

HURRICANE CHARLEY
POST-STORM
TRANSPORTATION ANALYSIS

September 2005

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HURRICANE CHARLEY TRANSPORTATION ASSESSMENT

TRANSPORTATION AND EVACUATION

The primary objective of the FEMA / USACE comprehensive hurricane evacuation studies (HES) is the calculation of clearance times. They are the amount of time needed to clear the entire evacuation road network of all evacuation traffic and convey those vehicles and their occupants to a point of relative safety. Clearance times are calculated for a variety of evacuation scenarios based on hurricane intensity, tourist occupancy and response timing, and are used by emergency managers to determine when to issue evacuation orders.

The transportation analysis combines variables from the vulnerability analysis (evacuation zones, vulnerable population and evacuating vehicles); behavioral analysis (response rates, participation percentages, intended destinations per evacuation zone); and shelter analysis (shelter use percentages and locations) into a hurricane evacuation transportation model. This transportation model emulates the characteristics of the evacuation roadway network during various hurricane evacuation scenarios to determine the most congested segments.

The most recent Transportation Analysis for the Southwest Florida Region, namely Collier, Lee, Charlotte, Sarasota, Glades and Hendry Counties, was completed in 2000, while the Tampa Bay hurricane evacuation transportation work, which included Manatee, Pinellas, Hillsborough and Pasco Counties was finished and distributed also in 2000. The 2000 Southwest Florida Hurricane Evacuation Study was prepared by the Southwest Florida Regional Planning Council using another transportation analysis methodology. The clearance times prepared under that effort will not be discussed in the post storm transportation analysis for Hurricane Charley. In the latter effort, one of the less surprising findings was that the Tampa Bay region had the worst regional clearance times in the country.

For the at-risk counties on the exiting side of this storm, the East Central Florida HES prepared in 1999 and the Northeast Florida HES, dated 1998 provided the clearance times used for evacuation planning purposes. The counties in the interior of north Florida and down the spine of central Florida were covered by the Cedar Key and Central Florida HESs respectively, both conducted in 1995.

COUNTY POST-STORM SURVEY RESPONSES REGARDING EVACUATIONS AND TRAFFIC CONDITIONS

Table 1 provides the observations of local and state government representatives regarding evacuation and transportation related issues during Hurricane Charley. Transportation and clearance time issues discussed by the study teams with local and state officials for the Hurricane Charley event included the following:

- ▶ The perception of the roadway network's ability to meet evacuation traffic demand;
- ▶ The perceptions regarding how quickly the public responded to evacuation orders;
- ▶ The apparent volume of traffic during the evacuation;
- ▶ The duration of the evacuation event relative to clearance times; and
- ▶ Any traffic problems experienced during the evacuation.

Fourteen of the 21 counties surveyed after Hurricane Charley indicated that heavy traffic, congestion, traffic jams or gridlock characterized the road conditions during the evacuation. Three county emergency management offices indicated that traffic gridlock characterized the roadways in or near their jurisdictions for Hurricane Charley. Other predominant problems were availability of fuel, the lack of adequate signage and road construction. None of the counties that used the clearance times included in their HES indicated that they were insufficient for the magnitude of the storm.

Table 2 provides evacuation route information collected from officials of local governments surveyed during this effort. The data details what roadways are considered primary and secondary evacuation routes for residents and visitors within their communities. Where it was reported by local officials, Table 2 includes any anecdotal information regarding the observed traffic conditions in their areas. The table also indicates which roadways specifically referenced by local officials in their surveys are covered by a traffic counter or included in ETIS as an evacuation route.

Table 1. HURRICANE CHARLIE LOCAL EMERGENCY MANAGEMENT SURVEY RESPONSES

County	Evacuation Decision	Indicated Time of Order or Possible Evacuation Start Time	Estimated Number of Vehicles Evacuating	Estimated Percent Compliance With Evac Orders	Estimated Arrival Tropical Storm Winds	Public Response	Tourist Occupancy	Clearance Time Sufficient	Heavy Traffic	Congestion	Traffic Jams	Gidlock	Tolls	Fuel Availability	Inadequate Signage	Uncoordinated Traffic Signals.	Diversions from Other Co.	Construction
West Coast Coastal Counties (in geographic order south to north)																		
Collier	Cat 2	NS	NS	15%	8/13-8 AM	S	N	NA	●	●	●	●	●	●				
Lee	Cat 1	8/12-8 AM	29,130	40%	8/13-11 AM	N	L	NA	●									
Charlotte	Cat 1	NS	NS	NS	8/13-12 PM	NS	L	NA		●								
Sarasota	Cat 1	8/12-10 AM	7,000	80%	8/13-12 PM	NS	N	NA						●				
Manatee	Cat 2	8/12-10 AM	NS	NS	8/13-1 PM	N	N	✓						●				●
Hillsborough	Cat 3	9/13-6 AM	NS	35%	8/13-5 PM	N	L	NS	a	a	a	a	a	a	a	a	a	a
Pinellas	Cat 3	8/12-6 PM	150,000	NS	8/13-5 PM	S	N	✓		●		●						
Pasco	Cat 2	8/12-6 PM	7,560	NS	8/13-6 PM	S	L	✓						●				
Citrus	Cat 1	8/13-8 AM	NS	NS	8/13-8 PM	NS	H	✓	a	a	a	a	a	a	a	a	a	a
East Coast Coastal Counties (in geographic order south to north)																		
Palm Beach	Belle Glade	NS	NS	NS	^b	N	L	NA	●	●	●			●				●
Volusia	Cat 3	8/13-6 PM	58,000	80%	8/13-8 PM	F	N	✓	●	●		●			●			
Inland Counties (listed alphabetically)																		
Bradford	MH, FPA	NS	NS	NS	^b	F	H	NS	●					●				
DeSoto	MH, LLA	8/13-3 PM	NS	50%	8/13-1 PM	S	L	NA						●		●		
Glades	Whole Co.	NS	NS	80%	8/13-1 PM	NS	L	NA	●	●	●			●			●	
Hardee	Cat 3	NS	NS	50%	8/13-2 PM	NS	NS	NA							●	●		
Hendry	MH, LLA	NS	NS	10%	8/13-12 PM	S	L	NA	●					●	●			
Highlands	MH, LLA	8/13-12 PM	NS	30%	8/13-1 PM	S	L	NA	●					●				
Orange	MH, LLA	NS	NS	25%	8/13-7 PM	F	H	NS		●	●		●	●	●			
Osceola	MH, LLA	NS	NS	10%	8/13-6 PM	S	H	NS		●				●	●			●
Polk	S of SR 60	NS	NS	10%	8/13-5 PM	S	L	NA	●	●				●	●		●	●
Seminole	MH, LLA	NS	NS	25%	8/13-7 PM	N	N	NA		●	●		●	●	●			

Table 1 Continued. HURRICANE CHARLIE LOCAL EMERGENCY MANAGEMENT SURVEY RESPONSES

Footnotes and Explanations

- Blue fill in Evacuation Decision box = mandatory order
- Yellow fill in Evacuation Decision box = voluntary order
- Green fill in Evacuation Decision box = recommended order
- No fill in Evacuation Decision box = type not specified
- Cat 1,2,3,4,5 in Evacuation Decision box = highest category of surge evacuation zone. Unless otherwise specified any level of surge area evacuations include mobile homes, flood prone or low lying areas.
- MH in Evacuation Decision box = Mobile home orders
- FPA in Evacuation Decision box = Flood prone areas
- LLA in Evacuation Decision box = Low lying areas

S= Slow Public Response

N = Normal Public Response

F = Fast Public Response

L= Low Tourist Occupancy

N = Normal Tourist Occupancy

H = High Tourist Occupancy

✓ = Clearance Times judged sufficient by county

✗ = Clearance Times judged insufficient by county

NA = Not Applicable (Not studied under the US Army Corps of Engineers HES Program)

NS = Data not specified by County

a No specific evacuation problems indicated by county

b Not forecast to receive tropical storm force winds

Table 2. HURRICANE CHARLEY LOCAL EMERGENCY MANAGEMENT EVACUATION ROUTE DATA

Responding County	Recommended Primary And Secondary Evacuation Routes	Descriptions of Traffic Conditions from Local Officials		
		Roads with Heavy Traffic	Roads with Congestion	Roads at Gridlock
East Coast Coastal Counties (in geographic order south to north)				
Palm Beach	<ul style="list-style-type: none"> • I-95 • US 27 • Florida Turnpike • SR 710 • SR 80 			
Volusia	<ul style="list-style-type: none"> • I-4 • I-95 • US 92 • SR A1A • SR 40 • SR 44 • SR 414^a 		<ul style="list-style-type: none"> • SR 40 (in Lake and Marion Co. where roadway goes from 4 to 2 lanes) 	<ul style="list-style-type: none"> • General description of roadway network, specific roads not identified
West Coast Coastal Counties (in geographic order south to north)				
Collier ^b	<ul style="list-style-type: none"> • I-75 • US 41 • Secondary Roads 	<ul style="list-style-type: none"> • Secondary Roads 	<ul style="list-style-type: none"> • US 41 	<ul style="list-style-type: none"> • I-75
Lee ^b	<ul style="list-style-type: none"> • I-75 • US 41 • SR 80 • SR 82 			
Charlotte ^b	<ul style="list-style-type: none"> • I-75 • US 41 			
Manatee	<ul style="list-style-type: none"> • I-75 • I-275 • US 41 • US 301 • SR 64 • SR 70 			
Sarasota ^b	<ul style="list-style-type: none"> • I-75 • US 41 • River Road 			

Table 2. HURRICANE CHARLEY LOCAL EMERGENCY MANAGEMENT EVACUATION ROUTE DATA

Responding County	Recommended Primary And Secondary Evacuation Routes	Descriptions of Traffic Conditions from Local Officials		
		Roads with Heavy Traffic	Roads with Congestion	Roads at Gridlock
Pinellas	<ul style="list-style-type: none"> • I-275 • US 19 • SR 60 • SR 688 			<ul style="list-style-type: none"> • I-275 • US 19 • SR 60 • SR 688
Hillsborough	<ul style="list-style-type: none"> • I-4 • I-75 • I-275 			
Pasco	<ul style="list-style-type: none"> • I-75 • US 19 • US 41 • US 310 • Suncoast Expressway^c • SR 52 • SR 54 	<ul style="list-style-type: none"> • Normal on all routes 	<ul style="list-style-type: none"> • Normal on all routes 	<ul style="list-style-type: none"> • Normal on all routes
Citrus	<ul style="list-style-type: none"> • SR 44 E of Crystal River • CR 490 • Grover Cleveland Blvd • US 41 			
Inland Counties (listed alphabetically)				
Bradford	<ul style="list-style-type: none"> • US 301 North • SR 100 East • SR 100 West • SR 16 East • SR 16 West 	<ul style="list-style-type: none"> • US 301 North • SR 100 East • SR 100 West • SR 16 East • SR 16 West 		
DeSoto	<ul style="list-style-type: none"> • US 17 • SR 70 • SR 72 			
Glades	<ul style="list-style-type: none"> • US 27 • SR 29 • SR 78 	<ul style="list-style-type: none"> • US 27 • SR 78 		
Hardee	<ul style="list-style-type: none"> • US 102 • SR 64 West • SR 66 East • SR 104 East 	<ul style="list-style-type: none"> • Light on all routes 	<ul style="list-style-type: none"> • Light on all routes 	<ul style="list-style-type: none"> • Light on all routes

Table 2. HURRICANE CHARLEY LOCAL EMERGENCY MANAGEMENT EVACUATION ROUTE DATA

Responding County	Recommended Primary And Secondary Evacuation Routes	Descriptions of Traffic Conditions from Local Officials		
		Roads with Heavy Traffic	Roads with Congestion	Roads at Gridlock
Hendry	<ul style="list-style-type: none"> • US 27 • SR 29 • SR 78 • SR 80 	<ul style="list-style-type: none"> • All routes 		
Highlands	<ul style="list-style-type: none"> • US 27 • US 98 • SR 64 • SR 66 • SR 70 	<ul style="list-style-type: none"> • US 27 		
Orange	<ul style="list-style-type: none"> • I-4 • SR 46 • SR 50 • SR 520 • SR 528 			
Osceola	<ul style="list-style-type: none"> • I-4 • US 192 • US 441 • Florida Turnpike • SR 60 		<ul style="list-style-type: none"> • One or more roads (not specified) 	
Polk	<ul style="list-style-type: none"> • I-4 • US 17-19 • US 27 • SR 60 		<ul style="list-style-type: none"> • I-4 (during some periods) • US 27 (during some periods) • SR 60 (during some periods) 	
Seminole	<ul style="list-style-type: none"> • I-4 • US 17-92 • SR 46 • SR 434 • SR 436 			

Red Bold Letters = ETIS route and TTMS counter in or near county boundaries
 Blue Bold Letter = Route modeled in ETIS only, no TTMS counter in or near boundaries
 Green Bold Letters = TTMS counter only in or near county boundaries, but not modeled in ETIS
 Black Lettering, No Bold Letters = route with no TTMS counter and not modeled in ETIS
 Letters in italics indicate routes recommended by emergency management not modeled in most recent transportation analysis

^a SR 414 is located in Seminole County, not in Volusia County
^b Study not prepared by FEMA/USACE/PBS&J
^c Road not yet constructed when last HES Analysis was prepared

ANALYSIS OF THE TRAFFIC COUNTER DATA

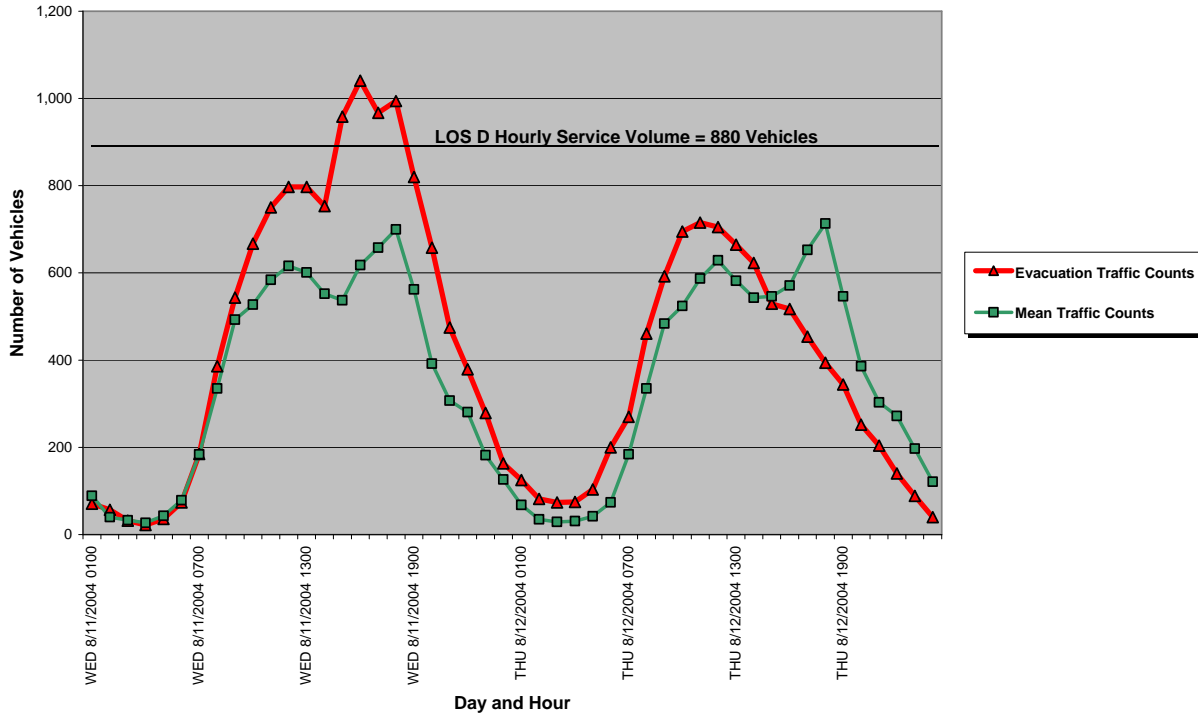
Florida has the benefit of strategically located traffic counters that record hourly counts as well as average speeds and provide that data in real time to a website that can be easily accessed. Analysis of the traffic counter data collected during Hurricane Charley indicated that evacuation congestion as widespread, but appeared relatively localized relative to what segments actually experienced traffic problems. The following pages include figures graphically depicting the data collected at these counters during the evacuations for Hurricane Charley.

US 1 Northbound (TTMS Counters 0227 and 0164)

- The traffic counters indicate that evacuations from Monroe County began at approximately 8:00 AM on Wednesday, August 11, 2004 (See Figure 1) from as far south as the Lower Keys and continued until 5:00 PM on Thursday, August 12 in the Upper Keys near Key Largo (See Figure 2).
- The Big Pine Key counter recorded that the hourly traffic volume surpassed the hourly evacuation roadway capacity of 880 vehicles from 3:00 PM to 6:00 PM on Tuesday, August 11.
- At the counter near Key Largo (Figure 2), the hourly traffic volume exceeded the hourly evacuation roadway capacity of 880 vehicles per hour from noon to 10:00 PM on Tuesday, August 11 with the peak 504 vehicles over Level of Service (LOS) D at 7:00 PM on that day. A second peak occurred on the following day from 10:00 AM to 5:00 PM with a maximum recorded volume of 1,238 vehicles at noon, 491 vehicles over the average daily volume.
- Despite the incidences where the recorded traffic topped the average daily volumes for both counters, the average speeds (See Table 2) did not drop significantly below average posted speed limits during those periods. This indicates that although there were reasonably high volumes at both counters they certainly did not result in serious congestion or a traffic queuing situation.
- Hourly traffic volumes at both Big Pine Key and Key Largo dropped well below normal daily levels before the of tropical storm force winds arrived at the counter on Big Pine Key at 2:00 AM, August 13, 2004. By the time traffic levels dropped off, a total of approximately 4,000

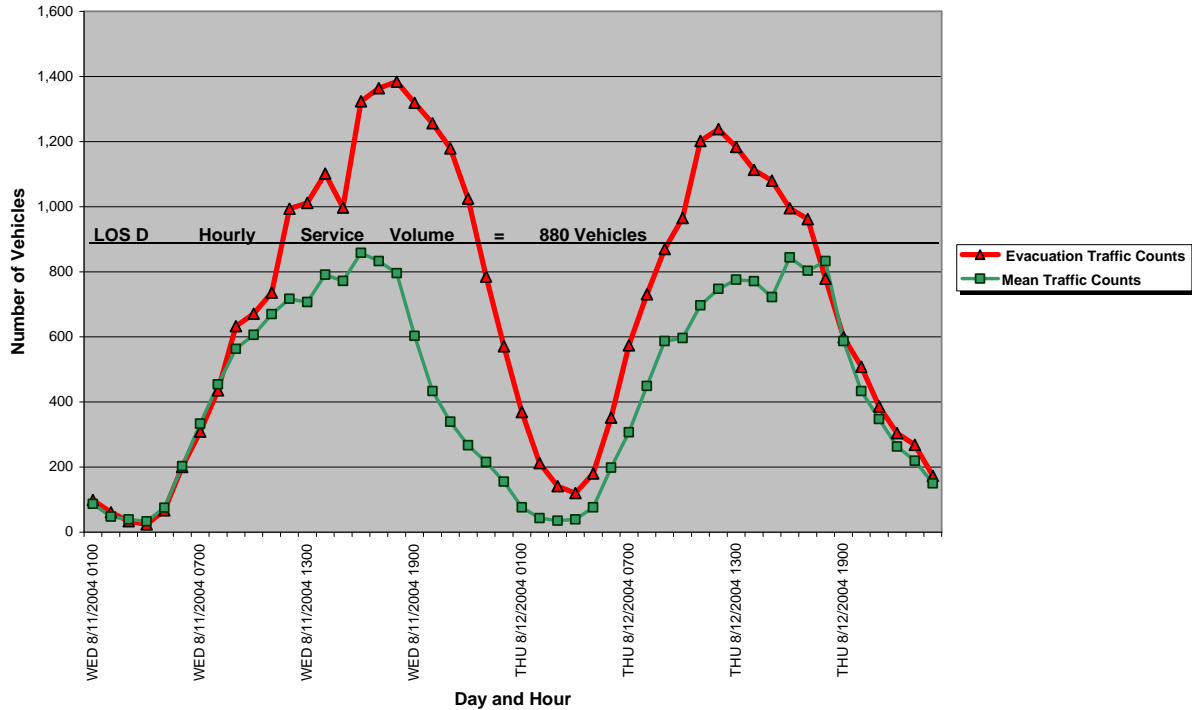
additional vehicles over ADT had used US 1 near Big Pine Key and about 11,100 additional vehicles had crossed the counter on US 1 near Key Largo.

Figure 1. Charley - US 1 Northbound Near Big Pine Key (0227 NB)



- The significantly higher volume at the more northerly counter implies that more residents and visitors complied with evacuation orders in the Middle and Upper Keys than from the Lower Keys. Reportedly the evacuation orders issued by Monroe County included non-residents south of mile marker 72, as well as mobile home residents below the Seven-Mile Bridge.
- According to the National Hurricane Center data displayed in HURREVAC, only the traffic counter at Big Pine Key experienced tropical storm force winds. The estimated arrival time for those winds was at 2:00 AM on Friday, August 13, 2004, 27 hours after the hourly traffic volumes dropped below ADT.

Figure 2. Charley - US 1 Northbound Near Key Largo (0164 NB)

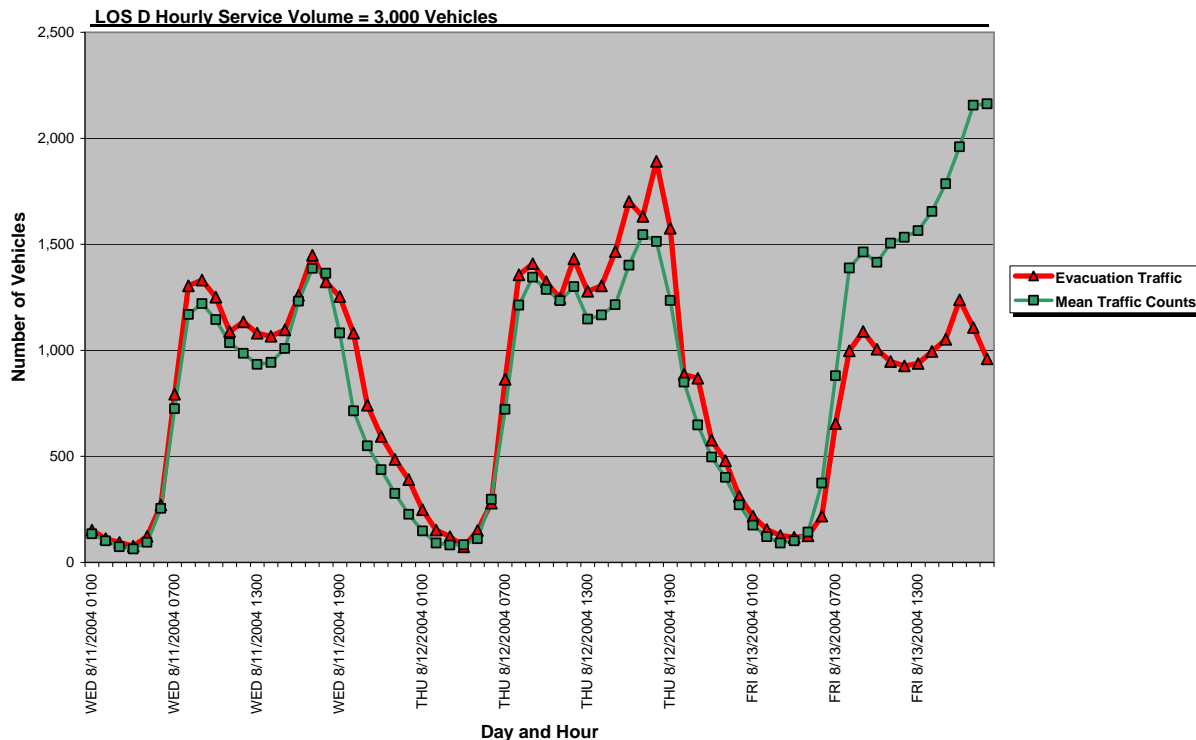


Florida Turnpike Northbound (TTMS Counter 0417)

- The traffic counter indicates that traffic began increasing to levels above normal hourly volumes at 7:00 AM on Wednesday, August 11, 2004 (See Figure 3), an hour before either of the above traffic counters recorded an increase in the number of vehicles leaving the Florida Keys.
- Despite the peak hourly volume of vehicles traveling across this counter reached almost 1900 vehicles at 6:00 PM on Wednesday August 12, 2004, it did not come close to exceeding the maximum evacuation service volume of 3,000 vehicles per hour. Furthermore, during the period of higher than normal volumes at this counter prior to the landfall of Hurricane Charley, the average hourly speed did not drop significantly below the posted speed limit of 70 miles per hour.

- The period of significantly higher traffic volumes at this counter continued well after the counters in Monroe County dropped off to below normal levels. Hourly traffic volumes at this counter on the Florida Turnpike near Jupiter continued above ADT levels until 3:00 AM, August 13, 2004, 10 hours after the hourly volumes at counter on US 1 near Key Largo dropped below normal figures. This occurred despite the fact that no other counties in Southeast Florida (Miami-Dade or Broward) issued evacuation orders for their surge or mobile home residents. Although Palm Beach County issued a mandatory evacuation order for the residents of Belle Glade at an unspecified time, it is not likely that many of them would have used the Florida Turnpike to evacuate instead opting for US 27, US 441 or SR 80 into West Palm Beach.
- The data at this counter suggests that a fair number of residents and visitors from Miami-Dade, Broward and Palm Beach may have decided to evacuate of their own volition despite the lack of evacuation orders, or that a significant number of evacuees that traveled eastbound across the Alligator Alley from Southwest Florida (Collier and Lee Counties) continued an additional 60 miles north past Jupiter on the Turnpike. Unfortunately, neither of the traffic counters on Alligator Alley were switched to emergency mode until 1:00 AM on August 13th. Between 1:00 and 9:00 AM the easternmost counter on that roadway recorded an additional 1,136 vehicles over ADT, probably the tail end of a larger evacuation event that occurred during the previous two days.
- From 7:00 AM, August 11, to 3:00 AM, August 13th, a total of approximately 5,000 additional vehicles above ADT used that segment on the Florida Turnpike. The hourly recorded volumes were higher than the standard deviation for the ADT at that counter for 29 hours.
- Tropical Storm Force winds did not arrive at this counter location during the entire course of this hurricane.

Figure 3. Charley - Florida Turnpike Northbound Near Jupiter (0417 NB)



US 41 Both Directions (TTMS Counter 0270)

- The traffic counter indicates that traffic began increasing consistently to levels above normal hourly volumes at 1:00 PM on Wednesday, August 11, 2004 (See Figure 4) in the westbound direction, and at 9:00 AM in the eastbound direction (See Figure 5). Interestingly, this increased traffic volume began in both directions well before official evacuation orders were reportedly issued by any coastal or inland county on either coast. Of additional note is the indication that a previous period of higher than normal traffic volume was tapering off in the westbound direction at 1:00 AM on that Wednesday, just as the traffic counter was converted to real-time emergency operation.
- The peak hourly volume of vehicles traveling across this counter traveling in a westbound direction reached approximately 150 vehicles at 4:00 PM on Tuesday, August 11, 2004, less than 20% of hourly evacuation service volume. Nonetheless, this peak in traffic volume may be attributable to vehicles evacuating from Monroe County which was already underway according to counters in Big Pine Key (See Figure 1) and Key Largo (See Figure 2).

- In the eastbound direction the peak amount of traffic occurred at 2:00 PM on August the 12th with a total of 163 vehicles, well below (19%) the hourly directional service volume of 880 vehicles. This peak amount of traffic in the eastbound direction since it was almost a day later than the westbound direction, may be attributable to evacuation beginning in counties in the Southwest Region.
- Higher than normal hourly traffic volumes continued for 13 hours longer in the eastbound direction than the westbound. The westbound traffic volumes dropped below ADT roughly coinciding with the traffic volumes tapering to below normal levels at the TTMS counters in Monroe County mid afternoon on August 12th.
- During the entire evacuation period both directions processed slightly over a total 1,300 vehicles, the higher share traveling to the east. According to the average speeds and the total number of vehicles that traveled on that segment in both directions, traffic congestion was not an issued on the western side of Tamiami Trail.
- Unfortunately the traffic counters on either side of the Alligator Alley (TTMS 0351 or 0357) were not turned on in emergency mode until August the 13th, just as any higher than normal traffic counts were dropping below ADT for this event. Nonetheless it appears that evacuation traffic did use that road, at least on the 11th and 12th of August.

Figure 4. Charley - US 41 (Tamiami Trail) Eastbound Near Naples (0270 WB)

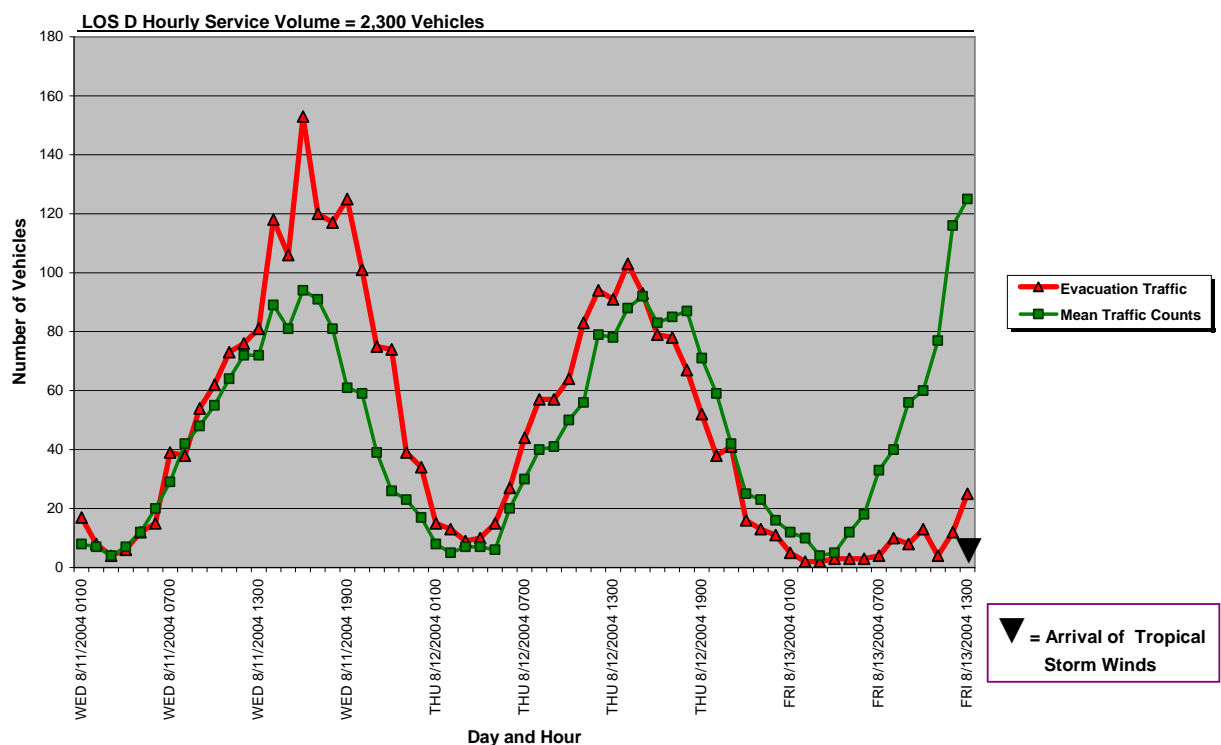
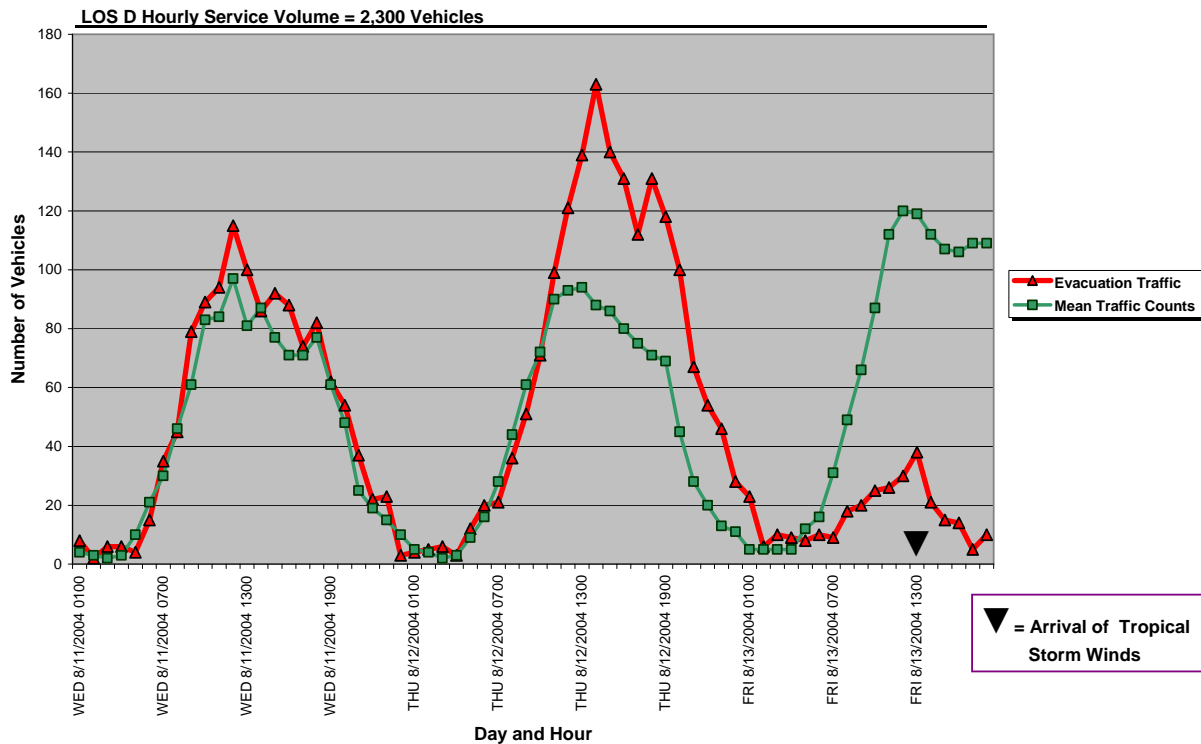


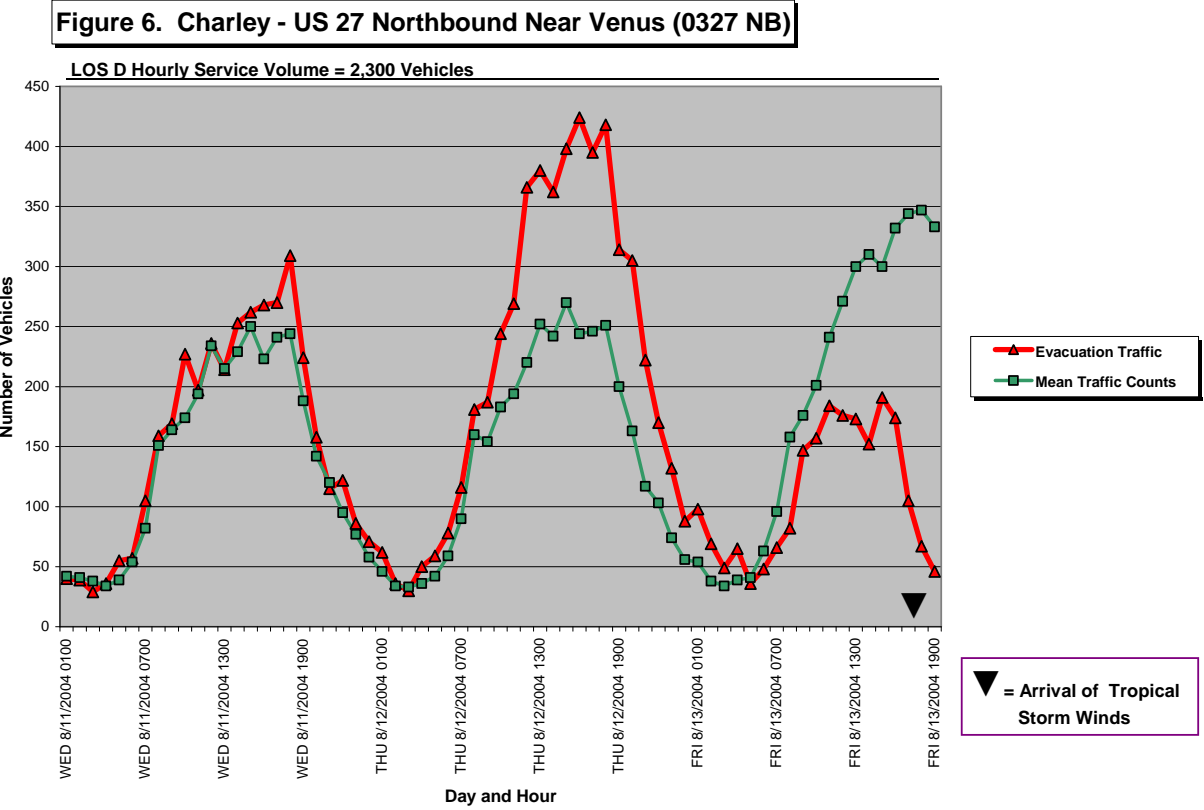
Figure 5. Charley - US 41 (Tamiami Trail) Eastbound Near Naples (0270 EB)



US 27 Northbound (TTMS Counter 0327)

- Although above normal traffic volumes began as early as 5:00 AM on Wednesday, August 11, 2004, the levels did not remain consistently high until 2:00 PM the same day (See Figure 6 and Table 2). Above average traffic volumes were recorded at this counter until Friday, the 13th of August at 5:00 AM, 12 hours before Hurricane Charley made landfall in Charlotte County.
- The peak hourly volume of vehicles traveling on this roadway segment traveling northbound exceeded a maximum of 400 vehicles per hour at 6:00 PM and again at 8:00 PM on Tuesday, August 12th. These peak hours of evacuation traffic were well below the hourly evacuation service volume of 2,300 vehicles, constituting less than 20% of the roadway’s directional capacity.
- There are no indications of any congestion problems during the entire evacuation period for the adjoining region. Hourly traffic counts and the average speeds are testimony to the fact that traffic flow on this segment of US 27 remained unconstrained for the entire evacuation period. Traffic was allowed to flow freely enough that the average speed was 74.8 miles per hour, almost 10 miles an hour over the posted speed limit.

- During the evacuation period a total of 2,300 vehicles over ADT were recorded by this sensor (See bottom of Table 2).



US 19 and Suncoast Parkway Northbound (TTMS counters 0199 and 0406)

- The TTMS counter on US 19 northbound in Pasco County (see Figure 7) was not turned on until Thursday August 12th, 2004, so there is no data to indicate whether Tampa Bay residents began their evacuations prior to then. Nonetheless, the counter did not register any significant increase in traffic volume until 8:00 AM and the recorded figures only were slightly above average hourly numbers. By the time the traffic counts dipped below the ADT at this counter at 5:00 AM on Friday, August 13th, 2,000 additional vehicles had used that segment on US 19.
- The traffic on the Suncoast Parkway was already registering above average volumes as soon as the TTMS counter on the roadway (Figure 8) was activated in emergency mode at 12:00 AM on August 12, 2004. Traffic on that portion of the Suncoast Parkway remained consistently above ADT for the next 37 hours until finally dropping below normal volumes at 1:00 pm on Friday, August 13th. In that time over 4,400 vehicles over normal hourly volumes had used that roadway.

➤ Based on the data provided by the counter on each roadway, there is no evidence that traffic flow was at all impeded by the volumes registered during the evacuation period of August 12 and 13, 2004. Although the volumes on US 19 northbound did exceed the evacuation hourly service volume for that roadway, it appears that normal daily traffic does also on a routine basis. In fact the peak value during the evacuation period, recorded at 5:00 PM on the 12th, was under the normal ADT by 212 vehicles. In looking at the average hourly speeds recorded by the counter during this peak volume period, 1:00 PM to 7:00 PM on August 12th, the average speed was always above the posted speed limit for that segment. On the Suncoast Parkway on the other hand, the peak hourly observed volume did not get above 600 vehicles, which is only slightly over one quarter of its hourly evacuation service volume. During the entire evacuation period on this roadway the average hourly speed consistently remained at or above the posted speed limit.

Figure 7. Charley - US 19 Northbound Near New Port Richey (0199 NB)

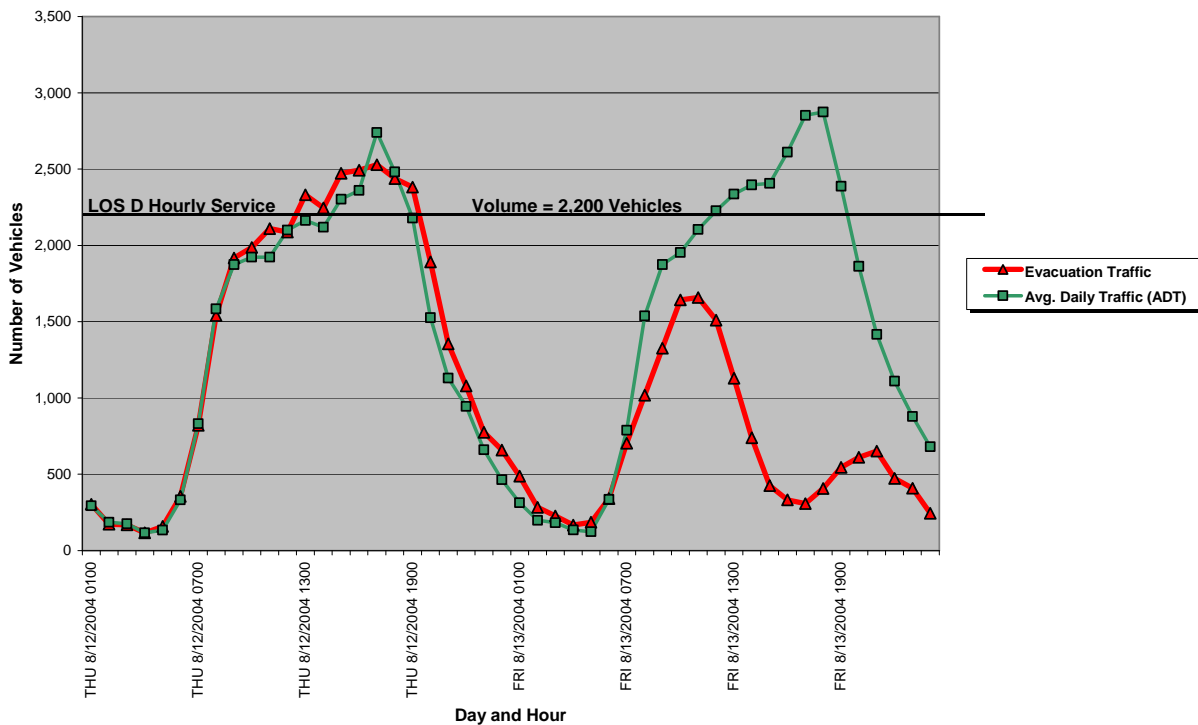
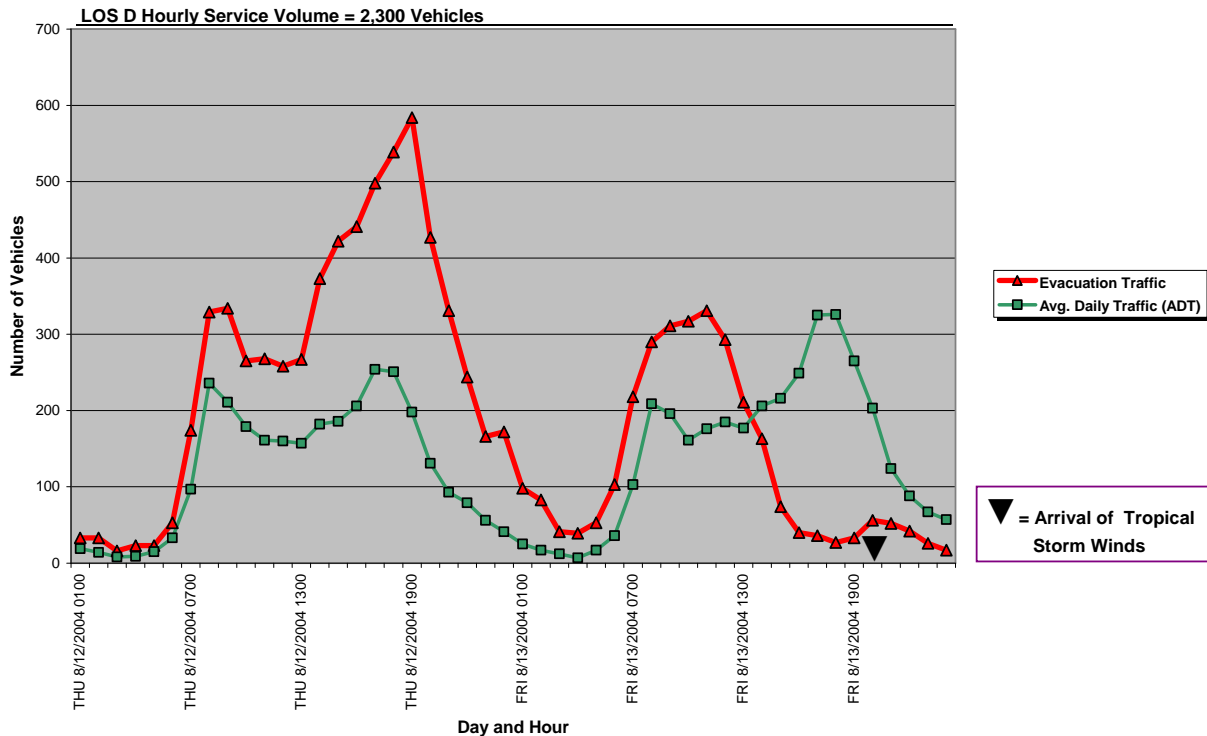


Figure 8. Charley - Suncoast Parkway Northbound Near Brooksville (0406 NB)



I-75 Northbound (TTMS Counters 0350, 0225, 0190, 0317, 0112)

- Of the five TTMS counters on I-75, the two in the Southwest Florida Region recorded an increase in traffic above ADT as early as 5:00 AM on Wednesday, August 11, 2004 (See Figures 9 and 10). A third counter on the Florida-Georgia state line (See Figure 13) began registering higher than normal hourly counts at 6:00 AM on the same day. The two other TTMS sensors (Figures 11 and 12) on I-75 northbound were not switched to the emergency operational mode until 1:00 AM, August 12th, but immediately recorded above average hourly volumes on the roadway segments near Zephyr Hills and Ocala.
- During the entire course of the evacuation period for Hurricane Charley, only one of the traffic counters recorded hourly values that exceeded the evacuation directional service volume for their particular roadway segment. TTMS counter 0190 near Zephyr Hills (Figure 11) recorded a five hour period where the number of vehicles surpassed the evacuation directional service volume of 3,000 vehicles per hour for that portion of I-75. Two peak values of over 3,400 vehicles were registered at that counter at 4:00 and 7:00 PM on August.

- The average speed (See Table 3) observed by the Zephyr Hills counter during the above specified peak time period was 63 miles per hour. The posted speed limit for that portion of I-75 is 70 miles per hour. The average recorded speed at that counter went as low as 52 miles an hour, coinciding with the time that Pinellas and Pasco Counties reportedly issued their evacuation orders and eight hours after Sarasota and Manatee advised their populations to leave the hazard areas.
- The average speeds recorded at the other three counters on I-75 (the counter near Ocala was not recording average speeds) were 71 mph at Punta Gorda, 74 mph near Sarasota and 73 mph at the Florida-Georgia state line. Of the 140 hours of average hourly speeds recorded at all three counters only 12 of them were below 70 miles an hour, the slowest average speed was 66 mph.
- There are no indications of any major traffic congestion during the entire evacuation period for the adjoining region. The only tangible evidence of somewhat restricted flow at any of the counters in emergency mode during the entire event, regardless of roadway, is at the Zephyr Hills counter. This lends some credence to Pinellas County's report that their roadways were at gridlock. Although the local roadways could possibly be characterized in that manner, the nearest counter on I-75 northbound does not support such an assertion.
- The bottom of Table 3 provides total figures for each of the counters operating in emergency mode during the disaster. In looking at those totals, it appears that a preponderance of the trips over ADT at all counters on I-75 were generated in the Southwest Florida region accounting for approximately 8,100 vehicles. It also appears that another 3,600 vehicles came from the Tampa Bay region. Logically, the counter at Ocala recorded the highest number of additional trips during the evacuation period at about 11,700 vehicles. Of those vehicles, approximately 9,000 continued into Georgia.
- Of all the TTMS counters recording data during this event, two counters on I-75 recorded the most number of hours of above average hourly volume. The sensors at Punta Gorda and the Georgia-Florida state line both recorded over 40 hours of vehicle processing time, where the hourly number of vehicles observed was above the standard deviation for the average hourly volume.

Figure 9. Charley - I-75 Northbound Near Punta Gorda (0350 NB)

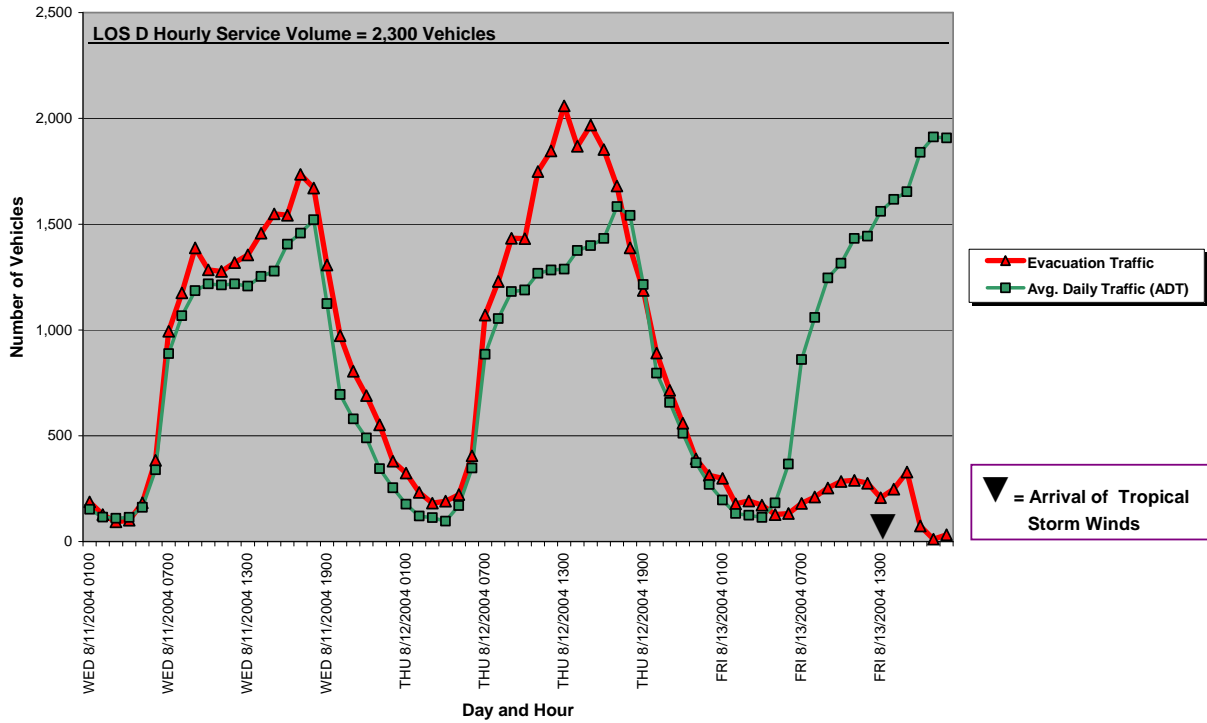


Figure 10. Charley - I-75 Northbound Near Sarasota (0225 NB)

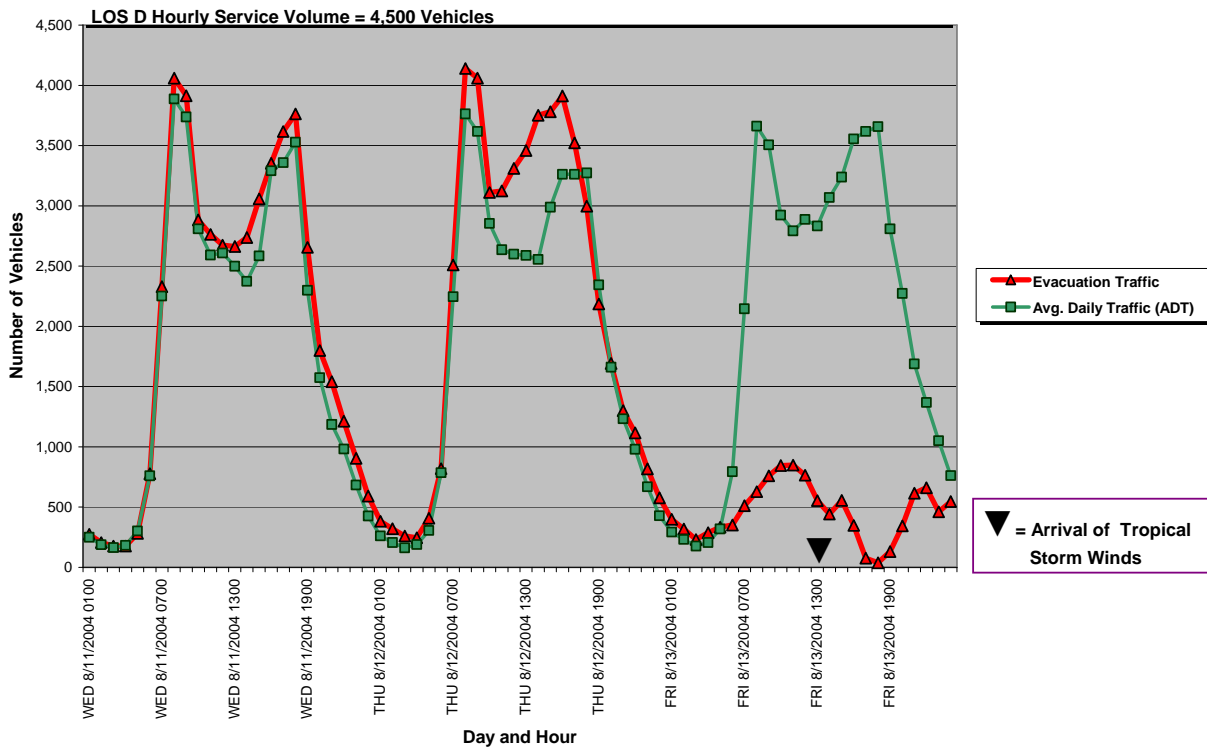


Figure 11. Charley - I-75 Northbound Near Zephyrhills (0190 NB)

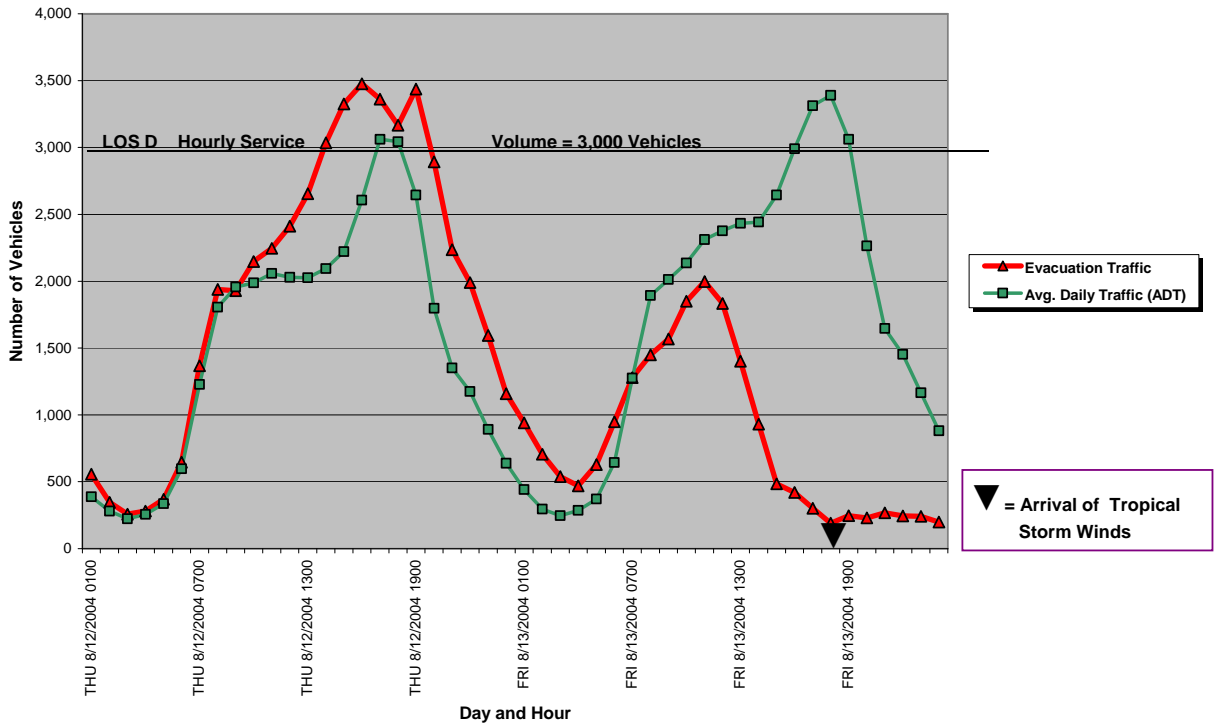


Figure 12. Charley - I-75 Northbound Near Ocala (0317 NB)

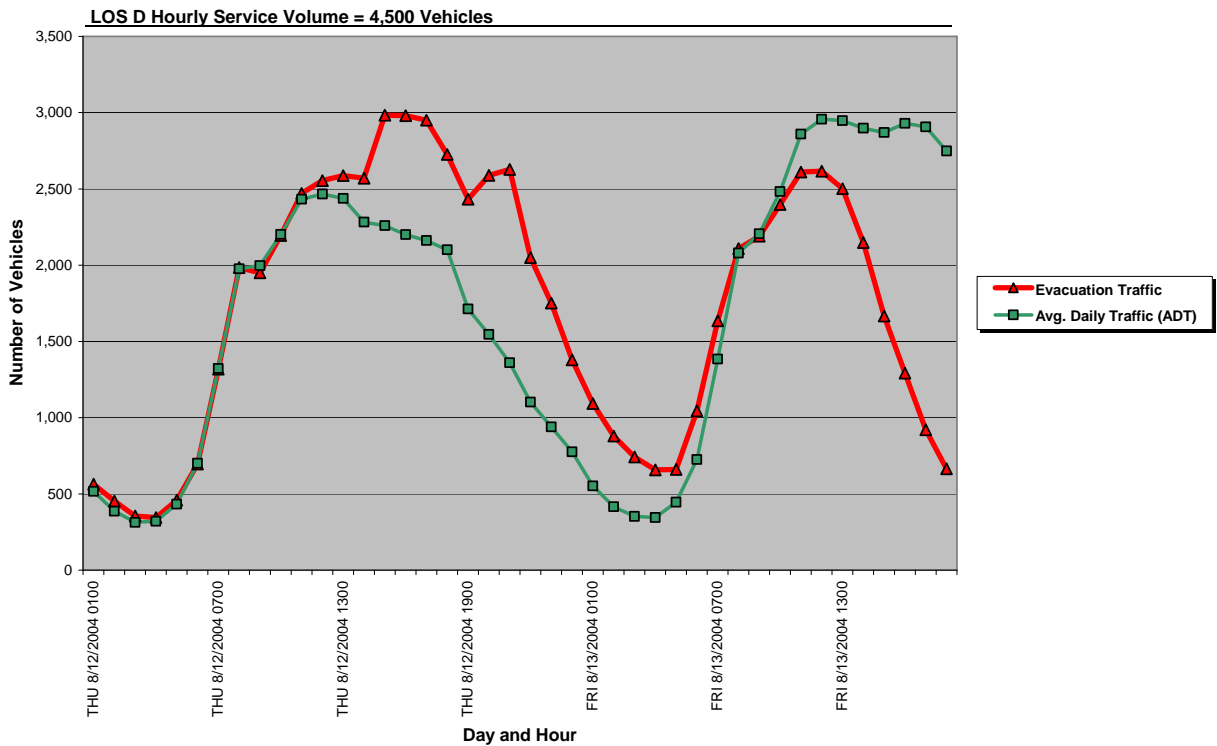
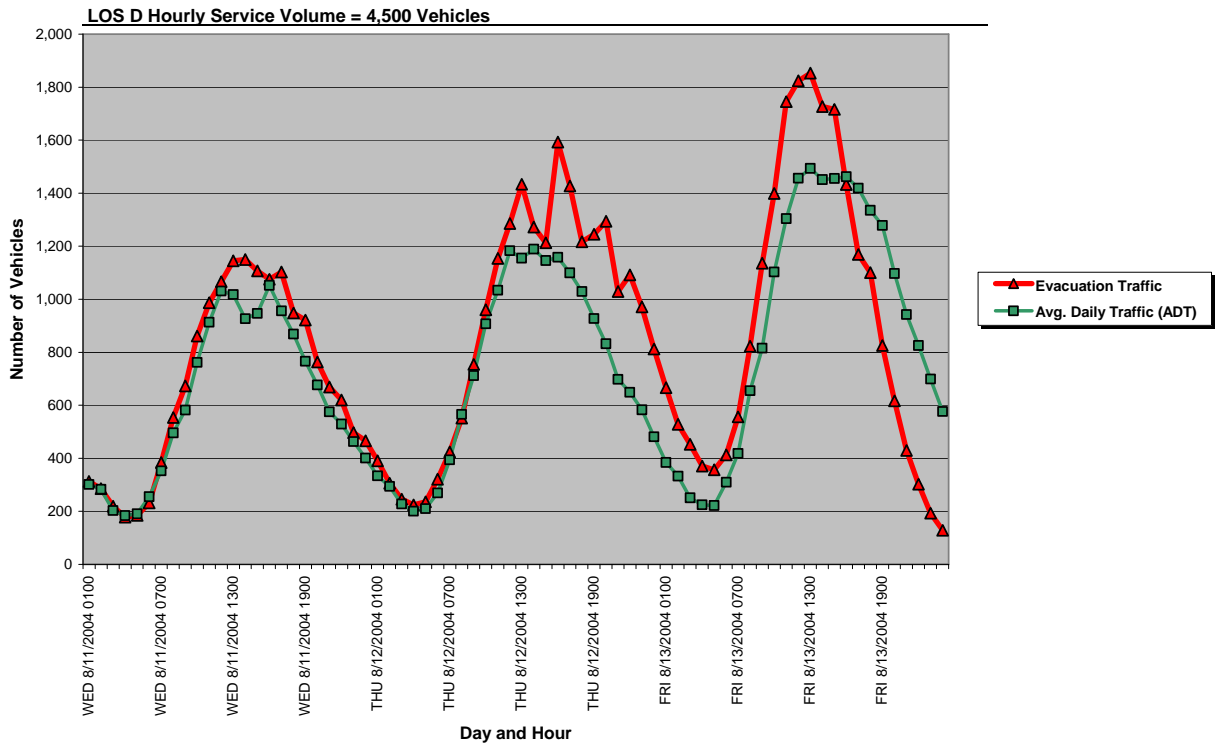


Figure 13. Charley - I-75 Northbound Near Georgia State Line (0112 NB)



I-4 Eastbound (TTMS Counters 0106, 0130, 0196, 0343)

- Of the four TTMS counters on I-4 eastbound, none recorded an above normal increase in traffic until the morning of Thursday, August 12th. The two operating counters (0196 and 0343) north of Orlando (Figures 16 and 17) recorded the first significant increase in traffic beginning at 7:00 AM on August 12. For the next 30 hours the Plant City and Longwood TTMS sensors would register 25 hours of traffic significantly above their ADT figures.
- During the entire course of the evacuation period for Hurricane Charley, only one of the traffic counters recorded hourly values that exceeded the evacuation directional service volume for their particular roadway segment. Starting at noon on August 12th, TTMS counter 0130 south of Orlando (Figure 15) recorded a three hour period where the number of vehicles surpassed the evacuation directional service volume of 5,000 vehicles per hour. All of the other counters on I-4 registered very high peak hourly volumes during the evacuation period for Hurricane Charley, but none actually exceeded their hourly evacuation service volume.

- The traffic counter near Plant City in the 25 hours that it recorded higher than ADT volumes, tallied the highest total number of additional vehicles of any counter in emergency operation during the evacuation event. The totals at the bottom of Table two indicate that approximately 22,500 vehicles over ADT were recorded at that sensor moving eastbound. Unfortunately the next counter (0130) on I-4 south of Orlando (See Figure 15) did not become operational until 1:00 AM on August 13, so it cannot be ascertained whether those additional trips eastbound on I-4 in Hillsborough County dispersed into the eastern interior of that county or continued into Polk County and the greater Orlando metropolitan area.
- In looking at Figure 15 (TTMS counter 0130) though, it does appear that a period of higher than normal volume is tapering off for a short time before another high volume episode begins in the early morning hours of August 13th. Based on this observation and comparing the values for the two counters for the timeframe where both were recording higher than normal volumes, it appears that approximately 67% of the additional vehicles recorded at counter 0106 near Plant City may have continued on to the Orlando area and sought refuge there.
- The average speeds (See Table 3) recorded by the two sensors (0130 south of Orlando and 0343 near Longwood) that were collecting average speed data during Hurricane Charley do not indicate that the flow of traffic was significantly hindered by the traffic volumes experienced on I-4 during the evacuation. In both cases the average hourly speed is above the posted speed limit for those segments.

Figure 14. Charley - I-4 Northbound Near Plant City (0106 EB)

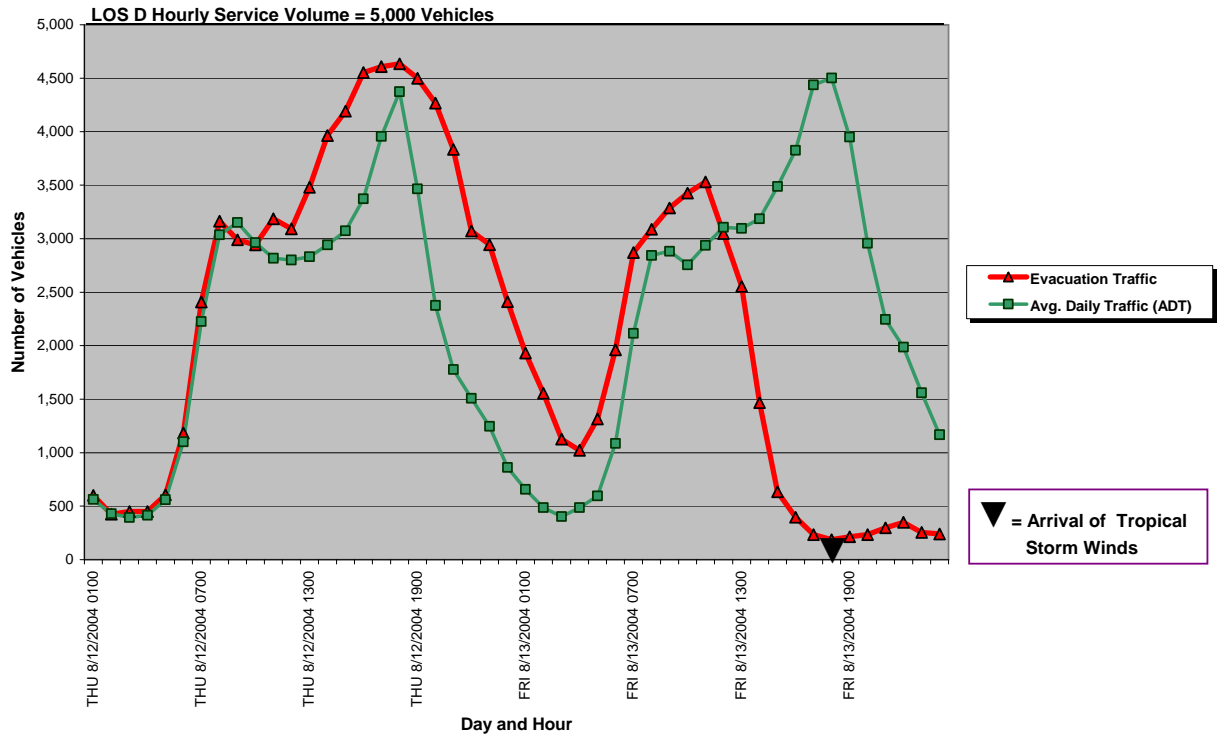


Figure 15. Charley - I-4 Northbound South of Orlando (0130 EB)

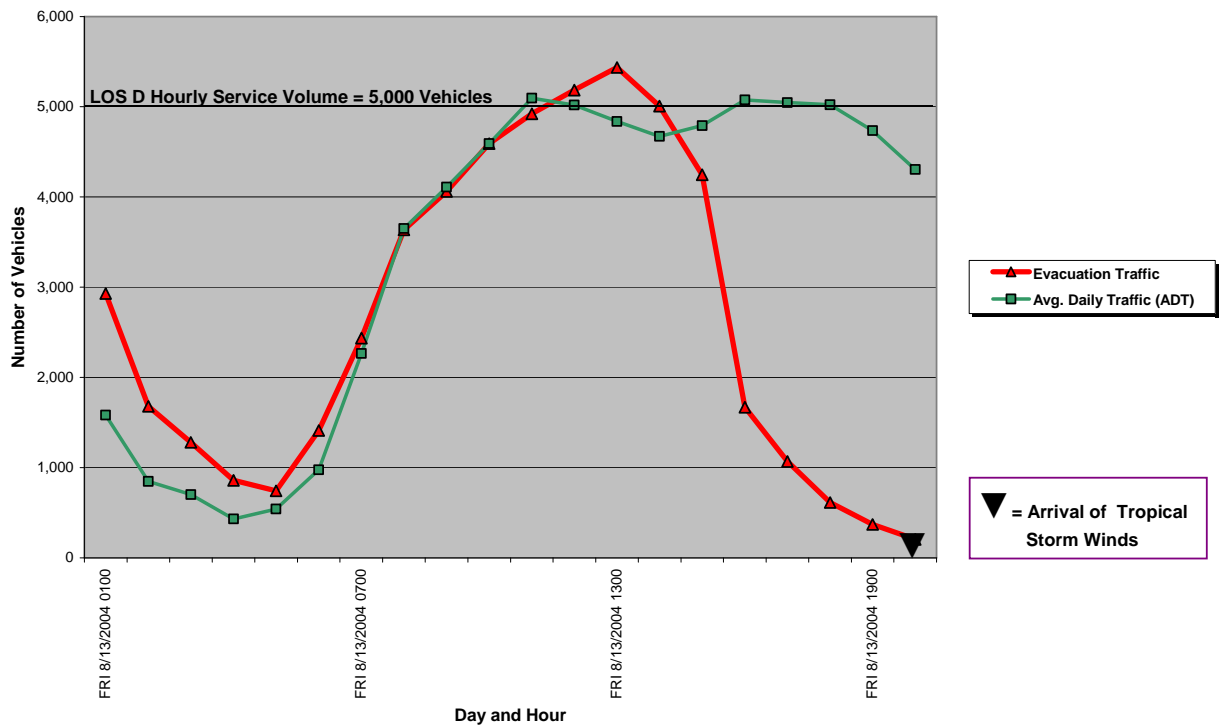


Figure 16. Charley - I-4 Northbound North of Orlando (0196 EB)

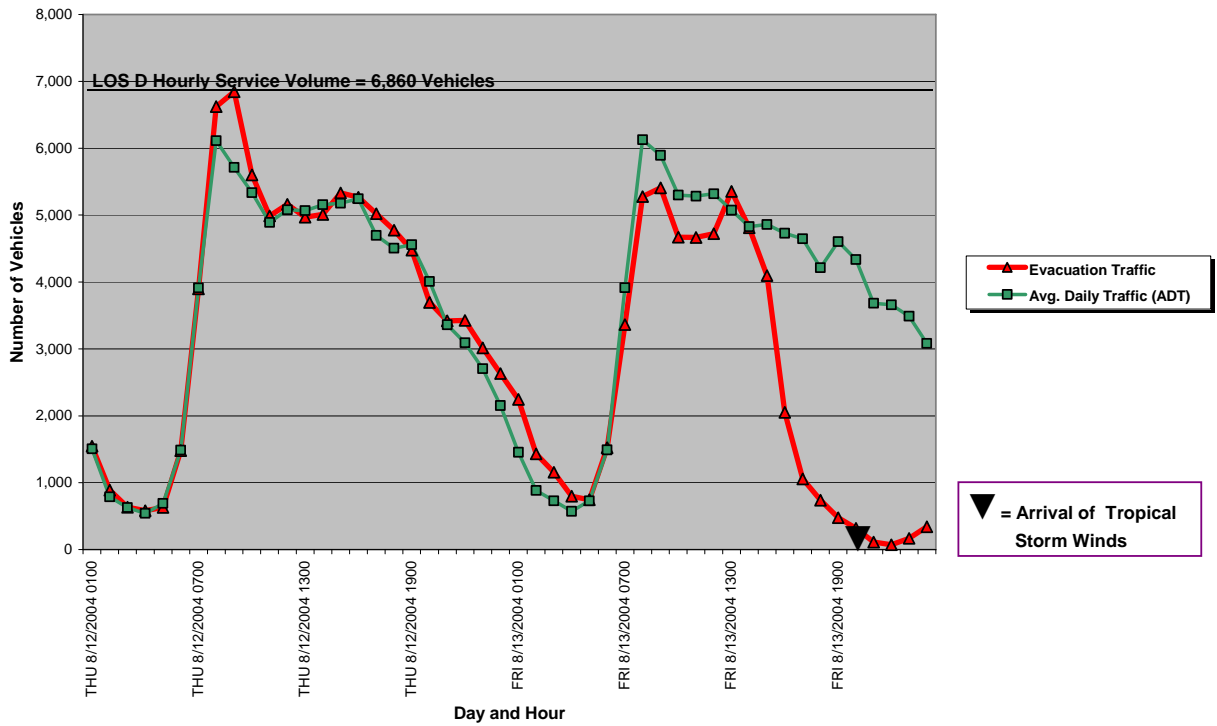
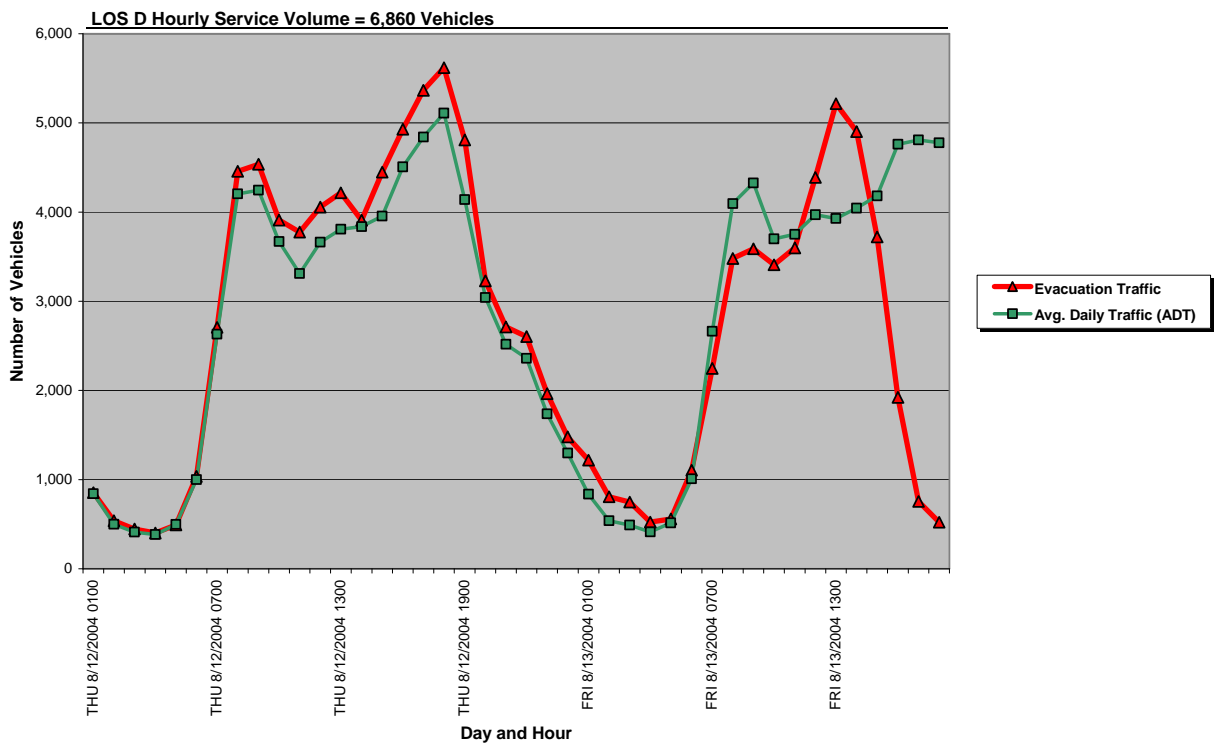


Figure 17. Charley - I-4 Northbound Near Longwood (0343 EB)



COMPARISON OF ETIS TRAVEL DEMAND AND CONGESTION LEVEL FORECASTS TO TTMS COUNTER DATA DURING HURRICANE CHARLEY

- Table 3 relates the hours where Telemetered Traffic Monitoring System (TTMS) traffic counters were recording traffic counts that exceeded the average daily traffic (ADT) figures to weather related and operational events that were occurring during Hurricane Charley.
- Table 4 below provides a comparison between the travel demand and congestion level forecasts with the actual numbers of additional vehicles over the average daily traffic (ADT) figures collected for those same segments. The table does not include all segments on a particular corridor, only those segments on roadways covered by ETIS and having an operational Telemetered Traffic Monitoring System (TTMS).
 - In cases where both HES and ETIS data were appropriate and available for the road segments included in this table, those data were provided. In most instances for this table only the ETIS data is provided since many of these segments with TTMS sensors are used by many counties from many different regions simultaneously for evacuation. This multi-regional travel demand data is not always readily available from most regional HES Transportation Analyses. Because ETIS is specifically designed to consolidate the maximum travel demands for many counties and regions during an evacuation event, and therefore most the appropriate data for the purposes of this analysis, its vehicle forecast are by far the most prevalent figures in the table. Where appropriate, the HES vehicle numbers were included in the table 4.
 - The first column provides the name of the specific roadway segment used to compare HES / ETIS forecast data with the actual values recorded by the TTMS counters during the Hurricane Charley evacuation event. These roadways are aggregated by corridor and listed in succession based on the likely travel direction of evacuation traffic, in most cases south to north and west to east.
 - The column labeled HES / ETIS Hourly Service Volume indicates how many vehicles per hour each specific roadway segment can process in one direction under hurricane evacuation conditions. The figure normally used in the HES and ETIS to characterize the roadway segment's ability to convey traffic is Level of Service (LOS) D, one step lower than maximum theoretical hourly through-put (LOS E). This slight attenuation of hourly capacity takes into account reductions caused by higher than normal traffic volumes, the

potential for less than optimal weather conditions and a certain degree of duress imposed by the situation on the drivers using the roadway.

- The third column relating to HES / ETIS Predicted Number of Vehicles provides the total number of vehicles forecast in the HES or by ETIS to use that particular segment of roadway during the entire course of an evacuation. The travel demand figures provided in this column relate only to the additional number of vehicles on the roadway generated by evacuation orders and not the entire number of vehicles using the roadway segment. The number of over average daily traffic (ADT) figures, also known as the “background traffic” is not included in these figures. In most cases, for the reasons explained above only the ETIS data is provided.
- The data under the column heading of HES / ETIS Predicted Congestion Levels is the forecast amount of time needed to process the travel demand in the previous column given the hourly directional service volume figures provided in the second column. In most cases, for the reasons explained above, only the ETIS data is provided.
- The next column labeled Additional Number of Vehicles over ADT during Event provides data regarding the actual values recorded by the TTMS counters during Hurricane Charley. This column specifies the difference between the total number of vehicles counted during the evacuation event against those normally using the segment (ADT) during the higher than average volume hours. For comparisons of forecast versus real event data, the values in this column also specifically relate to the data in the third column under the HES / ETIS Predicted Number of Vehicles heading. This additional vehicles figure is also reiterated at the bottom of Table 3 in the row labeled Difference Between Recorded and ADT Volume During Evacuation Period.
- The Total Number of Vehicles Recorded during Event column in Table 4 represents the total number of vehicles counted during the same hours as in the previous column, or the additional vehicles plus the historical number of vehicles for that time and day (ADT). The total vehicles column information is also found in the Total Number of Vehicles Recorded during Evacuation Period row at the bottom of Table 3.
- The column labeled Number of Hours above ADT During Event Column specifies the length of time that each TTMS counter recorded hourly vehicle counts above the standard deviation of the ADT traffic volumes. The hours in this table coincide with the bright green boxes for each counter in Table 3 as well as the row labeled Total Number of

Hours above ADT Volume. The data in this column also relates specifically to the final column in the table called Actual Service Volume / Evac Vehicle Ratio.

CAVEATS REGARDING THE ANALYSIS OF TRAFFIC COUNTER DATA RELATIVE TO HES AND ETIS FIGURES

The following points must be taken into consideration when comparing the traffic counter data collected during the hurricane evacuation against the figures contained in the HES the Abbreviated Transportation Model (ATM) or generated by ETIS.

- Some of the differences between the vehicle counts from roadway sensor data and the evacuating vehicle figures provided in the HES related products are attributable to the generalized information collected by the traffic counter itself.
 - The hourly vehicle numbers recorded by traffic sensors are strictly raw data with no differentiation between the evacuation trips and those not leaving an area in response to a storm threat. Therefore, the counters cannot assist in determining when the first or last trip used a roadway segment with the express purpose of evacuating. The customary criteria for establishing the hour an evacuation begins or ends from traffic counter data is when the number of recorded vehicles exceeds or drops below ADT figures. Although this is a reasonable method, there are many likely scenarios where a significant number of vehicles may be on the roadway leaving an area in response to a potential hurricane threat days in advance of the ADT values being exceeded by traffic counts. Clearly, determining when the evacuation began and ended relative to the traffic counts can have a significant impact on the number of vehicles considered to be evacuating.
 - The inability to definitively separate evacuation from non-evacuation trips in the traffic counter data may also account for further differences in the number of vehicles recorded on a roadway segment for an event and the vehicle demand forecasts provided in the HES-related products. Even for those hours when actual vehicle counts are significantly above ADT at a roadway segment, the actual proportion of evacuation to non-evacuation trips cannot be discerned from the traffic counter data. Again, the general rule of thumb for separating the evacuation from the non-evacuation trips is to use the ADT figures, so that the vehicle counts over that number constitute the traffic associated with evacuations. As in the discussion above, using the ADT as a method to mete out the different types of traffic recorded at a counter site during evacuations, while valid, does not necessarily

constitute the real number of evacuating to non-evacuating vehicles. It could easily be argued that during evacuations, the amount of traffic normally using a roadway would be suppressed since many people are evacuating rather than going to school, work and their other routine daily destinations. Especially over time as more vehicles are involved in the evacuation, the higher the proportion of evacuating to non-evacuating vehicles recorded on a roadway segment.

- Finally, traffic counter data cannot be used to differentiate the high traffic volumes due to evacuations from those caused by special events or other traffic anomalies. The height of hurricane season also coincides with the beginning of college football season, high tourist season and many one-time or recurring special events. If hurricane evacuations coincide with other high-traffic volume generating events, the vehicle counts in these overlapping instances would not be able to discriminate between those two types of vehicle trips.
- There are significant variations in the methodologies used by the HESs, ATMs and ETIS to determine the number of vehicles on key roadway segments during evacuations. These variations may also serve to exacerbate the differences between the traffic counter figures and the evacuating vehicle forecasts provided in the HES products during an evacuation event.
 - In addition to the number of vehicles trips specifically associated with evacuations, the methodology for calculating the clearance times provided in the HESs does factor in the trips considered to be background traffic. Background traffic is the other vehicles using an evacuation roadway segment for purposes not specifically related to evacuating from the tropical cyclone. The background numbers used in the HES clearance time methodology are based on annual ADT averages which would not account for the wide daily variations in normal traffic that may exist on days when evacuations are occurring. This difference in determining the normal traffic in developing the clearance times may account for differences between the HES and actual counter figures during the theoretical evacuation period for a particular event.
 - The ATM vehicle figures provided in the Vehicles by Roadway and Clearance Time tabs for key evacuation roadway segments in the spreadsheets do not include the background traffic numbers. However, the clearance times provided in the ATMs do factor in the additional time needed for the key roadway segment to process the background vehicles.

- The ETIS figures do not factor in the number of vehicles that would be considered background traffic on each of the modeled roadway segments. Therefore, the forecast number of vehicles for each roadway segment in ETIS includes those additional vehicles theoretically using the roadway for evacuation purposes only. Certainly this fact may account any differences between the total vehicle traffic count recorded by a traffic counter and the ETIS forecasted number of vehicles on a roadway segment during an evacuation event.
- Differences in the way that the HES transportation model and ETIS factor in participation rates will have an impact on their agreement regarding the vehicle numbers for a roadway segment. Whereas the vehicle by road segment numbers in the HESs and initial versions of the ATMs are based on fixed, behaviorally derived evacuation participation numbers, ETIS allows the user to select those variables based on storm and other situation-specific parameters. Additionally in the HESs, each traffic evacuation zone, evacuation zone and each housing type has its own set of participation rates already selected, while the percentage selected in ETIS applies to the entire population that is committed to evacuate by the user in the program. Therefore, these differences in the application of participation rates between the HESs and ETIS can account for any discrepancies between the evacuating vehicle figures from both sources.
- Finally, the interval between the collection of socio-economic, behavioral and roadway data for the last hurricane evacuation study / restudy can also accentuate differences between the traffic counter evacuating vehicle numbers and those provided in the HESs or in ETIS. Many of the hurricane evacuation studies / restudies in Florida were completed on or before 2000. Therefore, the data used to develop socio-economic figures for those studies was not based on the most recent U.S. census, but instead on the one conducted in 1990 with projections to the study date. Many regions in Florida are experiencing dynamic population growth where four or five years can mean a significant increase in the number of evacuating vehicles. Certainly that is true for the Southwest Florida, Treasure Coast, Tampa Bay, East Central Florida and Northeast Florida regions, many of which were impacted during this hurricane event.
- The congestion times provided by ETIS are not the same as clearance times in the HESs and do not coincide with the total number of hours that a counter recorded hourly volumes above ADT.

- The ETIS congestion time represents the hours of expected travel demand for that specific roadway segment and is determined by dividing the forecast number of vehicles by the hourly directional service volume (e.g. a roadway segment that has an hourly directional service volume of 1,000 vehicles can process a total travel demand of 10,000 vehicles in 10 hours).
- The congestion time calculated by ETIS represents only the queuing delay time component of an HES clearance time. The other components of an HES clearance time not included in the ETIS figures are mobilization time (usually accounted for by the response time) and the travel time.
- Unfortunately much of the operational data regarding the effective times of evacuation orders, levels of evacuation and other details which have an impact on evacuations, and hence traffic volumes and timing, is not complete. Most of this operational data was collected during the post-storm surveys that were conducted as part of this report effort.
- Table 4 is a quantitative assessment of HES and ETIS figures against the traffic counter data collected during Hurricane Charley. Although this could have been a large-scale evacuation event theoretically suitable for assessing the accuracy of transportation models and other HES data, it does not appear that the data on hand will support any definitive conclusions. The participation rates categorically were very low and many of the evacuations on the west coast were only partially underway when the storm made landfall, thereby ending those operations. Therefore, it does not appear that the counter data on hand will support any definitive conclusions, or is at all suitable for validation of any evacuation transportation data.
- In this case, almost none of the clearance time figures in the HESs or in ETIS can be validated by how long the roadway segments with traffic counters actually experienced higher than normal traffic volumes. Almost all of the traffic counters witnessed very long periods where the vehicle counts, probably due to evacuations from Hurricane Charley, were above the average daily totals. Even relatively obscure evacuation routes experienced extended episodes where the hourly traffic totals during the event were above the normal daily figures. Evidently, evacuees from all the at-risk regions began evacuating, many without the benefit of an evacuation order, very early relative to the storm's approach and landfall and they did so quite slowly. For the most part the evacuation roadway network was

allowed to process the travel demand for this event in small increments over a long time span rather than all at once.

- Another shortcoming to relating the traffic counter data to clearance times and roadway segment travel demand forecasts for this event is that many of the TTMS stations are located at regional evacuation links. There are very few instances where a TTMS traffic counter is located on a roadway that is most likely used by a single county for evacuation: US 29; US 192/SR 520/SR50, SR 71, US 231 below I-10 and US 1 at Key Largo are about the only TTMS sites that can be used to validate county clearance times. Unfortunately few of the counties that rely on those specific roadway segments issued evacuation orders during Hurricane Charley. Even the regional clearance times and travel demand forecasts are based on incomplete or outdated information. Only 13 of the 32 inland counties in the State of Florida have current evacuation data; and counties such as Polk, Alachua, Leon and others have the potential to impose a significant number of evacuating vehicles on the statewide evacuation roadway network. Therefore, the travel demand forecast figures in ETIS and the regional clearance times in many of the regional HESs do not factor in the vehicles from many of the inland counties.
- Using the figures in Table 4 and the traffic counter data included in the above charts (Figures 1 through 41) and in Table 2, the following observations apply to Hurricane Charley:
 - In many cases, the ETIS forecast of travel demand for roadway segments with traffic counters were higher than the actual number of additional vehicles over ADT that were recorded by the traffic counters. Much of this is possibly attributable to an overestimation of participation rates by local emergency management offices, which is a very subjective figure in almost all cases. Another factor that contributed to the differences in the data was that many of the evacuations ceased to continue once the actual track of the storm became evident early in the afternoon of Friday, August 13th, 2004.
 - Other reasons for the discrepancies between the HES / ETIS roadway segment travel demand figures and the traffic counter totals during Hurricane Charley are: lack of data regarding some inland counties and their contributions to the evacuating number of vehicles; spotty data regarding evacuation zones or what populations were ordered to evacuate; and outdated information regarding the destinations of out-of-county evacuees.

Table 3a. HURRICANE CHARLEY Traffic Counter Timelines

Date	Advisory	Time	Situation / Conditions	0227	0164	0417	0270	0270	0327	0199	0406	
				NB	NB	NB	WB	EB	NB	NB	NB	NB
				US 1 Near Big Pine	US 1 Near Key Largo	FL Turnpike Near Jupiter	US 41 Near Naples	US 41 Near Naples	US 27 Near Venus	US 19 Near New Port Richey	Suncoast Pkwy Near Brooksville	
Wednesday, August 11, 2004	Adv # 7 Tropical Storm	12:00 AM					56					
		1:00 AM				58						
		2:00 AM				59						
		3:00 AM				65						
		4:00 AM				62				75		
	Adv # 8 Tropical Storm	5:00 AM	<ul style="list-style-type: none"> Charley a tropical storm with 65 MPH winds Forecast to make landfall in Charlotte Co as a Cat 1 Hurricane Watch issued for Dry Tortugas to Islamorada 				60			74		
		6:00 AM				69	63		74			
		7:00 AM		45		68	63		72			
		8:00 AM		43	51	68	62	67	73			
		9:00 AM		43	52	70	62	68	75			
	Adv # 9 Tropical Storm	10:00 AM		43	52	70	61	64	76			
		11:00 AM		41	51	70	64	66	75			
		12:00 PM		43	51	69	61	66	76			
		1:00 PM		44	50	71	56	64	75			
		2:00 PM		37	50	71	58	66	75			
	Adv # 10 Cat 1	3:00 PM		41	45	70	59	66	76			
		4:00 PM		30	44	69	65	68	77			
		5:00 PM	<ul style="list-style-type: none"> Hurricane Watch extended from Elliot Key to Ft. Myers Beach and FL Keys 	39	47	68	62	69	76			
		6:00 PM		43	45	69	60	67	75			
		7:00 PM		44	49	70	63	69	75			
		8:00 PM		40	47	70	63	68	73			
Adv # 11	9:00 PM		39	49	70	62	65	74				
	10:00 PM		38	51	68	62	66	74				
		11:00 PM		41	53	68	61	75	73			

Table 3a. HURRICANE CHARLEY Traffic Counter Timelines											
Date	Advisory	Time	Situation / Conditions	0227	0164	0417	0270	0270	0327	0199	0406
				NB	NB	NB	WB	EB	NB	NB	NB
				US 1 Near Big Pine	US 1 Near Key Largo	FL Turnpike Near Jupiter	US 41 Near Naples	US 41 Near Naples	US 27 Near Venus	US 19 Near New Port Richey	Suncoast Pkwy Near Brooksville
Thursday, August 12, 2004	Adv # 11 Cat 1	12:00 AM	<ul style="list-style-type: none"> Hurricane Watch extended from Elliot Key to St. Pete Beach Forecast landfall in 37 hours in Charlotte Co. as a cat 1 	42	52	68	64	68	75		71
		1:00 AM		41	53	68	61	66	74		73
		2:00 AM		42	52	70	62	65	75		71
		3:00 AM		42	53	67	63	75	75		70
		4:00 AM		40	54	70	61	72	77		69
	Adv # 12 Cat 1	5:00 AM	<ul style="list-style-type: none"> Hurricane Warning issued for Dry Tortugas to Marathon and from Flamingo to Ft. Myers Beach Hurricane Watch from Ft. Myers Beach to Anclote Key Forecast track landfall shifted to St. Pete Beach in 37 hours as cat 2 	42	54	69	63	65	74		71
		6:00 AM		44	51	69	64	68	75		71
		7:00 AM		45	39	68	62	67	74	50	71
		8:00 AM	❖ Lee Co., FL Issues Mandatory Evac Order for Cat 1	44	50	67	64	69	74	49	71
		9:00 AM		43	51	70	61	66	74	47	71
		10:00 AM	<ul style="list-style-type: none"> ❖ Manatee Co., FL Issues Voluntary Evac Order for Cat 1-2, CA, MH, LLA ❖ Sarasota Co., FL Issues Mandatory Evac Order for Cat 1 	42	52	70	60	68	75	46	71
	Adv # 13 Cat 1	11:00 AM	<ul style="list-style-type: none"> Hurricane Watch extended from Ft. Myers Beach to Horseshoe Beach 	44	51	70	58	66	75	46	71
		12:00 PM		44	52	72	59	68	76	44	71
		1:00 PM	❖ Highlands Co., FL Issues Recommended Evac Order for MH, LLA	45	52	72	53	67	75	47	72
		2:00 PM	<ul style="list-style-type: none"> Charlie upgraded to cat 2 		53	65	51	66	75	46	72
		3:00 PM			54	63		68	75	46	73
		4:00 PM			54	69		66	76	46	72
	Adv # 14 Cat 2	5:00 PM	<ul style="list-style-type: none"> Hurricane Warning is extended from Ft. Myers Beach to Homosassa 			67		68	76	46	73

Table 3a. HURRICANE CHARLEY Traffic Counter Timelines												
Date	Advisory	Time	Situation / Conditions	0227	0164	0417	0270	0270	0327	0199	0406	
				NB	NB	NB	WB	EB	NB	NB	NB	NB
				US 1 Near Big Pine	US 1 Near Key Largo	FL Turnpike Near Jupiter	US 41 Near Naples	US 41 Near Naples	US 27 Near Venus	US 19 Near New Port Richey	Suncoast Pkwy Near Brooksville	
Thursday, August 12, 2004	Adv # 14 Cat 2	6:00 PM	❖ Pasco Co., FL Issues Mandatory Evac Order for Cat 1-2, MH ❖ Pinellas Co., FL Issues Mandatory Evac Order for Cat 1-3, CA, MH			69		69	76	47	73	
		7:00 PM				73		70	76	48	73	
		8:00 PM				70		67	75	46	72	
		9:00 PM				69		64	73	47	70	
	10:00 PM				68		62	74	48	69		
	Adv # 15 Cat 2	11:00 PM	• Hurricane Warning is extended from Ft. Myers Beach to Horseshoe Beach			69		64	75	49	69	
Friday, August 13, 2004	Adv # 15 Cat 2	12:00 AM				70		63	73	49	71	
		1:00 AM	• Hurricane Charley makes landfall in Cuba as a cat 2			72		56	73	49	70	
		2:00 AM	• Tropical storm force winds begin in Key West and Dry Tortugas			68		60	74	49	70	
		3:00 AM	• Charley exits Cuba as a cat 2					63	73	50	68	
		4:00 AM								49	67	
	Adv # 16 Cat 2	5:00 AM										68
		6:00 AM	❖ Hillsborough Co., FL Issues Mandatory Evac Order for Cat 1-3, MH, LLA									68
		7:00 AM										70
		8:00 AM	❖ Citrus Co., FL Issues Mandatory Evac Order for CA, MH, LLA									70
		9:00 AM	• Tropical Storm Winds arrive at Collier Co, FL									70
		Adv # 17 Cat 2	10:00 AM									70
	11:00 AM		• Tropical Storm Winds arrive at Lee Co, FL • Hurricane Watch issued for Ormond Beach north to Hilton Head, SC									70

Table 3a. HURRICANE CHARLEY Traffic Counter Timelines

Date	Advisory	Time	Situation / Conditions	0227	0164	0417	0270	0270	0327	0199	0406
				NB	NB	NB	WB	EB	NB	NB	NB
				US 1 Near Big Pine	US 1 Near Key Largo	FL Turnpike Near Jupiter	US 41 Near Naples	US 41 Near Naples	US 27 Near Venus	US 19 Near New Port Richey	Suncoast Pkwy Near Brooksville
Friday, August 13, 2004	Adv # 17 Cat 2	12:00 PM	<ul style="list-style-type: none"> Tropical Storm Winds arrive at Charlotte Co, FL ❖ Highlands Co., FL Issues Mandatory Evac Order for MH, LLA 								70
		1:00 PM	<ul style="list-style-type: none"> Hurricane Charley begins more easterly movement, forecast track landfall is still near St. Petersburg as a cat 3 Hurricane Charley upgraded to cat 3 Tropical Storm force winds arrive Sarasota, Glades, Hendry and DeSoto Co., FL 								
	Adv # 18 Cat 3	2:00 PM	<ul style="list-style-type: none"> Hurricane Warning posted from Melbourne north to Mouth of the Santee River, SC Forecast track landfall now shifted to Charlotte Harbor as a 125 MPH storm (cat 3), estimated time of arrival is in 3 hours at 5:00 PM Tropical Storm force winds arrive Manatee, Highlands, and Hardee Co., FL 								
		3:00 PM	•								
		4:00 PM	❖ Volusia Co., FL Issues Mandatory Evac Order for CA, MH, LLA								
	Adv # 19 Cat 4 to 1	5:00 PM	<ul style="list-style-type: none"> Hurricane Charley makes landfall in Charlotte Harbor as a cat 4 , or 140 MPH storm Hurricane Warning extended up east coast from Melbourne, FL to Cape Lookout, NC Hurricane Warning dropped for Florida Keys, extends from Cape Sable north to Horseshoe Beach Tropical Storm winds arrive Hillsborough, Pinellas and Polk Co., FL 								
		6:00 PM	<ul style="list-style-type: none"> Tropical Storm winds arrive Okeechobee and Osceola Co., FL 								
		7:00 PM	<ul style="list-style-type: none"> Eye over Polk County as a cat 3 (115 MPH) storm Tropical Storm winds arrive Pasco, Lake, Sumter and Orange Co., FL 								

Table 3a. HURRICANE CHARLEY Traffic Counter Timelines

Date	Advisory	Time	Situation / Conditions	0227	0164	0417	0270	0270	0327	0199	0406	
				NB	NB	NB	WB	EB	NB	NB	NB	NB
				US 1 Near Big Pine	US 1 Near Key Largo	FL Turnpike Near Jupiter	US 41 Near Naples	US 41 Near Naples	US 27 Near Venus	US 19 Near New Port Richey	Suncoast Pkwy Near Brooksville	
Friday, August 13, 2004	Adv # 19 Cat 4 to 1	8:00 PM	<ul style="list-style-type: none"> Tropical Storm winds arrive Seminole and Volusia Co., FL 									
		9:00 PM	<ul style="list-style-type: none"> Eye over Orange County at cat 1 intensity (90 MPH) All Watches and Warnings dropped for west coast 									
		10:00 PM	<ul style="list-style-type: none"> Tropical Storm winds arrive Flagler and Putnam Co., FL 									
	Adv # 20 Cat 1	11:00 PM	<ul style="list-style-type: none"> Hurricane Warning extended up east coast from Melbourne, FL to Cape Lookout, NC Tropical Storm winds arrive St. Johns Co., FL 									
Saturday, August 14, 2004	Adv # 20 Cat 1	12:00 AM	<ul style="list-style-type: none"> Hurricane Charley Exits Florida east coast near Daytona Beach as a cat 1 (85 MPH) Tropical Storm winds arrive Duval Co., FL 									
		1:00 AM										
		2:00 AM										
		3:00 AM										
		4:00 AM										
	Adv # 21 Cat 1	5:00 AM	<ul style="list-style-type: none"> Hurricane Warning dropped for Florida east coast, extends from St. Simons Island, GA to Virginia Beach, VA 									
		6:00 AM										
		7:00 AM										
		8:00 AM										
		9:00 AM										
	Adv # 22 Cat 1	10:00 AM										
		11:00 AM	<ul style="list-style-type: none"> Hurricane Warning shifted up east coast, extends from Mouth of the Santee River, SC to Virginia Beach, VA 									
		12:00 PM	<ul style="list-style-type: none"> Charley makes second landfall on SC / NC state border as weak cat 1 									
1:00 PM												

Table 3a. HURRICANE CHARLEY Traffic Counter Timelines											
Date	Advisory	Time	Situation / Conditions	0227	0164	0417	0270	0270	0327	0199	0406
				NB	NB	NB	WB	EB	NB	NB	NB
				US 1 Near Big Pine	US 1 Near Key Largo	FL Turnpike Near Jupiter	US 41 Near Naples	US 41 Near Naples	US 27 Near Venus	US 19 Near New Port Richey	Suncoast Pkwy Near Brooksville
Saturday, August 14, 2004	Adv # 22 Cat 1	2:00 PM	<ul style="list-style-type: none"> Charley downgraded to a Tropical Storm Hurricane Warning dropped to Tropical Storm Warning from SC/NC state line to MA/NH state line Eye in Duplin Co, NC at 70 MPH sustained winds 								
		3:00 PM									
		4:00 PM									
	Adv # 23 Cat 1	5:00 PM	<ul style="list-style-type: none"> Eye in Bertie Co, NC at 70 MPH sustained winds Tropical Storm Warning narrowed from Cape Lookout, NC to MA/NH state line 								
		6:00 PM									
		7:00 PM									
		8:00 PM	<ul style="list-style-type: none"> Eye exits at near Virginia Beach, VA at 50 MPH sustained winds Tropical Storm Warning narrowed from Nags Head, NC to MA/NH state line 								
		9:00 PM									
	Adv # 24	10:00 PM									
		Adv # 24	11:00 PM								
Total Number of Hours Above Average Directional Total (ADT) Volume				31	33	29	28	26	39	15	37
Hourly Evacuation Directional Service Volume (In Thousands of Vehicles per Hour)				1.35	1.8	3.0	2.3	2.3	2.3	2.2	2.3
ADT Volume for Evacuation Period (X 1,000 Vehicles)				14.7	14.9	35.0	1.3	2.1	6.4	24.5	4.3
Total Number of Vehicles Recorded During Evacuation period (X 1,000 Vehicles)				19.8	26.0	40.0	1.8	2.8	8.6	26.4	8.6
Difference Between Recorded and ADT Volume During Evacuation (X 1,000 Vehicles)				4.0	11.1	5.0	.6	.7	2.3	2.0	4.4

See final page of table for footnotes and other explanations

Table 3b. HURRICANE CHARLEY Traffic Counter Timelines (Continued)

Date	Advisory	Time	Situation / Conditions	0350	0225	0190	0317	0112	0106	0130	0196	0343	
				NB	NB	NB	NB	NB	EB	EB	EB	EB	
				I-75 Near Punta Gorda	I-75 Near Sarasota	I-75 Near Zephyr Hills	I-75 Near Ocala	I-75 Near GA Line	I-4 Near Plant City	I-4 South of Orlando	I-4 North of Orlando	I-4 Near Longwood	
Wednesday, August 11, 2004	Adv # 7 Tropical Storm	12:00 AM											
		1:00 AM											
		2:00 AM											
		3:00 AM											
		4:00 AM											
	Adv # 8 Tropical Storm	5:00 AM	<ul style="list-style-type: none"> Charley a tropical storm with 65 MPH winds Forecast to make landfall in Charlotte Co as a Cat 1 Hurricane Watch issued for Dry Tortugas to Islamorada 	71	76	1	1						
		6:00 AM		71	76	1	1	71					
		7:00 AM		71	76	1	1	72					
		8:00 AM		71	75	1	1	70					
		9:00 AM		71	75	1	1	74					
		10:00 AM		70	74	1	1	70					
	Adv # 9 Tropical Storm	11:00 AM		71	74	1	1	72					
		12:00 PM		70	74	1	1	68					
		1:00 PM		70	74	1	1	72					
		2:00 PM		70	74	1	1	74					
		3:00 PM		70	74	1	1	75					
	Adv # 10 Cat 1	4:00 PM		71	74	1	1	75					
		5:00 PM	<ul style="list-style-type: none"> Hurricane Watch extended from Elliot Key to Ft. Myers Beach and FL Keys 	71	75	1	1	75					
		6:00 PM		72	76	1	1	74					
		7:00 PM		72	78	1	1	73					
8:00 PM			72	73	1	1	74						
Adv # 11 Cat 1	9:00 PM		71	72	1	1	73						
	10:00 PM		72	73	1	1	73						
	11:00 PM		71	72	1	1	72						
Thursday, August 12, 2004	Adv # 11 Cat 1	12:00 AM	<ul style="list-style-type: none"> Hurricane Watch extended from Elliot Key to St. Pete Beach Forecast landfall in 37 hours in Charlotte Co. as cat 1 	71	75	70	ND	73				71	
		1:00 AM		71	73	70	ND	72				70	
		2:00 AM		69	76	70	ND	72				70	

Table 3b. HURRICANE CHARLEY Traffic Counter Timelines (Continued)

Date	Advisory	Time	Situation / Conditions	0350	0225	0190	0317	0112	0106	0130	0196	0343	
				NB	NB	NB	NB	NB	EB	EB	EB	EB	EB
				I-75 Near Punta Gorda	I-75 Near Sarasota	I-75 Near Zephyr Hills	I-75 Near Ocala	I-75 Near GA Line	I-4 Near Plant City	I-4 South of Orlando	I-4 North of Orlando	I-4 Near Longwood	
Thursday, August 12, 2004	Adv # 11 Cat 1	3:00 AM		69	73	70	ND	72				69	
		4:00 AM		71	75	71	ND	72				70	
	Adv # 12 Cat 1	5:00 AM	<ul style="list-style-type: none"> Hurricane Warning issued for Dry Tortugas to Marathon and from Flamingo to Ft. Myers Beach Hurricane Watch from Ft. Myers Beach to Anclote Key Forecast track landfall shifted to St. Pete Beach in 37 hours as cat 2 	71	76	72		72			1		71
		6:00 AM		70	76	72		73			1		70
		7:00 AM		72	76	72		73			1	ND	71
		8:00 AM	❖ Lee Co., FL Issues Mandatory Evac Order for Cat 1	71	75	71		74			1	ND	70
		9:00 AM		71	75	71		73			1	ND	69
		10:00 AM	<ul style="list-style-type: none"> Manatee Co., FL Issues Voluntary Evac Order for Cat 1-2, CA, MH, LLA Sarasota Co., FL Issues Mandatory Evac Order for Cat 1 	69	74	71	ND	69	ND		1	ND	68
	Adv # 13 Cat 1	11:00 AM	<ul style="list-style-type: none"> Hurricane Watch extended from Ft. Myers Beach to Horseshoe Beach 	70	74	71	ND	72	ND		1	ND	69
		12:00 PM		69	73	70	ND	72	ND		1		69
		1:00 PM	❖ Highlands Co., FL Issues Recommended Evac Order for MH, LLA	70	73	69	ND	71	ND		1		68
		2:00 PM	<ul style="list-style-type: none"> Charlie upgraded to cat 2 	71	74	69	ND	66	ND		1	ND	69
		3:00 PM		71	72	63	ND	73	ND		1	ND	69
		4:00 PM		71	73	65	ND	76	ND			ND	68
	Adv # 14 Cat 2	5:00 PM	<ul style="list-style-type: none"> Hurricane Warning is extended from Ft. Myers Beach to Homosassa 	73		52	ND	76	ND		1	ND	68
		6:00 PM	<ul style="list-style-type: none"> Pasco Co., FL Issues Mandatory Evac Order for Cat 1-2, MH Pinellas Co., FL Issues Mandatory Evac Order for Cat 1-3, CA, MH 	73		62	ND	76	ND		1		69
		7:00 PM		72		69	ND	76	ND		1		72
		8:00 PM		72		69	ND	75	ND		1		70
		9:00 PM		71		69	ND	75	ND		1	ND	69
		10:00 PM		73		70	ND	74	ND			ND	70

Table 3b. HURRICANE CHARLEY Traffic Counter Timelines (Continued)

Date	Advisory	Time	Situation / Conditions	0350	0225	0190	0317	0112	0106	0130	0196	0343	
				NB	NB	NB	NB	NB	EB	EB	EB	EB	EB
				I-75 Near Punta Gorda	I-75 Near Sarasota	I-75 Near Zephyr Hills	I-75 Near Ocala	I-75 Near GA Line	I-4 Near Plant City	I-4 South of Orlando	I-4 North of Orlando	I-4 Near Longwood	
Friday, August 13, 2004	Adv # 15 Cat 2	11:00 PM	• Hurricane Warning is extended from Ft. Myers Beach to Horseshoe Beach	72		70	ND	74	ND	1	ND	70	
		12:00 AM		72		70	ND	74	ND	65	ND	70	
Friday, August 13, 2004	Adv # 15 Cat 2	1:00 AM	• Hurricane Charley makes landfall in Cuba as a cat 2	69		71	ND	73	ND	67	ND	70	
		2:00 AM	• Tropical storm force winds begin in Key West and Dry Tortugas	69		71	ND	73	ND	68	ND	70	
		3:00 AM	• Charley exits Cuba as a cat 2	66		71	ND	72	ND	67	ND	70	
		4:00 AM				71	ND	73	ND	68	ND	70	
	Adv # 16 Cat 2	5:00 AM					70	ND	71	ND	69		70
		6:00 AM	❖ Hillsborough Co., FL Issues Mandatory Evac Order for Cat 1-3, MH, LLA			70	ND	69	ND	69			71
		7:00 AM						69	ND	69			71
		8:00 AM	❖ Citrus Co., FL Issues Mandatory Evac Order for CA, MH, LLA					70	ND	67			71
	Adv # 17 Cat 2	9:00 AM	• Tropical Storm Winds arrive at Collier Co, FL					71	ND	66			70
		10:00 AM						72	ND	64			69
		11:00 AM	• Tropical Storm Winds arrive at Lee Co, FL • Hurricane Watch issued for Ormond Beach north to Hilton Head, SC					75			63		69
	Adv # 17 Cat 2	12:00 PM	• Tropical Storm Winds arrive at Charlotte Co, FL ❖ Highlands Co., FL Issues Mandatory Evac Order for MH, LLA					75			60		68
		1:00 PM	• Hurricane Charley begins more easterly movement, forecast track landfall is still near St. Petersburg as a cat 3 • Hurricane Charley upgraded to cat 3 • Tropical Storm force winds arrive Sarasota, Glades, Hendry and DeSoto Co., FL					75			63		68

Table 3b. HURRICANE CHARLEY Traffic Counter Timelines (Continued)

Date	Advisory	Time	Situation / Conditions	0350	0225	0190	0317	0112	0106	0130	0196	0343
				NB	NB	NB	NB	NB	EB	EB	EB	EB
				I-75 Near Punta Gorda	I-75 Near Sarasota	I-75 Near Zephyr Hills	I-75 Near Ocala	I-75 Near GA Line	I-4 Near Plant City	I-4 South of Orlando	I-4 North of Orlando	I-4 Near Longwood
Friday, August 13, 2004	Adv # 18 Cat 3	2:00 PM	<ul style="list-style-type: none"> Hurricane Warning posted from Melbourne north to Mouth of the Santee River, SC Forecast track landfall now shifted to Charlotte Harbor as a 125 MPH storm (cat 3), estimated time of arrival is in 3 hours at 5:00 PM Tropical Storm force winds arrive Manatee, Highlands, and Hardee Co., FL 					76				
		3:00 PM										
		4:00 PM	❖ Volusia Co., FL Issues Mandatory Evac Order for CA, MH, LLA									
	Adv # 19 Cat 4 to 1	5:00 PM	<ul style="list-style-type: none"> Hurricane Charley makes landfall in Charlotte Harbor as a cat 4 , or 140 MPH storm Hurricane Warning extended up east coast from Melbourne, FL to Cape Lookout, NC Hurricane Warning dropped for Florida Keys, extends from Cape Sable north to Horseshoe Beach Tropical Storm winds arrive Hillsborough, Pinellas and Polk Co., FL 									
		6:00 PM	<ul style="list-style-type: none"> Tropical Storm winds arrive Okeechobee and Osceola Co., FL 									
		7:00 PM	<ul style="list-style-type: none"> Eye over Polk County as a cat 3 (115 MPH) storm Tropical Storm winds arrive Pasco, Lake, Sumter and Orange Co., FL 									
		8:00 PM	<ul style="list-style-type: none"> Tropical Storm winds arrive Seminole and Volusia Co., FL 									
		9:00 PM	<ul style="list-style-type: none"> Eye over Orange County at cat 1 intensity (90 MPH) All Watches and Warnings dropped for west coast 									
		10:00 PM	<ul style="list-style-type: none"> Tropical Storm winds arrive Flagler and Putnam Co., FL 									

Table 3b. HURRICANE CHARLEY Traffic Counter Timelines (Continued)

Date	Advisory	Time	Situation / Conditions	0350	0225	0190	0317	0112	0106	0130	0196	0343	
				NB	NB	NB	NB	NB	EB	EB	EB	EB	
				I-75 Near Punta Gorda	I-75 Near Sarasota	I-75 Near Zephyr Hills	I-75 Near Ocala	I-75 Near GA Line	I-4 Near Plant City	I-4 South of Orlando	I-4 North of Orlando	I-4 Near Longwood	
Friday, August 13, 2004	Adv # 20 Cat 1	11:00 PM	<ul style="list-style-type: none"> Hurricane Warning extended up east coast from Melbourne, FL to Cape Lookout, NC Tropical Storm winds arrive St. Johns Co., FL 										
Saturday, August 14, 2004	Adv # 20 Cat 1	12:00 AM	<ul style="list-style-type: none"> Hurricane Charley Exits Florida east coast near Daytona Beach as a cat 1 (85 MPH) Tropical Storm winds arrive Duval Co., FL 										
		1:00 AM											
		2:00 AM											
		3:00 AM											
		4:00 AM											
	Adv # 21 Cat 1	5:00 AM	<ul style="list-style-type: none"> Hurricane Warning dropped for Florida east coast, extends from St. Simons Island, GA to Virginia Beach, VA 										
		6:00 AM											
		7:00 AM											
		8:00 AM											
		9:00 AM											
	Adv # 22 Cat 1	10:00 AM											
		11:00 AM	<ul style="list-style-type: none"> Hurricane Warning shifted up east coast, extends from to Mouth of the Santee River, SC to Virginia Beach, VA 										
		12:00 PM	<ul style="list-style-type: none"> Charley makes second landfall on SC / NC state border as weak cat 1 										
		1:00 PM											
		2:00 PM	<ul style="list-style-type: none"> Charley downgraded to a Tropical Storm Hurricane Warning dropped to Tropical Storm Warning from SC/NC state line to MA/NH state line Eye in Duplin Co, NC at 70 MPH sustained winds 										
		3:00 PM											
4:00 PM													

Table 3b. HURRICANE CHARLEY Traffic Counter Timelines (Continued)

Date	Advisory	Time	Situation / Conditions	0350	0225	0190	0317	0112	0106	0130	0196	0343
				NB Punta Gorda	NB Sarasota	NB Zephyr Hills	NB Ocala	NB GA Line	EB Plant City	EB of Orlando	EB of Orlando	EB of Orlando
Saturday, August 14, 2004	Adv # 23 Cat 1	5:00 PM	<ul style="list-style-type: none"> Eye in Bertie Co, NC at 70 MPH sustained winds Tropical Storm Warning narrowed from Cape Lookout, NC to MA/NH state line 									
		6:00 PM										
		7:00 PM										
		8:00 PM	<ul style="list-style-type: none"> Eye exits at near Virginia Beach, VA at 50 MPH sustained winds Tropical Storm Warning narrowed from Nags Head, NC to MA/NH state line 									
		9:00 PM										
	10:00 PM											
	Adv # 24	11:00 PM										
Total Number of Hours Above Average Directional Total (ADT) Volume				45	34	24 ^a	24 ^a	43	25	10 ^a	13	25
Hourly Evacuation Directional Service Volume (In Thousands of Vehicles per Hour)				2.3	4.5	3.0	4.5	4.5	5.0	5.0	6.86	6.86
ADT Volume for Evacuation Period (X 1,000 Vehicles)				38.4	86.5	38.2	29.6	49.3	52.1	44.1	73.8	94.5
Total Number of Vehicles Recorded During Evacuation period (X 1,000 Vehicles)				46.5	97.6	49.9	44.0	40.3	74.6	48.4	78.8	101.1
Difference Between Recorded and ADT Volume During Evacuation (X 1,000 Vehicles)				8.1	11.1	11.7	11.4	9.0	22.5	4.3	4.7	6.6

Light Green Fill = recorded hourly value for traffic counter above hourly average directional volume, but not above standard deviation.

Green Fill = traffic counter recorded hourly value above standard deviation for hourly average directional volume.

Red Fill = recorded peak at traffic counter for event.

Dark Blue Box = hour that tropical storm force winds arrived at counter location.

ND = No data provided by counter.

Numbers in boxes during evacuation periods indicate the average recorded speed for that hour.

1 No recorded values provided for this counter, but higher volumes than ADT likely.

Table 4. HURRICANE CHARLEY ETIS / HES TO COUNTER COMPARISONS								
Roadway Segment With Traffic Counter	HES / ETIS Service Volume (in Vehicles per Hour)	ETIS Forecast Vehicle Demand	Additional Number of Vehicles Over ADT During Event	Total Number of Vehicles Recorded During Event	ETIS Forecast Congestion Level (in Hours)	Number of Hours above Average Daily Traffic (ADT)	Actual Service Volume to Evac Vehicle Ratio	
							Vehicles Above ADT	Total Vehicles
US 1 Northbound								
US 1 Near Big Pine	880	¹ / NA	4,005	19,806	¹ / NA	31	4.6	22.5
US 1 Near Key Largo	880	¹ / NA	11,168	26,049	¹ / NA	33	12.7	29.6
Florida Turnpike Northbound								
Florida Turnpike Near Jupiter	3,000	4,527	4,968	39,990	1	29	1.7	13.3
US 41 Eastbound and Westbound								
US 41 Near Naples Westbound	2,300	0	722	2,801	0	27	0.3	1.2
US 41 Near Naples Eastbound	2,300	0	569	1,837	0	26	0.2	0.8
US 27 Northbound								
US 27 Near Venus	2,300	/ 0 ¹	2,256	8,615	0	42	1.0	3.7
I-75 Northbound								
I-75 Near Punta Gorda	2,300	10,602	8,089	46,492	5	45	3.5	20.2
I-75 Near Sarasota	4,500	26,602	11,059	97,557	6	34	2.5	21.7
I-75 Near Zephyrhills	3,000	41,460	11,696	49,873	40	24	3.9	16.6
I-75 near Ocala	4,500	97,143	11,353	44,013	22	24	2.5	9.8
I-75 near Georgia Line	4,500	57,991	7,311	34,333	13	29	1.6	7.6
I-4 Westbound								
I-4 near Plant City	5,000	35,713	22,482	74,616	18	25	4.5	14.9
I-4 South of Orlando	5,000	40,745	4,313	48,420	23	10	0.9	9.7
I-4 North of Orlando	6,860	2,259	4,670	127,000	1	13	0.7	18.5
I-4 near Longwood	6,860	2,259	6,573	121,531	1	25	1.0	17.7

Table 4. HURRICANE CHARLEY ETIS / HES TO COUNTER COMPARISONS								
Roadway Segment With Traffic Counter	HES / ETIS Service Volume (in Vehicles per Hour)	ETIS Forecast Vehicle Demand	Additional Number of Vehicles Over ADT During Event	Total Number of Vehicles Recorded During Event	ETIS Forecast Congestion Level (in Hours)	Number of Hours above Average Daily Traffic (ADT)	Actual Service Volume to Evac Vehicle Ratio	
							Vehicles Above ADT	Total Vehicles
US 19 Northbound								
US 19 Near New Port Richey	2,200	0	1,968	26,435	0	15	0.9	12.0
Suncoast Parkway Northbound								
Suncoast Pkwy Near Brooksville	2	2	4,350	8,628	2	37	2	2
<p>Orange Header Boxes = HES / ETIS data</p> <p>Yellow Header Boxes = Telemetered Traffic Monitoring System (TTMS) Data</p> <p>Blue = Columns related to ETIS forecast and TTMS figures above ADT during event</p> <p>Green = Columns related to overall number of vehicles (additional + ADT vehicles) for entire event</p> <p>1 Clearance Times not developed under USACOE Study efforts or using the PBS&J evacuation transportation model.</p> <p>2. New Roadway, has not yet been included in any HES study or ETIS</p>								

CONCLUSIONS

1. From Wednesday, August 11 to Friday, August 13, 2004, an additional 117,800 vehicles over the average daily directional trips used the major evacuation routes out of the Southwest Florida, Tampa Bay, Central Florida, Treasure Coast, East Central Florida and Northeast Florida Regions. The average number of hours that all activated traffic counters on the Florida evacuation roadway network recorded above average volumes was 27.6 hours.
2. According to the survey data collected from the most affected counties during this event, the primary observation by local emergency management officials was that fuel availability was the predominant problem during the evacuation, followed by traffic congestion. Other evacuation problems cited by the surveyed county officials were heavy traffic, inadequate signage and construction.
3. Three out of the 21 counties surveyed for this event, Collier, Pinellas and Volusia, indicated that gridlock conditions occurred on the roadways during the evacuation. Collier indicated that I-75 was the offending corridor and Volusia County specified State Route 40 westbound where it constricts from two lanes down to one lane in each direction was prone to gridlock. Pinellas County indicated that all evacuation routes near their jurisdiction were gridlocked during Charley.
4. Due to the low participation rates in Southwest and Tampa Bay regions in response to this storm, the vehicle numbers and congestion figures generated by ETIS during the storm would not have been realized.
5. The traffic counters indicate that all of the evacuation roadway segments on which they were located were clear of major traffic volumes before landfall or arrival of tropical storm force winds.
6. Despite reports of traffic congestion specifically attributed to many of the evacuation routes on which traffic counters were located, neither the hourly volumes nor the hourly average

speeds indicated that these roadways reached saturation or otherwise degraded to a traffic queuing situation. All of the traffic counters indicated that the evacuation roadways even during peak volume hours were able to convey traffic at the normal average posted speed limit. This does not mean that there were not isolated incidences of traffic congestion or even gridlock, only that those conditions were not readily apparent at the traffic counter locations.

RECOMMENDATIONS

1. **Update the clearance times for Tampa Bay Hurricane Study as soon as possible.**

Growth in the Tampa Bay region, as in any region within the State of Florida, has been significant since the last study was performed in 2000. Additionally, with the completion of the Suncoast Parkway, a significant new evacuation route has been added to the region. This new roadway has not yet been added to the regional evacuation transportation model. Although none of the counties in the region indicated that the current clearance times were insufficient for this event, none of them were tested with an actual landfall. Had a landfall actually occurred in the region, the outcome and the perceptions of clearance times could have been very different.

2. **Update the Central Florida HES from the 1995 effort.**

The last hurricane evacuation study prepared for this region was in 1995 on population and other data that was considerably older the issue date of the effort. During that time the numbers of mobile homes and normal residential developments have grown dramatically. In some of these inland counties the number of evacuees has surpassed those of their adjoining coastal communities. Additionally, these inland counties reported significant traffic congestion on their predominantly rural roadways which may have an adverse impact not only their own efforts to protect their at-risk residents, but also ultimately on the evacuation operations in the coastal communities adjoining them.

3. **Update the East Central Florida HES from the 1998 effort, especially for the inland locations.**

Although none of the counties in the region indicated that the clearance times generated in the 1999 study were insufficient for the threat. The local conditions in the region with regards to population growth, traffic management measures and other operational caution developments such as contra-flow plans and host sheltering requirements make a re-study effort in the region more important. In the surveys and in other post-storm data collection efforts, both of the coastal counties and two of the inland host counties have expressed a

great deal of interest in getting new evacuation data for their hurricane evacuation planning efforts.

4. **Update the North Central Florida Regional HES from the 1995 version.**

Although this region was always on the periphery of the main warning area for all four storms of the 2004 season, they nonetheless had to apply their decision making processes during each event. All four hurricanes during last year's hurricane season required that the coastal and inland counties of the North Central Florida region consider the implementation of their protective measures for their at-risk populations. Unfortunately, these coastal and inland counties had to rely on data that was over ten years old, or, in the case of the inland jurisdictions, no data at all. These jurisdictions also sit astride two of the major evacuation routes for the state and in that respect will be called upon to provide host shelters which further justifies the importance for updating this region's hurricane preparedness data.

5. **Complete the incorporation of all Florida inland counties into the ETIS program.**

Florida is essentially an amalgamation of 11 different hurricane evacuation studies. This fact increases the need for developing an integrated approach to hurricane evacuation decision making. Hurricane Charley caused many of the coastal and inland counties from eight different study regions to undertake their protective action decision making procedures and implement the operational plan to conduct evacuation and sheltering procedures. The Evacuation Traffic Information System, or ETIS, is a tool for assessing the cumulative effects of simultaneous evacuation decisions from many different study regions on the State's evacuation roadway network. ETIS provides travel demand estimates to state and local officials in Florida and in other states that may have to receive those evacuees. ETIS data can facilitate a more proactive application of traffic management, host sheltering and public information procedures that will enhance the overall success of any evacuation effort. ETIS can also be used as a post-storm assessment tool to assist in testing the validity of evacuation decisions and the data they are based on.

Unfortunately, most of the inland counties in the North Central Florida and Central Florida Regions are not included in ETIS. These regions include Alachua and Polk Counties which have significant mobile home populations that can have interstate impacts. During Charley, Polk County estimated that ten percent of their 35,000 at-risk residents evacuated. The more than 15,000 vehicles that such an exodus required more than likely had impacts that extended well beyond the county borders. A full evacuation of either county as well as the others not currently included in ETIS could possibly constitute a sizable proportion of vehicles in future events.

6. Assess the need and means to assimilate the new behavioral data collected during this post storm analysis effort into existing studies and models in the state, especially ETIS and HEADS UP.

The behavioral characteristics of the public's response to Hurricane Charley may have important implications for the accuracy of future evacuation study and transportation modeling efforts. Once the behavioral results are finalized, especially destination and participation rates, all efforts should be undertaken to ensure that they are input into the ETIS, as well as HEADS UP.

7. Develop strategies for the Evacuation Liaison Team (ELT) to collect better information regarding evacuation decisions from State and local governments.

The weakest link for real time evacuation coordination during hurricane events is the lack of good data from the states and local governments regarding the evacuation zones and times that the orders are issued. Without that data and some indication from local officials regarding participation rates, the scenario input into ETIS has the potential to not be a very accurate representation of what is actually occurring in the risk area. Additionally, this data is not formally archived anywhere during the event and is collected somewhat haphazardly during these post-storm reports. This paucity of evacuation related information makes preparing assessments for ETIS and other transportation models very difficult. Discussing the post event analyses results of the transportation data requires many caveats to explain the data or the problems therein.

The National Hurricane Mitigation and Preparedness Program (NHMPP) must develop a method for collecting these local evacuation decisions and other related variables and archiving them for future reference. It would be preferable to get this type of information to the ELT so that it can be input into ETIS and used for other coordination measures during the actual hurricane event. It may require the ELT employ more aggressive means to gather this type of information such as stationing a representative in each activated State or local EOC to act as an information conduit, or directly calling local governments regarding their evacuation decisions and other conditions that may have an impact on the overall progress of an evacuation. Also in the post-storm assessments, the questionnaire and the persons conducting the survey must insist on receiving the areas, communities and/or populations affected by the orders, as well as the time that they are issued or come into effect.

It may require that the ELT develop centralized databases with graphical depictions of the evacuation zones for every county. These databases should also include possible traffic and other control measures such as phased evacuations, blockades on certain roadway segments, traffic control points and of course one-way plans. Additionally, all construction zones on ETIS and other major evacuation routes, especially long-term construction projects, should be documented before the beginning of hurricane season and revised throughout the period to ensure its accuracy.

8. In future hurricane evacuation studies and transportation analyses develop regional clearance times that are tied to nearby traffic counters.

Given the increasing importance of traffic counters on evacuation operations, especially when coupled with a real time read capability a dynamic link between clearance times and real time traffic volumes would allow local officials to more accurately monitor the progress of their evacuation efforts. Of even more importance or consequence for real time evacuation operations may be having immediate access to traffic volume data on a regional basis, to an array of counters on regional evacuation routes. Clearance times and travel demand figures specifically tied to critical traffic counters on the regional evacuation roadway network could engender more proactive measures to facilitate evacuation and sheltering operations.

9. **Continue to emphasize and apply nationwide the evacuation shutdown criteria and other measures that are necessary for those types of operations.**

The reports of massive gridlock and congestion along the Louisiana evacuation corridors during Hurricane Charley could have resulted in stranded motorists as hurricane winds approached the area. Despite reverse lane operations to facilitate the evacuations from Charley, severe congestion and gridlock were common complaints from the officials surveyed for this post storm effort. Future incidences of this sort are likely in many areas of the nation. Very few current HESs include data to assist operational planning for exigent circumstances. Additionally, nearly all of the traffic counters included in this and the other post storm transportation assessments recorded elevated traffic volumes that lasted for days in some cases. These extended hours of significantly elevated traffic counts are indicative of the increasing possibility that evacuees may be stranded on evacuation routes. Clearly there is an increasing need to provide data that will assist in evacuation shutdown procedures.

10. **Investigate integrating a traffic counter function into HURREVAC for those systems that are automated and provide near-real time data.**

Recent improvements to HURREVAC have included the incorporation of tidal and rain gauge data. With more states attaining the capability to access their traffic counter data in near real time, the NHMPP should investigate including a function that would access traffic counter data and display that information. A significant number of emergency management officials use HURREVAC during evacuations, whereas ETIS is still only used by a very few.

11. **Advocate in the NHMPP agenda the importance of real time traffic counter data in managing evacuations.**

- a. Develop a centralized, nationwide network of real-time traffic counters, similar to IFLOWS and other integrated weather collection systems, which can be accessed and used by all Federal, State and local officials during emergencies.

b. Emplace in rural and urbanized jurisdictions real-time traffic counters that record and transmit hourly average speeds, another critical element in the interpretation of traffic data during emergencies.

12. **Refine the Corridor Table in ETIS to automatically and sequentially list all segments of roadway in a state to simplify data extraction.**

The Road Corridor Table in ETIS is difficult and cumbersome to use. It requires that the user know what roadways transect the roadway of interest to select the start and end point for the data query. Given that many users of ETIS will have varying knowledge of the roadway networks, the current format for this important function requires either a map and / or an intimate knowledge of local roadways in order to use it quickly and effectively.