one assumed final/preferred alignment for I-73 and SELL individually and in concert with each other for the future year scenario.
- 3) Develop a table that compares clearance times and controlling roadway bottlenecks for the current base year and future year scenario with and without the projects being constructed.
- 4) Incorporate the latest contraflow plans developed by state and local emergency management and law enforcement
- 5) Incorporate county growth factors into the demographic/dwelling unit data contained in the new hurricane study transportation analysis to create a future year analysis data set
- 6) Develop a brief technical memorandum to summarize the findings of the analysis and to report the possible benefits to evacuation if projects are implemented.



### **III. Study Limitations**

The analysis is a generalized system level planning study and is not intended to be used for environmental or state regulatory documentation regarding specific project approvals. The hurricane evacuation analysis is intended to provide general system level impacts of I-73 and SELL implemented alone or in combination and is not intended for EIS level documentation and analysis. The analysis makes no assertion as to the environmental feasibility or community impacts and acceptability of either corridor.

### **IV. System Level Modeling**

The model developed by Atkins to analyze the area's hurricane evacuation situation for a base and future year is set up to quickly analyze socioeconomic, behavioral, route usage, and roadway alternatives. With appropriate detail built into the model and updating of key inputs (based on the FEMA/USACE recent study for the northern conglomerate and new tourism data), Atkins was able to use the tool to analyze the clearance time impacts of the existing situation, a future no build alternative, and assumed route alignments for the I-73 and SELL project.

The modeling process includes several basic steps:

- Development of socioeconomic data by evacuation area for each analysis year;
- Development of behavioral assumptions by evacuation area;
- Generation of evacuating people and vehicles by evacuation area;
- Development of route utilization assumption by evacuation area; and
- Assignment of evacuating vehicles to the critical roadway segments and calculation of clearance times.

Major inputs to the model include:

- Evacuation Zones
- Socioeconomic/Land Use Data
- Evacuation Behavioral Assumptions
- Roadway Characteristics

Latest issues and model adjustments related to each of these model inputs are briefly described below:





## Evacuation Zones

Figures 1 and 2 show the new evacuation zones for Horry and Georgetown Counties respectively which the state and counties agreed to in the latest full hurricane study effort led by the USACE, Charleston District. These zones are based on the National Oceanic and Atmospheric Administration's (NOAA) latest storm surge model for the area and are the primary areas that will be asked to fully evacuate due to storm surge flooding potential from various intensities of hurricanes. In addition to these areas, mobile home residents in the non-colored zones will also be asked to relocate. These areas form the modeling zones which feed the road network to varying degrees depending on the intensity of the storm threat. Of particular importance to this effort, is the recognition that the zones encompass more evacuation areas in the Southern Grand Strand and Georgetown County than included in previous studies.

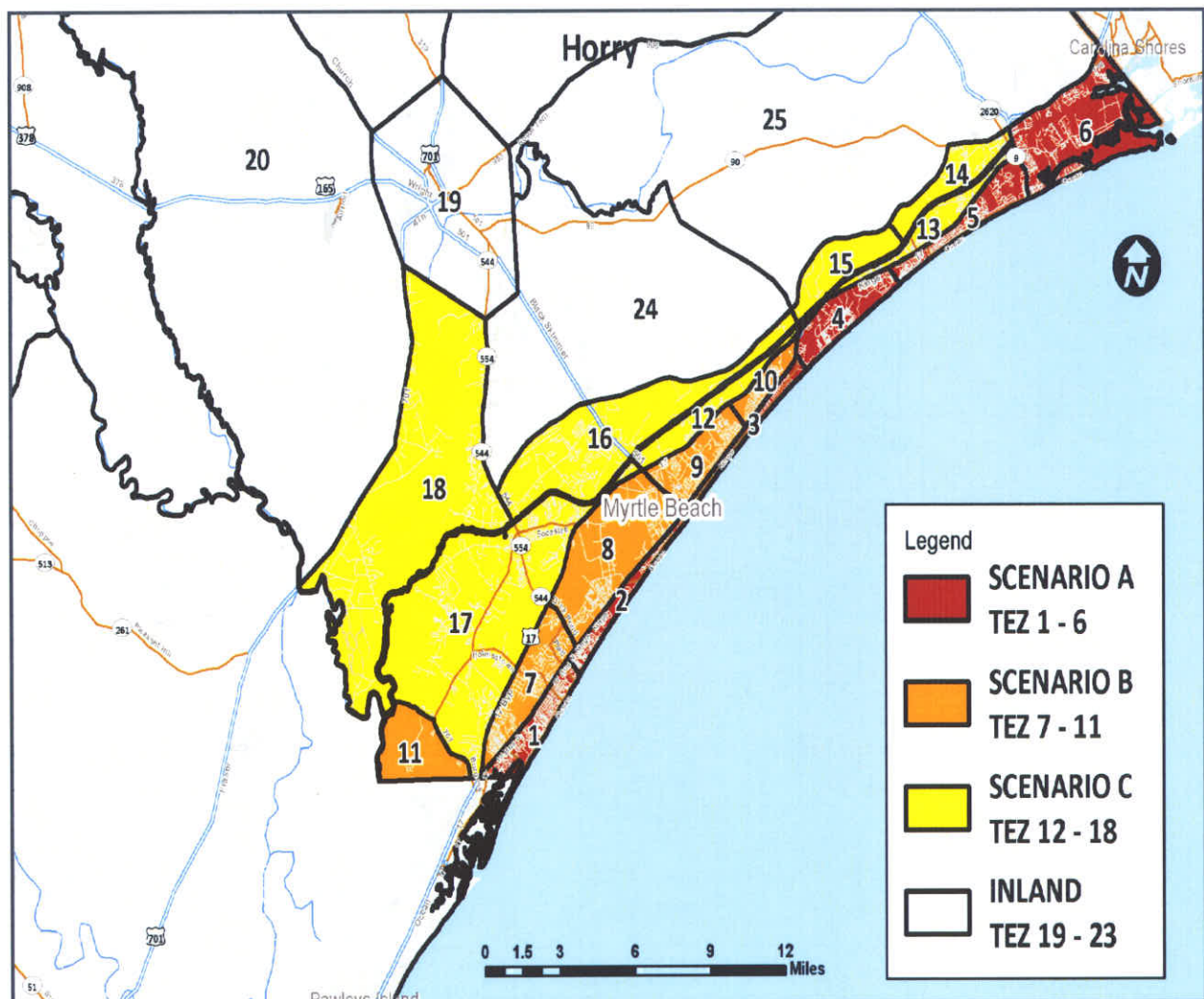


Figure 1: Traffic Evacuation Zones – Horry County



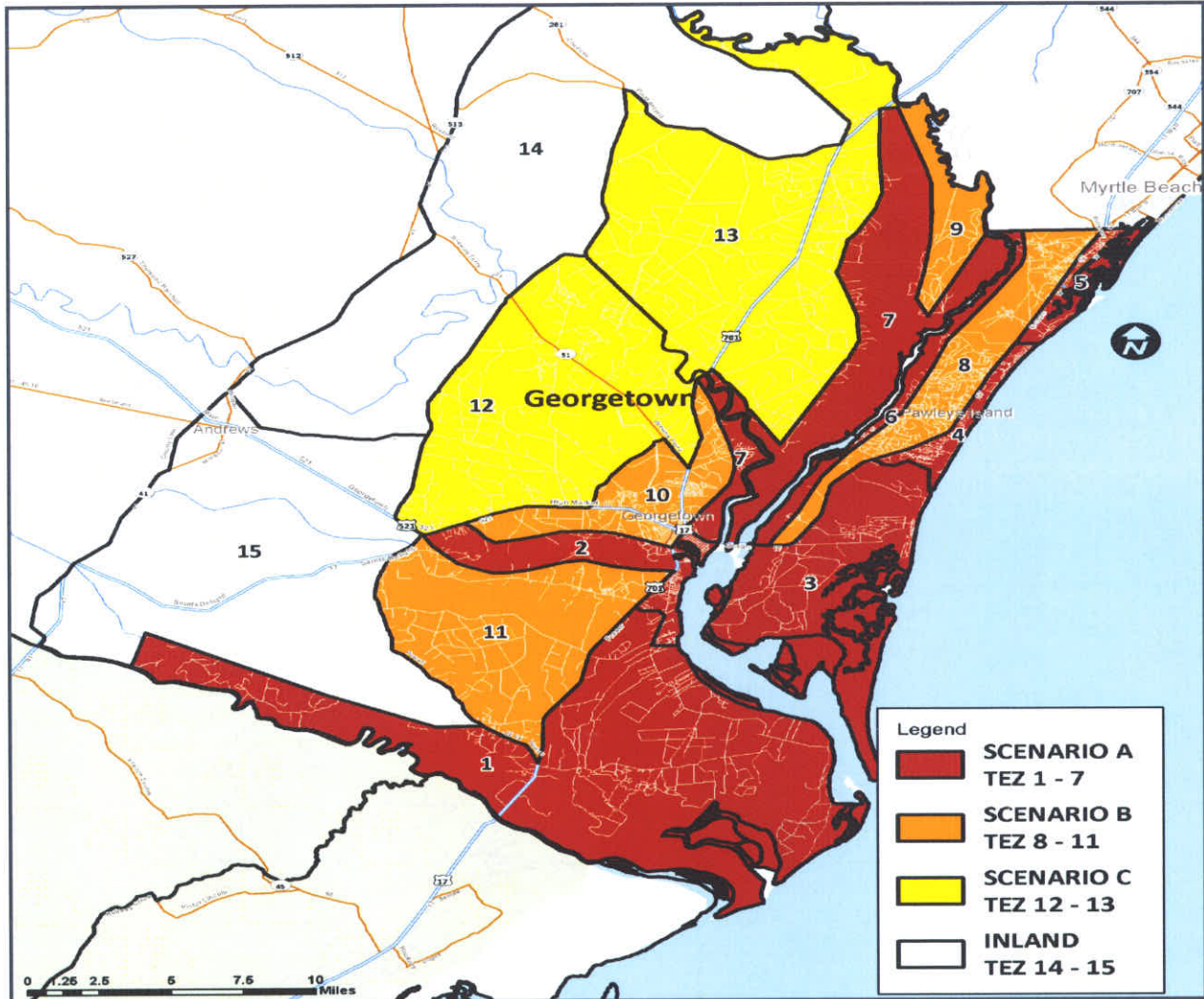


Figure 2: Traffic Evacuation Zones – Georgetown County

### Socioeconomic / Land Use Data

Previous hurricane study efforts for the area have primarily used the 2000 U.S. Census for information regarding permanent and seasonal dwelling units, numbers of people and vehicles per household, and mobile home data. This effort utilized the 2010 U.S. Census and detailed seasonal unit count research done as a part of the FEMA/USACE recent hurricane evacuation study update. In addition, the latest 2030 population projections by the South Carolina Budget and Control Board, Office of Research and Statistics and recent tourist characteristic data compiled by the Chamber for 2011 were used to refine this effort.

Earlier study efforts had assumed a current permanent population of approximately 200,000 people for Horry County. New data incorporated into the base year model for this effort was updated to reflect a current population of approximately 269,260 people





for Horry County and 60,190 people for Georgetown County. The future year 2030 model runs for Horry County and Georgetown County reflect a permanent population of 371,700 people for Horry and 65,100 people for Georgetown County and these are based on the state projections.

In a tourist area like the Grand Strand, seasonal population and occupancy levels of units are critical in calculating evacuation clearance time. For this analysis, Horry County was assumed to have approximately 80,000 seasonal units (includes hotel motels, condos, campground sites) with approximately 10,000 for Georgetown County. For the future year 2030, a conservative growth rate of 15% in tourism was assumed over and above the existing base year. Based on the latest occupancy data for 2011, a high occupancy of 85% was used and corresponds to the average July occupancy during hurricane season.

### **Evacuation Behavioral Assumptions**

To calculate reliable estimates of evacuation clearance times, Atkins made assumptions in regards to what the evacuating population will do. Assumptions regarding participation rates, destination percentages, and vehicle usage were made for permanent residents and tourists. To keep this analysis consistent with assumptions currently being used by state and county emergency management, Atkins used the latest FEMA/USACE study behavioral parameters by zone for each storm scenario and tourist occupancy tested. Also new tourist home origin data for the 2011 season were considered in understanding the percentage of evacuees who desire to travel in various directions. The new data indicates roughly 75% of the evacuees desire to travel north and northwest versus 25% who desire to travel west and southwest from the Grand Strand area.

Behavioral assumptions were incorporated for participation rates (i.e. what percent of the population in a given zone will evacuate for each scenario), and the percent of evacuees assumed to go out of county. So that clearance times calculated in the study give everyone who is vulnerable the opportunity to evacuate whether they choose to or not, 100% of surge areas were assumed to evacuate. The percent going out of county was varied between approximately 40% and 70% for the permanent population (depending upon storm intensity) and near 100% for the seasonal population.

Vehicle usage percentages refer to the percent of vehicles owned at the household that will be used in the evacuation. For the permanent population this percentage was varied between 70% and 80% (higher for beachfront zones) and is consistent with historical behavioral research for actual evacuations nationwide. For the seasonal population, vehicle usage was set at 100%.



## Route Assumptions

The existing road network with planned and funded improvements formed the existing plus committed network used to test the “no build” alternative for the future. In addition to these physical improvements, special traffic control that would be in place for hurricane evacuations were also taken into account. This included the reverse laning of US 501 from Aynor/Conway Bypass to Marion and US 501 from SC 544 to Conway in the State Hurricane Plan.

While the future I-73 alignment is generally understood, the SELL project alignment is not as far along in the planning stage. Atkins assumed that the southern terminus of SELL would line up with Holmstown Road and the northern terminus with SC 22 (the western end of the Conway Bypass). It was also assumed that SELL would have an interchange with US 701 and US 378.

## V. Study Findings

Currently, Horry County has a hurricane evacuation clearance time just below 30 hours for a Category 4/5 hurricane with July type tourist occupancy. This assumes the state’s law enforcement (working in concert with SCDOT and local officials) is able to fully staff and implement the current planned reversals on US 501 between Aynor and Marion and US 501 between SC 544 and Conway. Currently the planned reversal between SC 544 and Conway forces the reverse lane traffic onto US 378 which even in improved sections continues to be only two lanes with one westbound evacuation travel lane. It is not clear given visitors’ home origins, direction evacuees want to travel, and their local route knowledge that evacuees will be willing to use US 378 to the degree that the planned reversals assume.

In the future year 2030 planning horizon, with no reversals and no building of the I-73 or SELL projects, hurricane evacuation clearance times will balloon to well over 50 hours for a major hurricane with a July tourist occupancy. While the US 501 reversal from the Conway Bypass/Aynor to Marion would be essential to address this large time requirement, it is doubtful given the expected permanent population and tourist growth in the region, that the other US 501 reversal would be workable by the year 2030 as almost 40 hours of evacuation traffic would be forced onto US 378 under the current scheme.

Georgetown County currently has a 22 hour worst-case hurricane evacuation time that will grow to just below 28 hours if no improvement projects are implemented in the future.

Table 1 provides the Clearance Time Comparison data for each previously described alternative.





**Table 1: Clearance Time Comparison**

**Generalized Evacuation Clearance Times Category 4 / 5 High Tourist Occupancy** (all times are in hours)

Critical Evacuation Bottleneck Controlling Timing	Planning Year and Roadway Alternative						
	2011 Base Year (w current SLED & SCDOT reversals)	2030 No Build (w no reversals)	2030 No Build (w current SLED & SCDOT reversals)	2030 No Build-Realistic (w only 501 Aynor to Marion reversal)	2030 I-73 Only (w no reversals)	2030 SELL Only (w only 501 Aynor to Marion reversal)	2030 I-73 & SELL (w no reversals)
US 521 wb out of Georgetown Co	22.2	27.6	24.6	27.6	27.0	19.4	19.4
US 501 at Carolina Forest/Outlet Mall Area	25.7	30.6	30.6	30.6	20.6	25.9	17.1
US 501 from SC 544 to Conway	25.2*	44.7	30.6*	44.7	39.4	31.2	20.8
US 501 from Conway Bypass to Marion	22.7*	57.8	27.3*	33.9*	18.2	37.2*	18.8
Conway Bypass	12.1	13.9	13.9	13.9	23.7	12.0	19.1
US 378 wb 2 lane section	28.3**	15.4	35.5**	15.4	15.4	20.7	16.5
SC 9 from Green Sea to Nichols	21.6	26.2	26.2	26.2	16.1	26.2	16.1
I-73 Proposed Corridor	NA	NA	NA	NA	30.7	NA	32.4
SELL Corridor from Holmestown Rd tie in	NA	NA	NA	NA	NA	15.0	20.1

\*Times indicate the assumed reverse lane is in place. \*\*Times indicate forced use of evacuation route due to traffic control.

Key:   Indicates controlling time for evacuation under that scenario.

**Important Notes:**

- 1) Current SLED/SCDOT reversal plan includes US 501 from Aynor/Conway Bypass to Marion. It also includes reversing US 501 between SC 544 and Conway, forcing evacuees on the reversed side to use US 378 as their evacuation route.
- 2) Times are the total duration for all evacuee movements, not the time any one household will spend on the road network and are reported in hours.
- 3) Recent tourist home origin data implies that roughly 75% of evacuees will desire to travel northwest and north with the remaining 25% needing to travel west/southwest from the Grand Strand area.
- 4) Population totals used in the study based on census and state data center projections include 269,300 and 60,200 base year permanent residents for Horry and Georgetown Counties respectively. Future year estimates include 371,600 for Horry and 65,000 for Georgetown Counties. Conservative assumption of 15% tourist growth used.
- 5) Times reflect new evacuation zones from USACE/FEMA study effort.



### Proposed I-73 Corridor Evacuation Time Impacts

- 1) The I-73 facility (without SELL) provides major relief to the inland US 501 corridor and some lesser relief to the problematic US 501 section between SC 544 and Conway.
- 2) SC 31 and the Conway Bypass are used much more substantially as a relief evacuation corridor.
- 3) Provides major relief to US 501 near Carolina Forest/outlet mall bottleneck area.
- 4) Provides major evacuation congestion relief to SC 9.
- 5) Provides interstate quality traffic flow in the direction that approximately 75% of evacuees wish to travel.
- 6) Compared to the realistic no build future year alternative with reverse lane on US 501 from Aynor to Marion, if I-73 is built (without the SELL project), provides 5 hours of clearance time saving giving roughly 40,000 people the time to escape who otherwise would be trapped in the area under certain scenarios. (Assuming no reverse lane implementation in the future no build alternative, in comparison I-73 saves up to 18 hours of clearance time.)
- 7) I-73 provides a very slight improvement to Georgetown County times.
- 8) Alleviates the need for the state to expend resources needed to staff and implement reverse laning of US 501 from Aynor to Marion.

### Proposed SELL Corridor Evacuation Time Impacts

- 1) The SELL facility (without I-73) provides major relief to the critical evacuation bottleneck US 501 corridor between SC 544 and Conway.
- 2) Serves as a more efficient way to get southern Grand Strand and northern Waccamaw Neck evacuees to US 378 westbound and US 501 northbound at the junction of the Conway Bypass.
- 3) Provides major evacuation congestion relief to US 521 in and west of Georgetown.
- 4) Compared to the realistic no build future year alternative with reverse lane on US 501 from Aynor to Marion, if SELL is built (without the I-73 project), provides 7 hours of clearance time saving giving roughly 50,000 people the time to escape who otherwise would be trapped in the area under certain scenarios.





- 5) SELL provides a major improvement to Georgetown County future evacuation times (saving 8 hours) and keeps the times within the National Hurricane Center's 24 hour warning window.
- 6) Provides moderate relief to the US 501 near Carolina Forest/outlet mall area.

### **Proposed I-73 and SELL Joint Corridor Evacuation Time Impacts**

- 1) IF the I-73 facility and SELL projects are both built, they will provide major relief to the two most critical bottlenecks in the region: the US 501 corridor between Aynor and Marion and the problematic US 501 section between SC 544 and Conway.
- 2) Provides interstate quality traffic flow in the direction that approximately 75% of evacuees wish to travel.
- 3) SC 31 and the Conway Bypass would be used much more substantially has a relief evacuation corridor to area roadways.
- 4) Provides tremendous relief to US 501 near Carolina Forest/outlet mall bottleneck area.
- 5) Provides major evacuation congestion relief to SC 9.
- 6) Provides interstate quality traffic flow in the direction that approximately 75% of evacuees wish to travel.
- 7) Compared to the realistic no build future year alternative if I-73 and SELL are built, provides 12 plus hours of clearance time saving giving roughly 90,000 people the time to escape who otherwise would be trapped in the area under certain scenarios. I-73 provides a very slight improvement to Georgetown County times.
- 8) Alleviates the need for the state to expend resources needed to staff and implement reverse laning of US 501 from Aynor to Marion and US 501 from SC 544 to Conway
- 9) Provides major evacuation congestion relief to US 521 in and west of Georgetown.
- 10) I-73 and SELL provides a major improvement to Georgetown County future evacuation times (savings of 8 hours) and keeps the times within the National Hurricane Center's 24 hour warning window.





- 11) Serves as a more efficient way to get southern Grand Strand and northern Waccamaw Neck evacuees to US 378 westbound and I-73 northbound at the junction of the Conway Bypass.

The hurricane evacuation analysis is intended to provide general system level impacts of I-73 and SELL implemented alone or in combination and is not intended for environmental impact study (EIS) level documentation and analysis. The analysis makes no assertion as to the environmental feasibility or community impacts and acceptability of either corridor.