

# HURRICANE IVAN POST-STORM TRANSPORTATION ANALYSIS

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## **Hurricane Ivan 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 last full Transportation Analysis for the Northwest Florida Region, namely Escambia, Santa Rosa, Okaloosa, Walton, Bay, Holmes and Washington Counties, was completed in 1998, while the Alabama hurricane evacuation transportation work, which included Baldwin and Mobile Counties was finished and distributed also in 2000. Mississippi's hurricane evacuation data was completed in 1999 and updated by the Bi-State Hurricane Evacuation Study which is still underway. Finally, the Southeast Louisiana region is still waiting for a full hurricane evacuation study, but has received clearance time and other salient hurricane evacuation data through the efforts of the same Bi-State study referenced above.

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

- The perception of the roadway network's ability to meet evacuation traffic demand;
- The traffic control measures emplaced to improve flow or reduce congestion;

- 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.

## **COUNTY POST-STORM SURVEY RESPONSES REGARDING EVACUATIONS AND TRAFFIC CONDITIONS**

Virtually every county emergency management office in all four surveyed states indicated that heavy traffic, congestion and gridlock characterized the road conditions during the evacuations for Hurricane Ivan. Other problems also were evident during the evacuation based on the responses but none as prevalent as the volume issues. Table 1 below documents the responses of the various emergency management directors regarding the traffic control and evacuation problems that became apparent during the Hurricane Ivan response.

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 IVAN 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
<b>Florida (Geographically east to west)</b>																		
Bay	Cat 3	9/13 2 PM <sup>d</sup>	7,000	60%	9/15 - 9 AM	N	N	✓	●									
Walton	Cat 5	NS	NS	80%	9/15 - 9 AM	NS	N	✗		●	●							
Okaloosa	Cat 4	NS	NS	90%	9/15 - 9 AM	F	N	✗	●	●	●							
Santa Rosa	Cat 4	NS	NS	80%	9/15 - 8 AM	N	N	✓	●		●							
Escambia	Cat 5	9/13 12 PM <sup>d</sup>	52,000	70%	9/15 - 8 AM	F	N	✓	●				●					
<b>Florida Inland (Listed alphabetically)</b>																		
Holmes	MH, FPA	NS	NS	10%	9/15 - 2 PM	NS	N	✓	●									
Jackson	MH	NS	50	10%	9/15 - 2 PM	S	H	✓	●						●			
Leon	MH, FPA	NS	NS	10%	9/15 - 6 PM	NS	NS	NA	b	b	b	b	b	b	b	b	b	b
Liberty	MH, FPA	NS	85	50%	9/15 - 2 PM	F	N		b	b	b	b	b	b	b	b	b	b
Washington	a	a	a	a	9/15 - 12 PM	a	a	a	a	a	a	a	a	a	a	a	a	a
<b>Alabama Coastal (Geographically east to west)</b>																		
Baldwin	Cat 4	NS	NS	70%	9/15 - 8 AM	F	L	✓	●	●					●			
Mobile	Cat 3	9/14 10 AM <sup>d</sup>	50,000	50%	9/15 - 9 AM	N	H	✓	●	●	●	●						
<b>Alabama Inland (Listed alphabetically)</b>																		
Choctaw	c	c	c	c	9/15 - 5 PM	c	c	c	b	b	b	b	b	b	b	b	b	b
Coffee	MH	NS	800	10%	9/15 - 4 PM	N	L	NS	●									
Covington	MH, FPA	NS	NS	65%	9/15 - 2 PM	F	L	NA	●						●			
Dale	MH	NS	NS	10%	9/15 - 5 PM	S	L	✓	●									
Wilcox	NS	NS	NS	30%	9/15 - 6 PM	NS	NS	NA	b	b	b	b	b	b	b	b	b	b

**Table 1. HURRICANE IVAN 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
<b>Mississippi Coastal (Geographically east to west)</b>																		
Jackson	Cat 1-3, 4-5	9/13 3 PM <sup>d</sup>	30,000	30%	9/15 - 9 AM	F	H	✗		●	●		●					
Harrison	Cat 5	9/14 12 PM <sup>d</sup>	NS	NS	9/15 - 11 AM	N	N	✓		●	●							
Hancock	Cat 4	NS	NS	NS	9/15 - 11 AM	S	L	✓		●	●		●					
<b>Mississippi Inland (Listed alphabetically)</b>																		
Forrest	c	c		c	9/15 - 2 PM	NS	N	✗	●	●				●		●	●	
Pearl River	c	c	60	c	9/15 - 1 PM	S	L	NA	●	●			●				●	
<b>Louisiana (Geographically southeast to northwest)</b>																		
St Bernard	FPA	NS	NS	45%	9/15 - 8 AM	F	L	NS	●	●	●		●	●	●	●		
Plaquemines	Cat 5	NS	11,000	55%	9/15 - 5 AM	F	L	✓	●	●	●			●	●	●		
LaFourche	FPA	NS	7,650	35%	9/15 - 8 AM	N	N	✓	●				●					
Orleans	FPA	NS	300,000	40%	9/15 - 11 AM	S	L	✗		●	●	●	●		●			●
Jefferson	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
St Charles	Cat 4	NS	9,000	65%	9/15 - 12 PM	N	N	✓		●	●	●				●		
St John the Baptist	Cat 1-2, 3-5	NS	NS	45%	9/15 - 2 PM	N	N	NS	●		●				●	●	●	●
St James	MH, FPA	NS	2,000	25%	N/A	NS	L	✓	●	●								
Assumption	FPA	NS	3,000	40%	N/A	N	L	✗	●									
Ascension	MH, FPA	NS	NS	15%	N/A	N	L	NA	●	●	●	●	●				●	●
St Tammany	FPA	NS	1,500	15%	9/15 - 11 AM	N	L	✓	●	●	●		●					

Table footnotes on next page

**Table 1. HURRICANE IVAN 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
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- 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 data provided by county.  
 b No specific evacuation problems indicated by county  
 c No evacuations ordered  
 d Times based on closest traffic counter and earliest high volume hour during evacuation period

**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
<b>Florida (Geographically east to west)</b>				
Bay	<ul style="list-style-type: none"> <li>• <b>US 231</b></li> <li>• SR 79</li> <li>• SR 77</li> </ul>			
Walton	<ul style="list-style-type: none"> <li>• <b>US 331</b></li> <li>• SR 81</li> </ul>		<ul style="list-style-type: none"> <li>• US 331</li> </ul>	
Okaloosa	<ul style="list-style-type: none"> <li>• SR 85</li> <li>• SR 285</li> <li>• <i>Antioch Road</i></li> <li>• SR 189</li> <li>• Mid-Bay Bridge</li> </ul>	<ul style="list-style-type: none"> <li>• SR 285</li> <li>• <i>Antioch Road</i></li> <li>• SR 189</li> </ul>	<ul style="list-style-type: none"> <li>• SR 85</li> <li>• Mid-Bay Bridge</li> </ul>	
Santa Rosa	<ul style="list-style-type: none"> <li>• <b>SR 87</b></li> <li>• <b>I-10</b></li> <li>• US 90</li> <li>• US 98</li> <li>• CR191</li> <li>• CR197</li> </ul>	<ul style="list-style-type: none"> <li>• <b>SR 87</b></li> <li>• US 90</li> <li>• CR191</li> <li>• CR197</li> </ul>	<ul style="list-style-type: none"> <li>• <b>I-10</b></li> <li>• US 98</li> </ul>	
Escambia	<ul style="list-style-type: none"> <li>• <b>I-10</b></li> <li>• I-65 (in Alabama)</li> <li>• All Segments</li> </ul>	<ul style="list-style-type: none"> <li>• All Segments</li> </ul>		
<b>Florida Inland (Listed alphabetically)</b>				
Holmes	<ul style="list-style-type: none"> <li>• <b>I-10</b></li> <li>• US 90</li> <li>• SR 79</li> <li>• SR 81</li> <li>• SR 2</li> </ul>	<ul style="list-style-type: none"> <li>• <b>I-10</b></li> <li>• US 90</li> <li>• SR 79</li> </ul>		
Jackson	<ul style="list-style-type: none"> <li>• <b>I-10</b></li> <li>• <b>US 231</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>I-10</b></li> <li>• <b>US 231</b></li> </ul>		
Leon	<ul style="list-style-type: none"> <li>• Capital Circle</li> <li>• <b>US 319</b></li> </ul>			
Liberty	<ul style="list-style-type: none"> <li>• <b>SR 65</b></li> <li>• SR 12</li> </ul>			
Washington	<ul style="list-style-type: none"> <li>• No data provided</li> </ul>			

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
<b>Alabama Coastal (Geographically east to west)</b>				
Baldwin	<ul style="list-style-type: none"> <li>• SR 59</li> <li>• SR 27</li> <li>• I-65</li> <li>• I-10</li> </ul>	<ul style="list-style-type: none"> <li>• All Routes</li> </ul>		
Mobile	<ul style="list-style-type: none"> <li>• I-65</li> <li>• US 43 North</li> <li>• US 45 North</li> <li>• SR 188 to CR 19</li> <li>• I-10 to I-65</li> <li>• SR 193 to I-10</li> <li>• US 98 West</li> </ul>	<ul style="list-style-type: none"> <li>• US 43 North</li> <li>• US 45 North</li> <li>• SR 193 to I-10</li> </ul>	<ul style="list-style-type: none"> <li>• SR 188 to CR 19</li> <li>• I-10 to I-65</li> </ul>	<ul style="list-style-type: none"> <li>• I-65</li> </ul>
<b>Alabama Inland (Listed alphabetically)</b>				
Choctaw	<ul style="list-style-type: none"> <li>• No data provided</li> </ul>			
Coffee	<ul style="list-style-type: none"> <li>• SR 84</li> <li>• SR 167</li> <li>• US 231</li> </ul>	<ul style="list-style-type: none"> <li>• All Routes</li> </ul>		
Covington	<ul style="list-style-type: none"> <li>• SR 55 North &amp; South</li> <li>• US 331</li> <li>• SR 137</li> <li>• US 29</li> <li>• US 84</li> </ul>	<ul style="list-style-type: none"> <li>• SR 55 North &amp; South</li> <li>• US 331</li> <li>• US 29</li> <li>• US 84</li> </ul>		
Dale	<ul style="list-style-type: none"> <li>• US 231</li> </ul>	<ul style="list-style-type: none"> <li>• US 231</li> </ul>		
Wilcox	<ul style="list-style-type: none"> <li>• No data provided</li> </ul>			
<b>Mississippi Coastal (Geographically east to west)</b>				
Jackson	<ul style="list-style-type: none"> <li>• US 90</li> <li>• SR 57</li> <li>• SR 63</li> <li>• I-10</li> </ul>		<ul style="list-style-type: none"> <li>• All Routes</li> </ul>	<ul style="list-style-type: none"> <li>• Unspecified Roadways</li> </ul>
Harrison	<ul style="list-style-type: none"> <li>• US 49</li> <li>• SR 67</li> <li>• I-10 West</li> </ul>		<ul style="list-style-type: none"> <li>• Unspecified Roadways</li> </ul>	<ul style="list-style-type: none"> <li>• Unspecified Roadways</li> </ul>

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
<b>Mississippi Coastal (Geographically east to west)</b>				
Hancock	<ul style="list-style-type: none"> <li>• US 90 to SR 603 to I-10</li> <li>• SR 603 to SR 53 to I-59</li> <li>• US 90 to I-10 to I-12</li> </ul>		<ul style="list-style-type: none"> <li>• Unspecified Roadways</li> </ul>	<ul style="list-style-type: none"> <li>• Unspecified Roadways</li> </ul>
<b>Mississippi Inland (Listed alphabetically)</b>				
Forrest	<ul style="list-style-type: none"> <li>• US 49</li> <li>• US 98</li> <li>• I-59</li> </ul>			<ul style="list-style-type: none"> <li>• US 49</li> <li>• US 98</li> <li>• I-59</li> </ul>
Pearl River	<ul style="list-style-type: none"> <li>• I-59</li> <li>• SR 43</li> <li>• SR 53</li> <li>• SR 26</li> </ul>	<ul style="list-style-type: none"> <li>• SR 43</li> <li>• SR 53</li> <li>• SR 26</li> </ul>	<ul style="list-style-type: none"> <li>• I-59</li> </ul>	
<b>Louisiana (Geographically southeast to northwest)</b>				
St Bernard	<ul style="list-style-type: none"> <li>• SR 39</li> <li>• SR 46</li> <li>• SR 47</li> </ul>	<ul style="list-style-type: none"> <li>• SR 39</li> <li>• SR 46</li> </ul>	<ul style="list-style-type: none"> <li>• SR 47</li> </ul>	
Plaquemines	<ul style="list-style-type: none"> <li>• SR 23</li> <li>• SR 39</li> </ul>	<ul style="list-style-type: none"> <li>• SR 23</li> <li>• SR 39</li> </ul>		
LaFourche	<ul style="list-style-type: none"> <li>• SR 1 North</li> <li>• SR 308 North</li> <li>• US 90 West</li> <li>• SR 20 North</li> </ul>	<ul style="list-style-type: none"> <li>• SR 1 North</li> <li>• SR 308 North</li> </ul>		<ul style="list-style-type: none"> <li>• US 90 West</li> </ul>
Orleans	<ul style="list-style-type: none"> <li>• I-10</li> <li>• I-12</li> <li>• I-55</li> </ul>			<ul style="list-style-type: none"> <li>• I-10</li> <li>• I-12</li> <li>• I-55</li> </ul>
Jefferson	<ul style="list-style-type: none"> <li>• No data provided</li> </ul>			

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
St Charles	<ul style="list-style-type: none"> <li>• US 61</li> <li>• US 90</li> <li>• I-10</li> </ul>			<ul style="list-style-type: none"> <li>• US 61</li> <li>• US 90</li> <li>• I-10</li> </ul>
St John the Baptist	<ul style="list-style-type: none"> <li>• I-10</li> <li>• I-55</li> <li>• US 51</li> <li>• US 61</li> <li>• Local Routes</li> </ul>	<ul style="list-style-type: none"> <li>• I-55</li> <li>• US 51</li> </ul>	<ul style="list-style-type: none"> <li>• US 61</li> </ul>	<ul style="list-style-type: none"> <li>• I-10</li> </ul>
Louisiana (Geographically southeast to northwest)				
St James	<ul style="list-style-type: none"> <li>• I-10</li> <li>• US 61</li> <li>• SR 3127</li> <li>• SR 20</li> <li>• SR 18 &amp; SR 44</li> <li>• SR 3125</li> <li>• SR 70</li> </ul>	<ul style="list-style-type: none"> <li>• US 61</li> <li>• SR 3127</li> <li>• SR 70</li> </ul>	<ul style="list-style-type: none"> <li>• I-10</li> </ul>	
Assumption	<ul style="list-style-type: none"> <li>• US 90</li> <li>• SR 1</li> <li>• SR 308</li> <li>• SR 70</li> </ul>	<ul style="list-style-type: none"> <li>• US 90</li> </ul>		
Ascension	<ul style="list-style-type: none"> <li>• I-10 West</li> <li>• US 61 North</li> <li>• SR 1 North</li> </ul>		<ul style="list-style-type: none"> <li>• SR 1 North</li> </ul>	<ul style="list-style-type: none"> <li>• I-10 West</li> <li>• US 61 North</li> </ul>
St Tammany	<ul style="list-style-type: none"> <li>• SR 21</li> <li>• I-59</li> <li>• SR 25</li> <li>• I-55</li> <li>• US 190</li> <li>• I-12</li> </ul>	<ul style="list-style-type: none"> <li>• SR 25</li> <li>• I-55</li> <li>• US 190</li> </ul>	<ul style="list-style-type: none"> <li>• I-12</li> </ul>	

<b>Table 2. HURRICANE CHARLEY LOCAL EMERGENCY MANAGEMENT EVACUATION ROUTE DATA</b>				
<b>Responding County</b>	<b>Recommended Primary And Secondary Evacuation Routes</b>	<b>Descriptions of Traffic Conditions from Local Officials</b>		
		<b>Roads with Heavy Traffic</b>	<b>Roads with Congestion</b>	<b>Roads at Gridlock</b>
<p>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</p>				

## **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.

Alabama and Mississippi also have traffic counters on their major roadways, but they do not report in real-time and their information does not include average hourly speeds. Louisiana also has traffic counters which are collocated with their U.S. Geologic Survey river gauges and report in real-time, however the Hurricane Ivan traffic counter data was not available for this analysis.

The following pages include figures graphically depicting the data collected at these counters during the evacuations for Hurricane Ivan. The information included in Figures 1 through 27 below are further summarized in Table 2 and combine the situation and conditions associated with the storm and local protective actions with the data in each of the above specified traffic counters. Table 3 includes information regarding the comparison of travel demands from the HES, ETIS and the actual Hurricane Ivan traffic counter data.

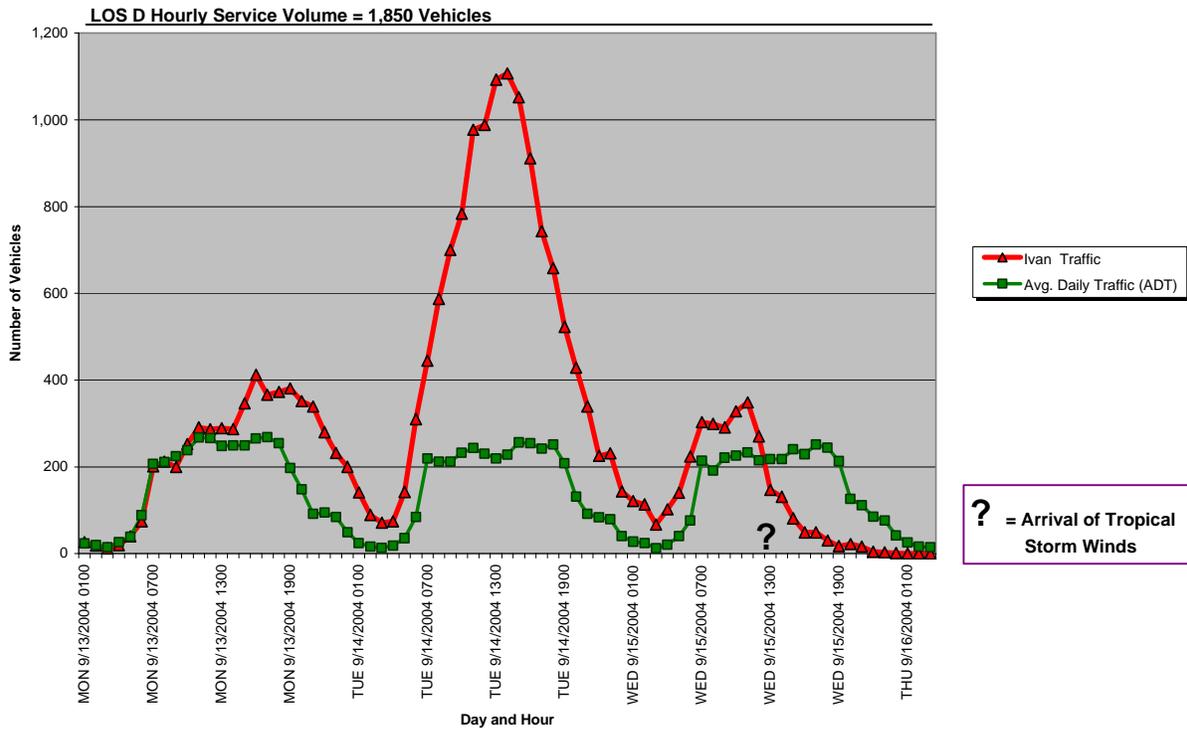
### **Florida**

#### **US 29 Northbound (TTMS Counter 0348)**

- The traffic counter on US 29 northbound (Figure 1 below) indicates that traffic volumes on this roadway segment exceeded the average daily traffic (ADT) numbers an hour before Escambia County, FL, issued an evacuation order at 12:00 PM on Monday September 13, 2004. Higher than normal traffic volumes continued on US 29 for the next 50 hours (see Table 2) and remained consistently above average levels during that entire time period.
- The bulk of the higher than average hourly traffic occurred on the second day-Tuesday, September 14<sup>th</sup>. The traffic volumes began to rise precipitously on this roadway as early as 6:00 AM on that day and remained at extremely high levels throughout the day. Of the 11,953 vehicles counted over ADT for the entire evacuation period for Ivan, 76%, or 9,141 were recorded on Tuesday. Monday's total vehicles over average figures accounted for 14% and Wednesday comprised the other 9% of total traffic volume over ADT.

- The peak hour recorded by the TTMS sensor was at 1:00 PM on September 14<sup>th</sup>, with 1,107 vehicles, well below the 1,900 vehicle per hour evacuation service volume assigned to that roadway segment.
- Unfortunately, the average traffic speed data for this counter was not available, so it is difficult to say whether traffic congestion actually occurred during the periods of peak traffic volume. Nonetheless given the reasonably short duration of extremely high traffic counts relative to ADT figures, it does not appear that volume seriously impeded the smooth flow of vehicles north.
- The traffic counts during Hurricane Ivan dropped to values well below normal volumes, just as the tropical storm force winds reached the TTMS sensor at 1:00 PM on September 15<sup>th</sup>. The hourly counts remained very low, dropping to single digits by 10:00 PM that night.
- Considering that most of the vehicles that use US 29 as an evacuation route probably originate in Escambia County and it is the critical link for that county, this traffic counter is at a good location to assess the accuracy of county clearance times. Using the Abbreviated Transportation Model (ATM) for Escambia County which was provided to them in November, 2004. The cat 5 clearance time for average-peak tourist occupancy is 18.8 hours and the time needed to clear 19,953 vehicles from that roadway is 11.4 hours. Local officials during the post-Ivan surveys estimated that their compliance rate (in Table 1) for the population order was 70%, or a clearance time of 13.2 hours. Prudently, Escambia County reportedly issued their evacuation order 50 hours before the arrival of tropical storm force winds, which provided them ample time to conduct an evacuation, even with a higher participation rate from the populace.

**Figure 1. Ivan - Florida - US 29 Northbound Near Century (0348 NB)**



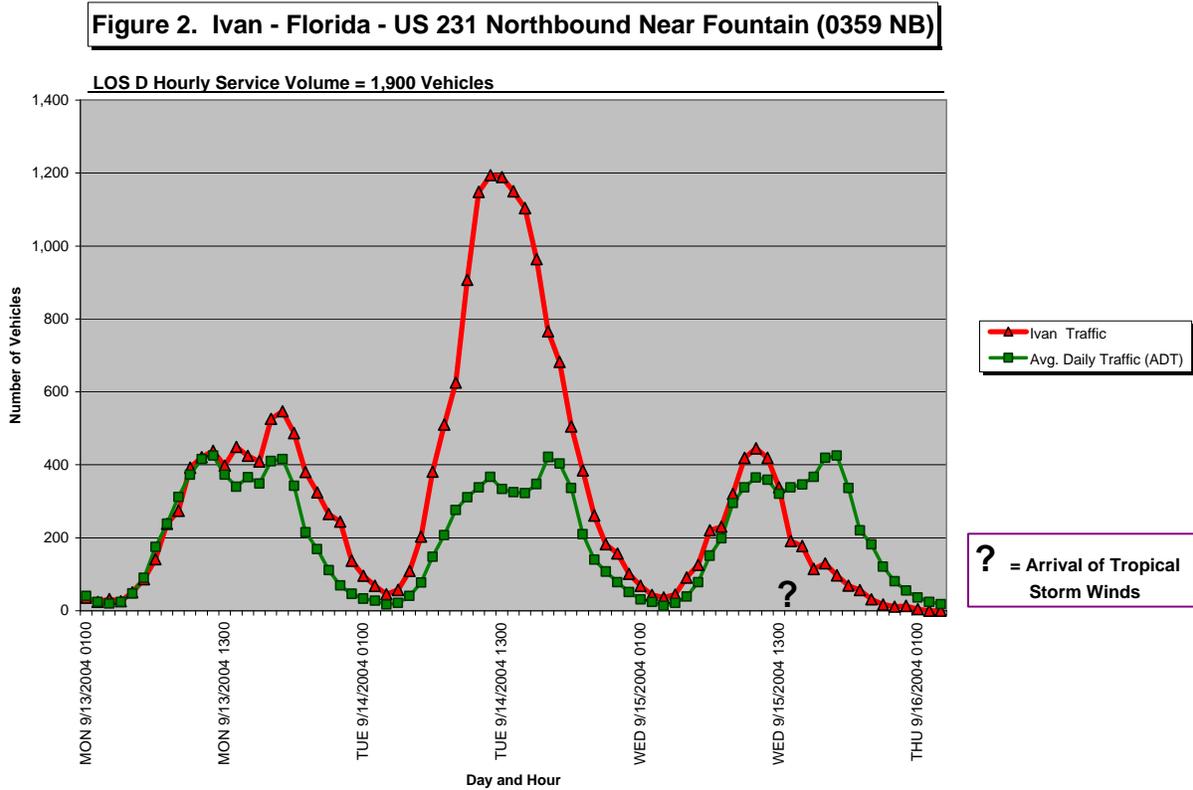
### US 231 Northbound (TTMS counter 0359 and 0050)

- TTMS Counter 0359 is located near Fountain in the “panhandle” portion north of the US 231 intersection with SR 20 and below the I-10 interchange. The site of Counter 0050 is just below the Florida – Alabama state line.
- The increase in traffic to counts above ADT at the Fountain site on US 231 coincides exactly with the stated time that the evacuation order was issued for Bay County-2:00 PM on Monday, September 13<sup>th</sup>.
- Interestingly, the traffic counter on US 231 at the state line recorded higher than average daily values beginning at 7:00 AM and ending at 4:00 PM on Sunday, September 12<sup>th</sup> and again at 8:00 AM the next day. A corresponding increase in traffic counts was not recorded at the Fountain site on US 231 on September the 12<sup>th</sup> and as mentioned above the figures at that site did not exceed ADT until six hours after increases began at the state line. Additionally, no mandatory evacuation orders had reportedly been issued on Sunday, September 12<sup>th</sup>, to account for this higher than normal increase on traffic at that counter. During the time Counter 0050 was recording counts higher than its neighbor to the south, 8,920 vehicles had used that particular road segment, 2,288 over ADT.

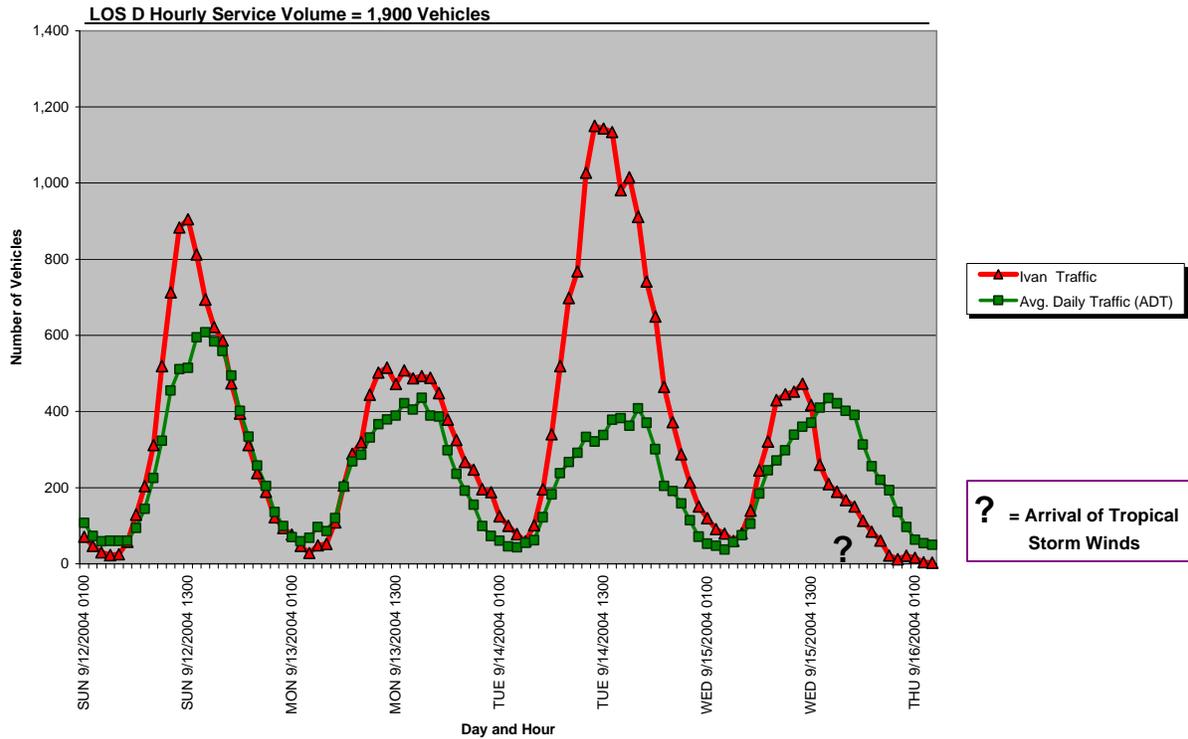
- Clearly, most of the additional vehicles crossing the counter at the state line did not come up US 231 from Bay County. A plausible explanation is that these additional vehicles got on US 231 at the I-10 interchange and may well have been comprised of tourists leaving hotels and their weekly rentals in the western Panhandle of Florida and returning to their homes further north.
- The peak hour of traffic for both counters on US 231 was 12:00 PM on Tuesday, September 14<sup>th</sup>. Both peak hour volumes were well below the hourly evacuation service volume for each segment of roadway. For the counter near Fountain in Bay County the high volume was 1,194 or 63% of the total service volume, and the counter near the Alabama border registered a peak hourly value of 1,150, 750 vehicles below the assigned hourly capacity for that roadway segment. During these peak hours of traffic during the Hurricane Ivan event, the average speeds at both counters remained relatively constant at or above the posted speed limit of 65 miles an hour.
- Given the additional capacity that was available on both segments during the peak hours of traffic volume, as well as average speeds remaining at the posted limit throughout the entire evacuation period for Hurricane Ivan, it is unlikely that congestion was a major issue on this roadway. There is no evidence of any significant impediments to traffic flow on US 231, below or above I-10.
- The final count of additional vehicles over ADT at both sites is approximately 9,824 at the counter below I-10 near Fountain and 12,070 at the counter near the Florida Alabama state line. These vehicle counts are relatively close to the HES and/or the ETIS forecasts for the road segments at either site (see Table 3).
  - There was only a difference of 1,677 vehicles between the HES figures and those at the Fountain TTMS station, but a more significant discrepancy with the ETIS number. This difference between ETIS and the actual number of additional vehicles over ADT is primarily attributable to all the evacuating vehicles leaving Bay County being assigned to the only roadway included in the model. The 2004 Bay County Abbreviated Transportation Model (ATM) assigns 57% of all vehicles leaving Bay County to US 231 above US 20; the other 43% use roadways such as SR 20, SR 77, SR79 and CR 386. When the ETIS travel demand forecast of 19,929 vehicles is meted out according to the

ATM out route distribution, the new number for US 231 south of I-10 is 11,359 which is much closer to the actual figure counted at the ATM station.

- The difference between the count of additional vehicles over ADT and the ETIS travel demand forecast was reasonably close. ETIS forecast 13,703 vehicles would use US 231 north of I-10, whereas the actual number over ADT recorded at the state border with Alabama was 12,070.
- Finally, based on the graphs below the vehicles at both counters had dropped to levels well below the average volumes by the time tropical storm winds had arrived at each location.



**Figure 3. Ivan - Florida - US 231 Northbound Near FL / AL Line (0050 NB)**



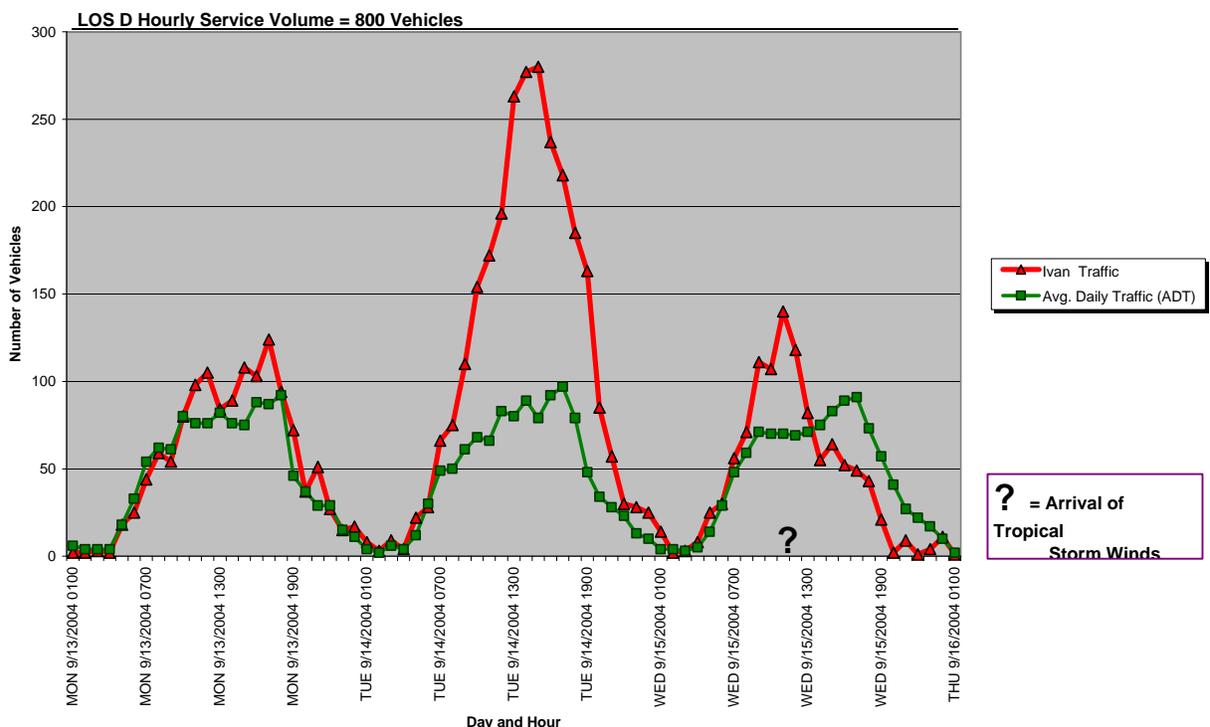
### SR 71 Northbound (TTMS counter 0328)

- Counter 0328 (Figure 4) is located on US 71 near Wewahitchka and is the primary evacuation route for Gulf County. Gulf County reportedly issued evacuation orders in response to Hurricane Ivan but the effective time and applicable zones or populations is not exactly known.
- Traffic began to increase over normal volumes at 11:00 AM on Monday, September 13<sup>th</sup>, 2004, and intermittently remained above average levels for 40 hours. The majority of the additional traffic was recorded on Tuesday, the 14<sup>th</sup> of September, accounting for 78% of the above normal trips for the entire Hurricane Ivan event.
- The peak hour of traffic occurred at this counter at 3:00 PM on September 14<sup>th</sup>, but it does not appear that the high volume created any significant congestion problems or other issues regarding vehicle flow. The high count for this event was 280 vehicles, only 32% of the total hourly evacuation service volume for that roadway segment. Furthermore, there was no significant reduction in the average speeds recorded at the apex of the volume line which

indicates that traffic, although well above normal at that time, should have moved reasonably smoothly.

- Most of the traffic on US 71 northbound had cleared by the estimated arrival of tropical storm force winds at noon on Wednesday, September 15<sup>th</sup>. At that time 118 vehicles were counted on the roadway, 49 more than the average count of 69 for that time of day. Nonetheless, two hours later the number had dropped below ADT and by 8:00 PM that evening the vehicle count was down to single digits where it remained for the rest of the pre-landfall time period.
- During the time preceding the arrival of Hurricane Ivan, the counter on US 71 northbound counted a total of 4,486 vehicles, 2,443 more than the normal count for the same time period. The figures in Table 3 indicate that the total amount of additional traffic recorded exiting Gulf County was reasonably consistent with the HES and ETIS numbers. Unfortunately, without better information on what areas were evacuated, the percentage of participation, or the level of tourist occupancy, it is hard to validate the clearance times. Nonetheless, the numbers are in reasonable agreement.

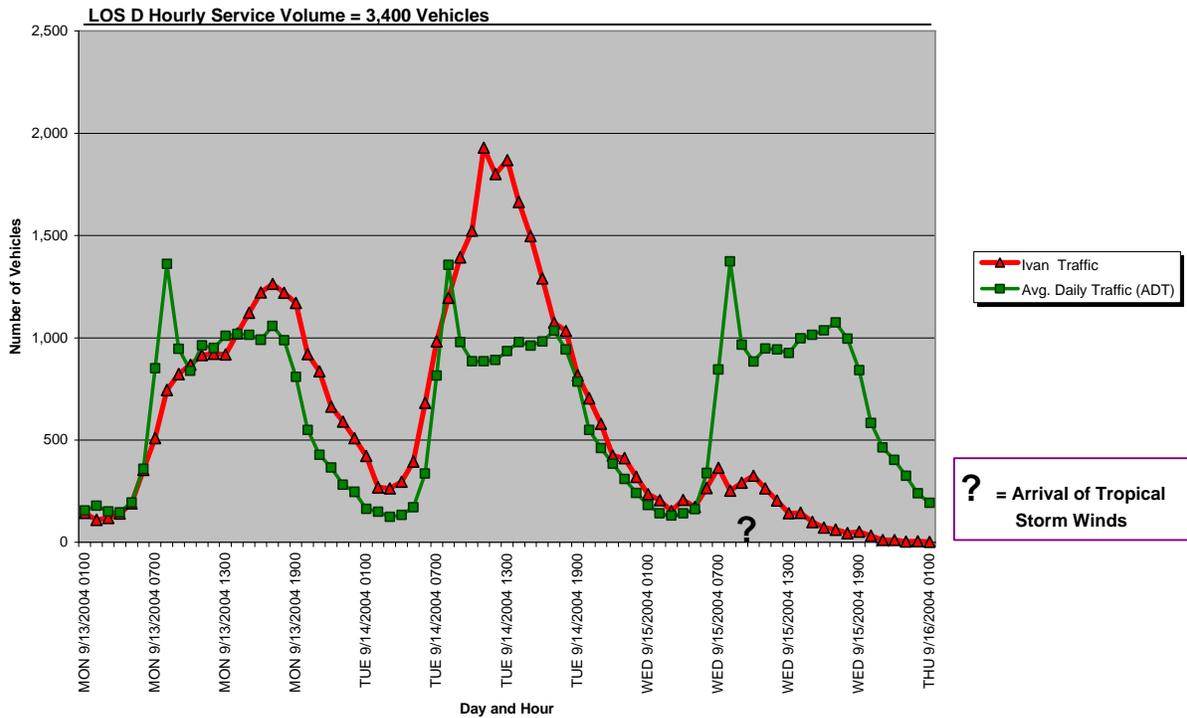
**Figure 4. Ivan - Florida - SR 71 Northbound Near Wewahitchka (0328 NB)**



### **I-10 Westbound (TTMS counter 0156)**

- The only traffic counter in the westbound direction on I-10 that showed significant or prolonged periods of traffic volumes higher than the average daily traffic (ADT) figures was the counter 0156 near the Florida-Alabama state line (see Figure 5). In fact the other two counters, near Quincy (0220) and DeFuniak Springs (0287), recorded hourly volumes consistently below ADT for most of the period marked by the approach of Hurricane Ivan.
- Counter 0156 measured that the hourly volume rose above normal figures beginning at 3:00 PM on Monday, September 13<sup>th</sup>, 2004 and remained above those levels for the next 34 hours. This timing roughly coincides with the issuance of an evacuation order in Escambia County at noon on the same day
- The peak hour of traffic volume occurred 11:00 AM on September 14<sup>th</sup> with a reading of 1,930 vehicles during that hour. That figure is well below the hourly evacuation service volume of 3,400 vehicles per hour assigned to that segment of westbound I-10. Unfortunately, the counter was not recording the average speed during the Hurricane Ivan event, so although there were no issues with hourly capacity during that time a definitive statement about congestion or other traffic impediments cannot be made. Nonetheless, based on traffic volume alone it does not appear that the progress of westbound traffic was hindered during this event.
- During the time of higher than normal hourly counts on this roadway segment, a total of 33,153 vehicles were recorded by that sensor, 10,552 over the normal daily average. ETIS forecast that 24,766 additional vehicles (see Table 3) would evacuate westbound into Alabama on I-10.
- By 6:00 AM on Wednesday, September 15<sup>th</sup>, the hourly recorded volumes dropped and remained below ADT for the rest of the Hurricane Ivan event. As tropical storm force winds were estimated to have reached the location of the counter at 1:00 PM that same day, the vehicle count for that hour was 334 or 39% of ADT. The numbers continued to drop until the counts reached single digits nine hours late at 10:00 PM.

**Figure 5. Ivan - Florida - I-10 Westbound Near FL / AL Line (0156 WB)**



**I-10 Eastbound (TTMS counters 0156, 0287, 0218, 0220, 0238, 0109)**

- I-10 is well served by an extensive array of traffic counters along its entire length in Florida, all of the counters in the eastbound direction recorded higher than average traffic volumes, most likely the result of evacuations from Hurricane Ivan. Counter 0156 (Figure 6) is on the state line with Alabama; 0287 (Figure 7) is east of DeFuniak Springs in Walton County; 0218 (Figure 8) is located near Marianna; counter 0220 (Figure 9) is near Quincy in Gadsden County; just west of the I-10 junction with I-75 is counter 0238 (Figure 10); and the most eastern sensor, 0109 (Figure 11), is just east of US 301 near Baldwin in Duval County.
- The first sensor on I-10 to register a significant increase over ADT was in Quincy (0220) which recorded slightly higher than average traffic volumes starting as early as 6:00 AM on Sunday, September 12<sup>th</sup>. That counter continued to record higher than normal hourly traffic volumes for the rest of Sunday, but by 1:00 AM the next day the counts dropped below normal levels and remained that way at the Quincy location until 1:00 PM, twelve hours later. The reason for this unexpectedly high traffic volume at this counter is not readily apparent, but it may not be attributable directly to any evacuations from Hurricane Ivan.

- As the Quincy counter was registering its last reading higher than ADT for half a day, the counters near Marianna and Live Oak were beginning to register significant increases in hourly traffic counts over normal values beginning at midnight on Monday, September 13<sup>th</sup>, followed by the counter near DeFuniak Springs at 1:00 PM, September 13 and 9:00 PM in Escambia County. At 1:00 AM on September 14<sup>th</sup> the sensor near Baldwin began recording traffic volumes and average speeds and registered its first peak hour soon thereafter.
- For more than two days following, all of the counters from DeFuniak Springs to Live Oak recorded higher than average volumes. The counter near Quincy measured the longest duration of above ADT traffic counts at 65 hours, but 11 of those hours were recorded on Sunday, when the real reason for those higher than normal values is not readily apparent. Nonetheless, even without the 11 hours from September 12, the Quincy station still logged the most hours above ADT during this event.
- Of all of the traffic counters activated in an emergency operations mode for all four of the hurricanes that made landfall in the United States during the 2004 season, two on I-10 during Hurricane Ivan have the dubious distinction of providing irrefutable evidence of traffic congestion. At 4:00 PM, on Tuesday September 14<sup>th</sup>, the traffic counter near Marianna (0218) and near Quincy (0220) documented a number of hours where the volumes nearly reached or exceeded the hourly evacuation service volume for their segments of roadway and had corresponding significant decreases in average speed.
  - The Marianna site (Figure 8) recorded two hours, between 4 and 6 PM where the traffic volumes approached or exceeded the hourly evacuation service volume and where the average speed during that period dropped from 70+ miles an hour to 40 and 44 mph.
  - The TTMS station near Quincy (Figure9), which in the next one eastward of Marianna, began documenting the same traffic congestion issues at the same time, but the congestion episode lasted much longer, until 1:00 AM on Wednesday, September 15<sup>th</sup>. At 11:00 PM the average recorded speed at that location was as low as 10 miles an hour and the average for all the hours of probable congestion was only 37 mph.
  - The traffic volume figures documented at the Quincy station although coming close did not exceed the hourly evacuation service volume that was assigned to that segment of I-10. At 7:00 PM, September 14<sup>th</sup>, the absolute peak of traffic, the count came to within 156 vehicles of reaching the hourly capacity of 3,000 vehicles an hour. But it is likely that from that point forward the slow movement of traffic reduced the number of vehicles that could pass through that road segment in one hour. Hence the hourly counts drop off

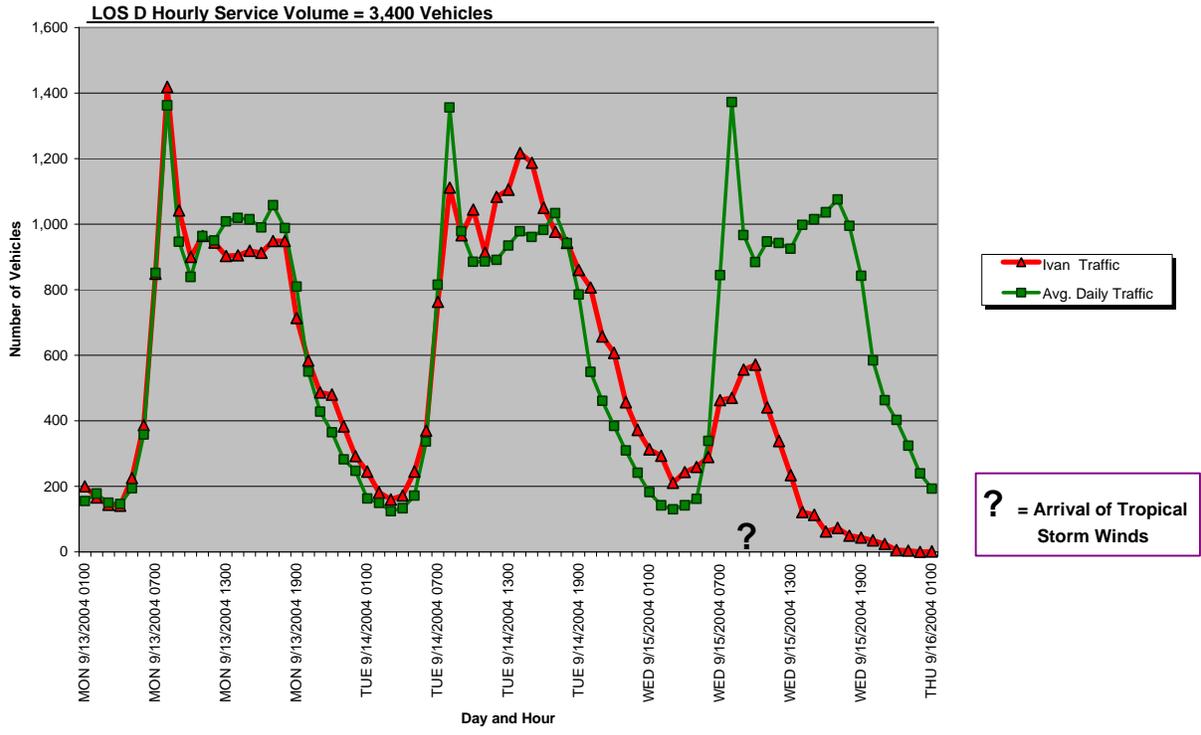
dramatically, coincidental to normal reductions in volume due to night-time hours. In fact the counts dropping off dramatically after the peak hour are most likely a reflection of fewer cars being able to move through that roadway segment because the average speed is also falling. The last dip seen at 10:00 PM on Tuesday occurs during the same hour that the average speed is 10 miles and hour, once the speed picks back up to 59 mph during the next hour the count also increases.

- This empirical evidence of traffic congestion at these sites is further corroborated by anecdotal observations provided by witnesses to the episode and emergency managers. In fact the traffic queues extended as far east as Tallahassee.
  - The period of congestion appears to be attributable to traffic volumes rather than some incident acting as a catalyst for restricting traffic flow.
- None of the other counters surpassed their hourly evacuation service volume and the average speeds recorded during the peak hours do not reflect any major reduction. This does not necessarily mean that congestion and some impediments to traffic flow did not occur at these other locations, just that they were not clearly evident from the data collected at the sites.
- In assessing the overall traffic count numbers on I-10 eastbound (see the bottom of Table 2 and Table 3), especially with respect to number of additional vehicles processed at each station during the evacuation event, the data helps disclose generally how the cars were distributed along the entire roadway, especially to likely host shelter locations and other major evacuation routes inland.
- The eastbound counter on I-10 in Escambia County documents that not many vehicles from Alabama or Mississippi evacuated into Florida during the Hurricane Ivan event. Only 2,600 vehicles moved eastbound into Escambia County from points westward.
  - Between Escambia County and Walton County on I-10, approximately 37,100 additional vehicles over ADT figures from those counties traveled eastbound, most likely as a result of evacuation for Hurricane Ivan.
  - The count at the Marianna count site indicates that about 39,300 vehicles more than normal volumes used that roadway segment. Since this counter location is east of US 231, one can infer that the Bay County contributions to I-10 traffic outweighed the number of vehicles that exited to head northbound into Alabama.
  - The Marianna counter recorded the highest number of vehicles over the average daily traffic figures, and the numbers were beginning to wane slightly by the next counter in Quincy. A reduction in the total of additional vehicles at the Quincy station by

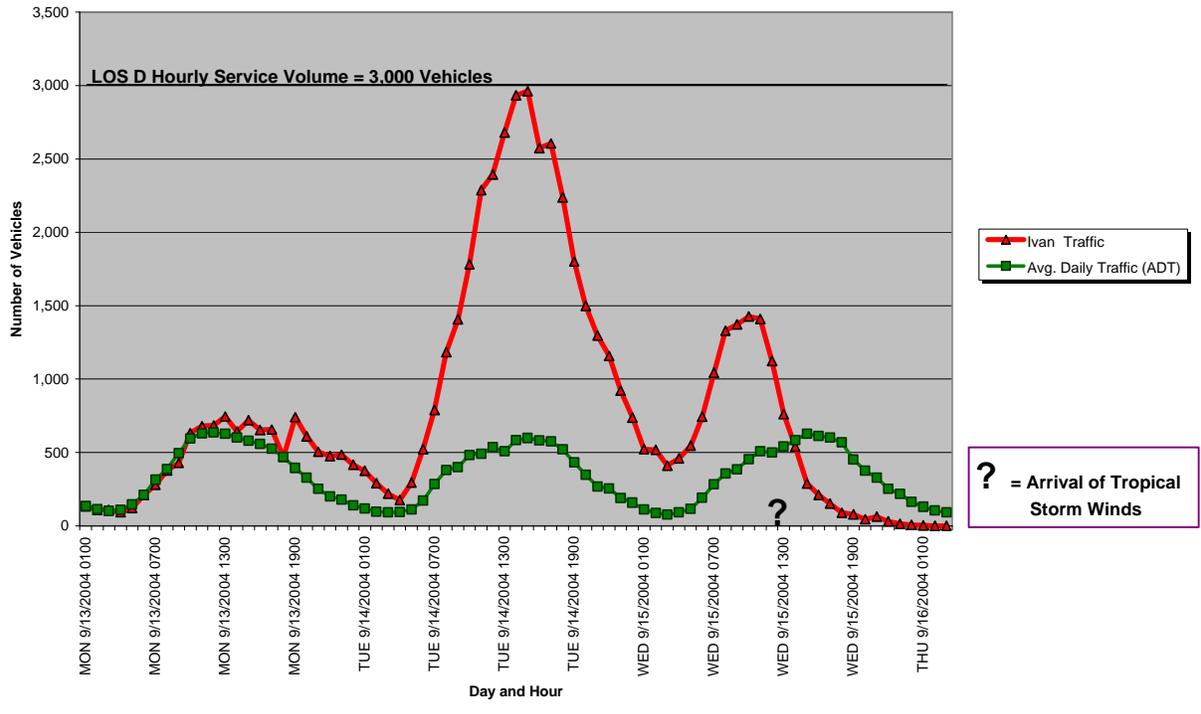
approximately 1,500 vehicles indicates that a small percentage of the vehicles counted at the Marianna location either stopped in Marianna and Chattahoochee or continued up into Alabama and Georgia on local roads, such as SR 71.

- The Live Oak traffic counter recorded only about 25,100 vehicles over ADT. The implication of this figure is that 12,700 vehicles ended their evacuation trips on I-10 before getting to that site. Likely destinations or alternative routes between Quincy and Live Oak are Tallahassee, probably where many of the vehicles stopped; US 27 into southeast Georgia; US 319 toward Thomasville, GA; US 19 into south Georgia, and possibly US 221 into Quitman and Valdosta, GA.
  - Finally, approximately 13,000 additional vehicles did not continue on I-10 as far east as Baldwin in Duval county, where the eastern-most traffic counter on that roadway is located. It is likely that those vehicles ended their journeys near Live Oak and Lake City or continued north or south on I-75. It appears that most of the vehicles exiting onto I-75 from I-10 probably went south. The northbound lanes at the traffic counter on I-75 near the Florida Georgia border indicate lower than normal traffic counts during the Hurricane Ivan event, while the TTMS sensors on the southbound lanes of I-75 near the state line and Ocala show higher than normal traffic counts during the period of Hurricane Ivan's approach.
  - In looking at the travel demand figures for I-10 from ETIS, there is reasonably good agreement with the numbers from the traffic counters. The actual numbers of additional vehicles over ADT were higher than the ETIS travel demand figures, but this may be explained by the lack of inland counties that can be committed to evacuate in ETIS or that actual participation rates were higher than estimated by emergency managers in the post-Ivan surveys.
- At every counter, it appears that traffic was at or below average daily traffic levels by the time tropical storm winds were estimated to arrive at those locations. Only the traffic counts near DeFuniak Springs were above ADT at the estimated arrival time of the winds, however the number dropped off dramatically the next hour to levels below the amount of traffic normally recorded there.
  - For Florida generally, the clearance times were sufficient, but then local governments were extremely proactive in issuing their orders which provided ample time for the evacuation to be completed.

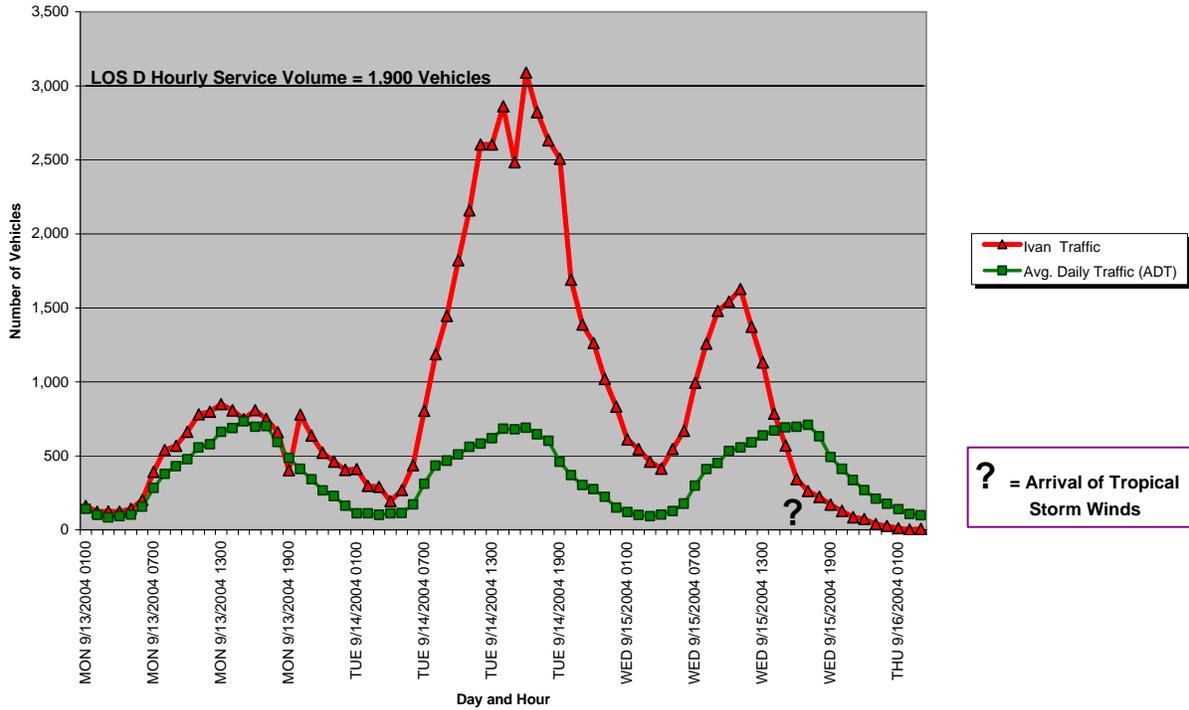
**Figure 6. Ivan - Florida - I-10 Eastbound Near Florida / Alabama Line (0156 EB)**



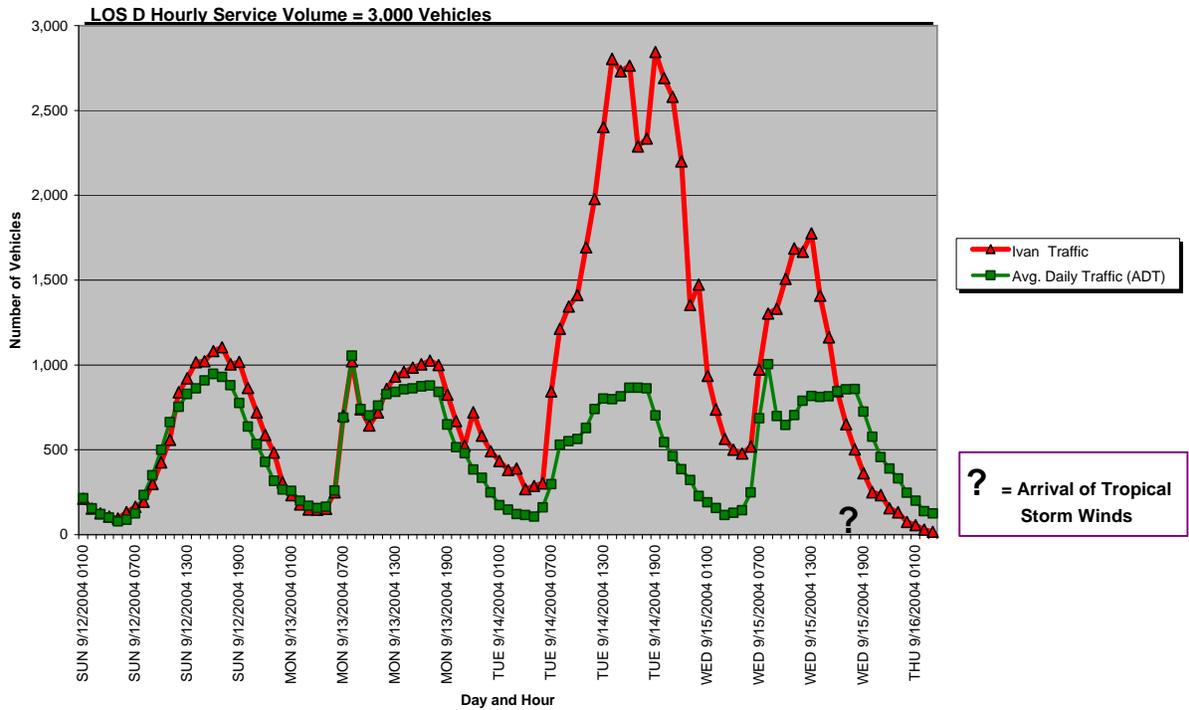
**Figure 7. Ivan - Florida - I-10 Eastbound Near Defuniak Springs (0287 EB)**



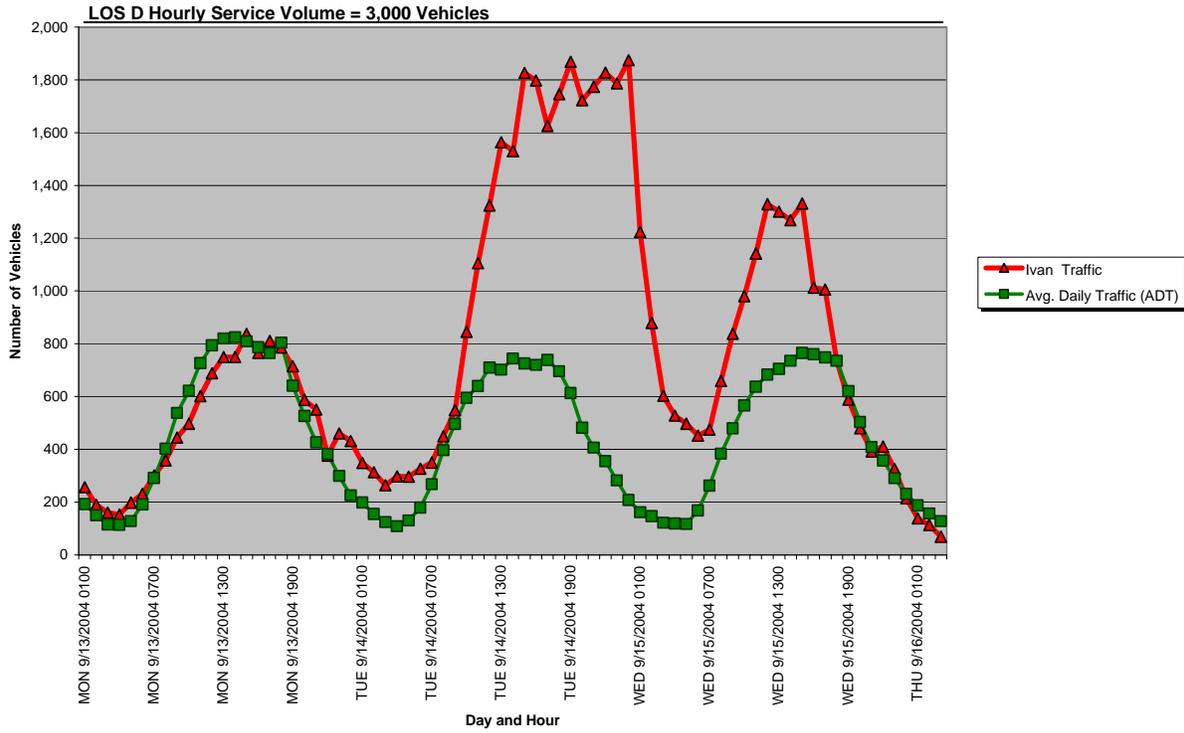
**Figure 8. Ivan - Florida - I-10 Eastbound Near Marianna (0218 EB)**



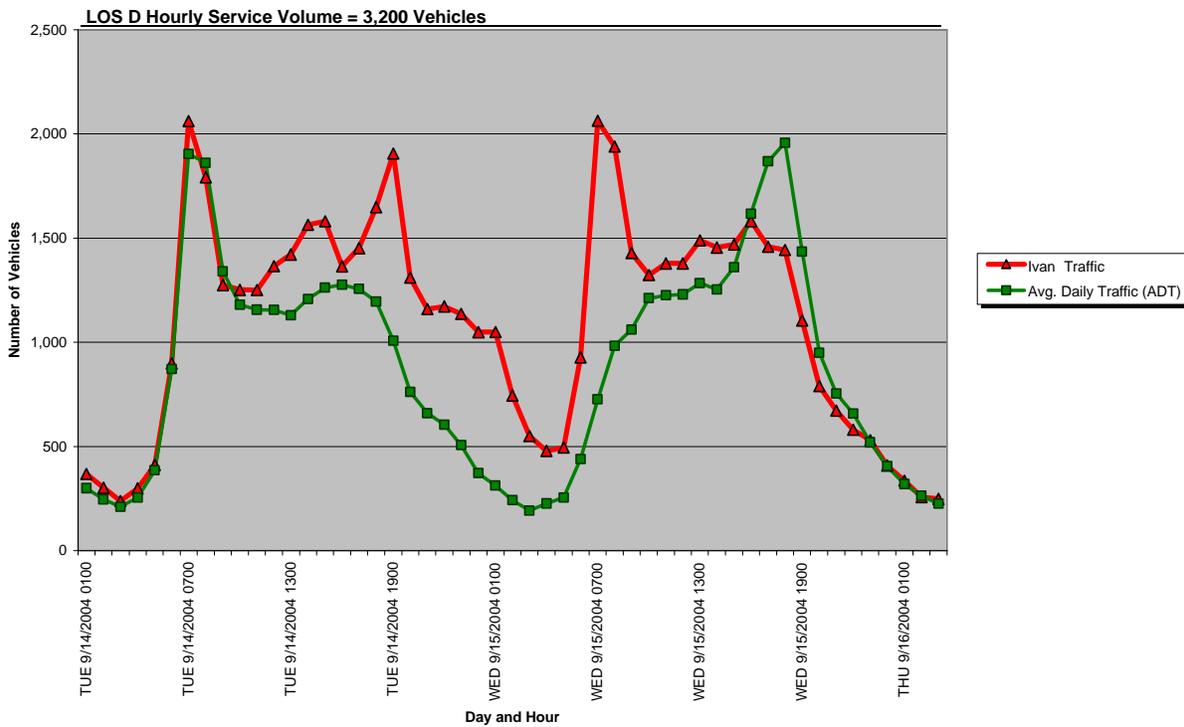
**Figure 9. Ivan - Florida - I-10 Eastbound Near Quincy (0220 EB)**



**Figure 10. Ivan - Florida - I-10 Eastbound Near Live Oak (0238 EB)**



**Figure 11. Ivan - Florida - I-10 Eastbound Near Baldwin (0109 EB)**



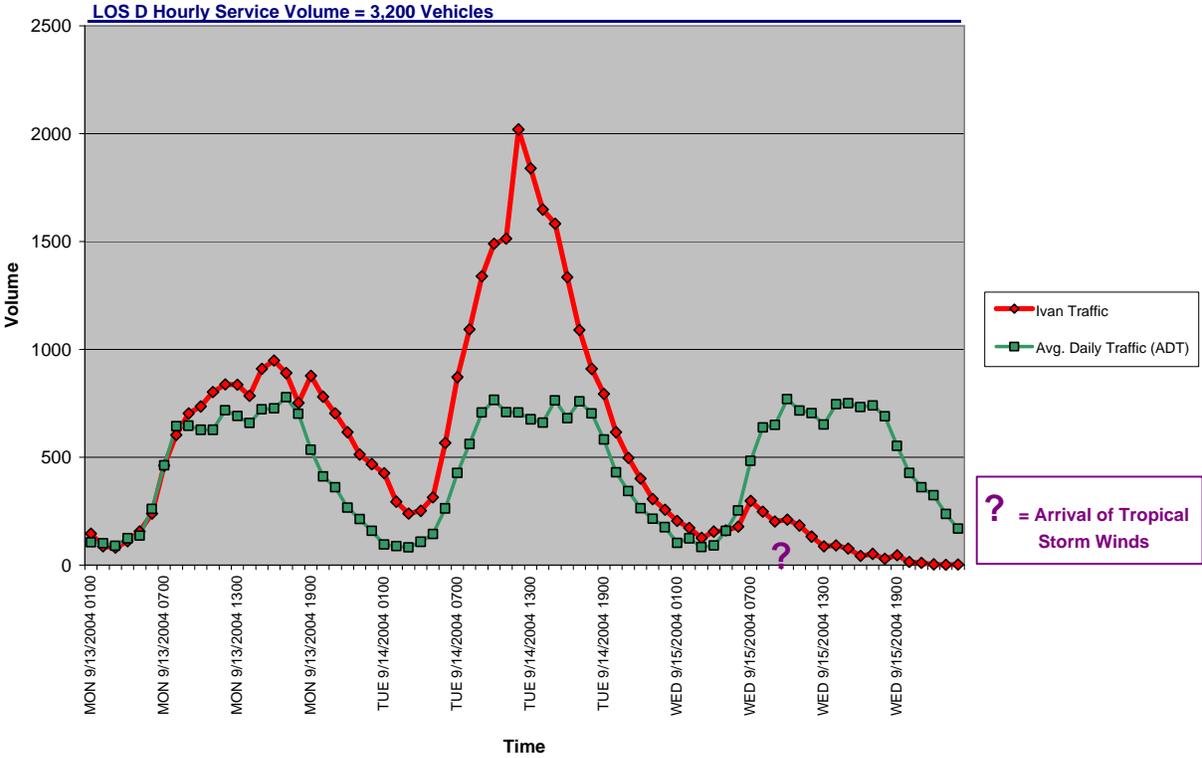
## **Alabama**

### **I-10 in Baldwin County Westbound and Eastbound**

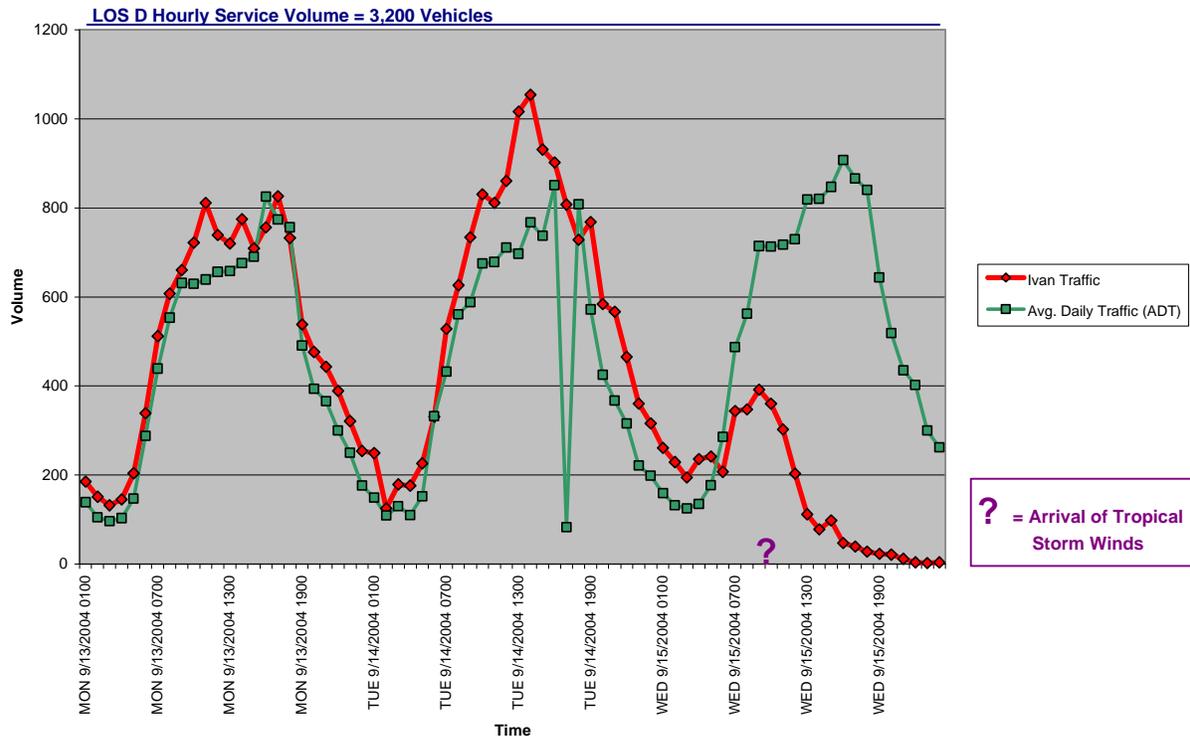
- The traffic counter on I-10 in Alabama is located in Baldwin County near the interchange of Alabama 59 at mile post 44.5. The eastbound direction probably indicates the evacuation activities in both Mobile and Baldwin Counties, whereas the westbound direction most likely applies to Baldwin County alone.
- The traffic traveling westbound (Figure 12) indicates that greater than average traffic counts began as early as 9:00 AM on Monday September 13<sup>th</sup>, 2004. Most of this additional traffic probably originated in Baldwin County since the westbound sensor on I-10 in Escambia County, Florida did not register traffic above normal levels until 3:00 PM the same day. Up to that point the westbound counts on the east side of the state line were below normal.
- The eastbound traffic had been at slightly above normal levels since the late evening hours of Sunday night, September 12<sup>th</sup>, but departed radically from ADT counts around 10:00 AM on the 13<sup>th</sup> of September.
- The westbound lane sustained higher than ADT traffic counts for 45 hours during the Hurricane Ivan event, whereas traffic heading to the east remained above normal levels for 52 hours. Nonetheless, during the entire period before Hurricane Ivan's landfall, the counter in the westbound lane processed approximately 14,400 additional vehicles over ADT to the 5,400 additional vehicles in the eastbound lane (see Table 2 below). Although 4,700 vehicles over average daily counts were recorded traveling in the eastbound lanes of I-10, only 2,600 were counted at the Alabama - Florida state line.
- At peak volume, 2,020 vehicles at noon on the 14<sup>th</sup> of September, the westbound lanes of I-10 achieved two thirds of their hourly evacuation service volume of 3,200 vehicles per hour, while the eastbound peak hour only accounted for 33% of the hourly capacity. Based on the apparent excess capacity relative the highest hours of peak demand, it does not appear that any major traffic congestion problems should have been evident during Hurricane Ivan on this portion of I-10 in either direction. Unfortunately without the benefit of average speed data at this location, that statement cannot be definitively supported.

- As seen in Table two and in the figures below, traffic counts dropped to levels well below normal hours before the estimated arrival of tropical storm force winds. This provides some indication that there was more than sufficient time to fully evacuate all the at-risk populations that wanted to use I-10.
- The agreement between the forecasted travel demand for that portion of I-10 in Alabama in the HES and those from ETIS and the actual additional vehicles over ADT was reasonably good. Table 3 provides a comparison between the various figures.

**Figure 12. Ivan - Alabama - I-10 Westbound in Baldwin Co. at Mile Post 44.5**



**Figure 13. Ivan - Alabama - I-10 Eastbound in Baldwin Co. at Mile Post 44.5**



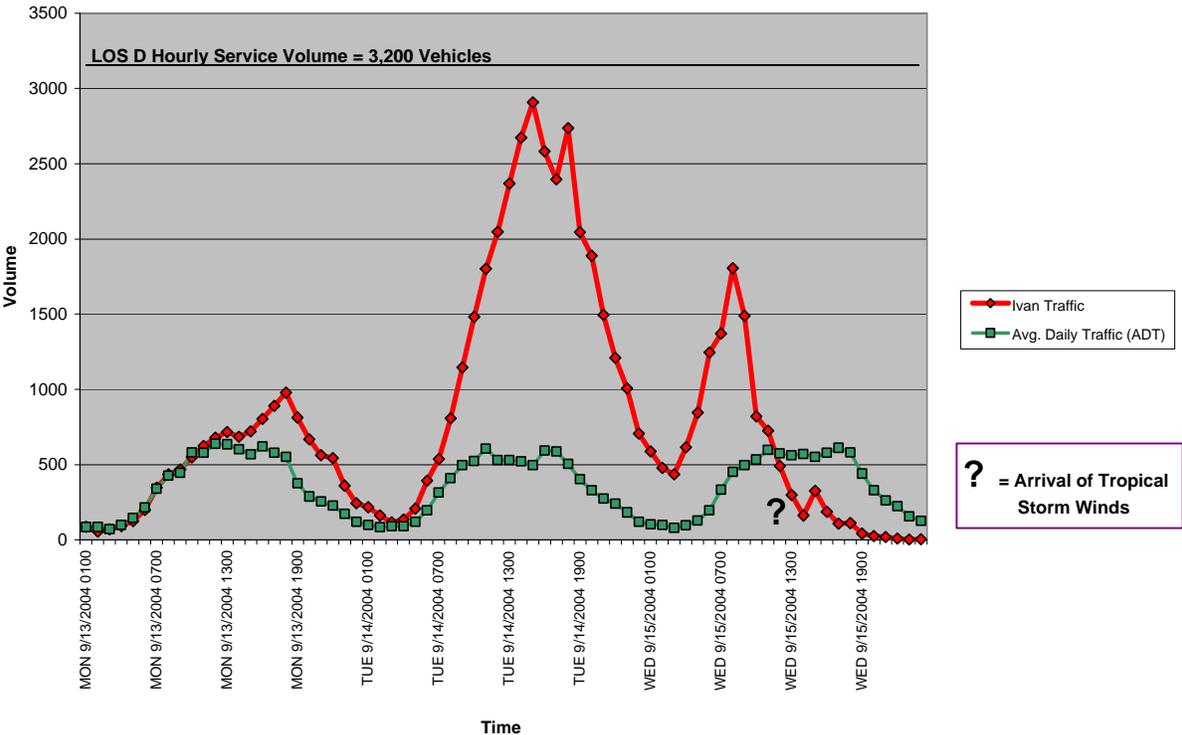
### **I-65 in Baldwin County Northbound and Southbound (during Contra-flow operation)**

- The primary direction of I-65 during evacuation operations is northbound from Mobile to Montgomery; however, the southbound lane during Hurricane Ivan was contra-flowed as a traffic improvement measure for the evacuations that were underway in response to that storm. The information included in this report for I-65 in the southbound direction only relates to the period under which it was conveying evacuation traffic northbound.
- On I-65 northbound the traffic volumes measured by the counter at mile post 42.8 (Figure 14) began to depart from normal traffic figures at 9:00 AM on Monday, September 13<sup>th</sup>, 2004. The numbers continued to escalate to volumes significantly higher than ADT almost consistently for the next 48 hours. The first day of evacuation traffic accounted for 8.6% of all additional cars over ADT that would use that roadway in the day prior to the arrival of Hurricane Ivan. Tuesday, September 14<sup>th</sup> constituted the bulk of the above normal counts in traffic at 70%, and the morning hours of Wednesday comprised the remaining 22.4% of all additional vehicles using this roadway during the Ivan event.

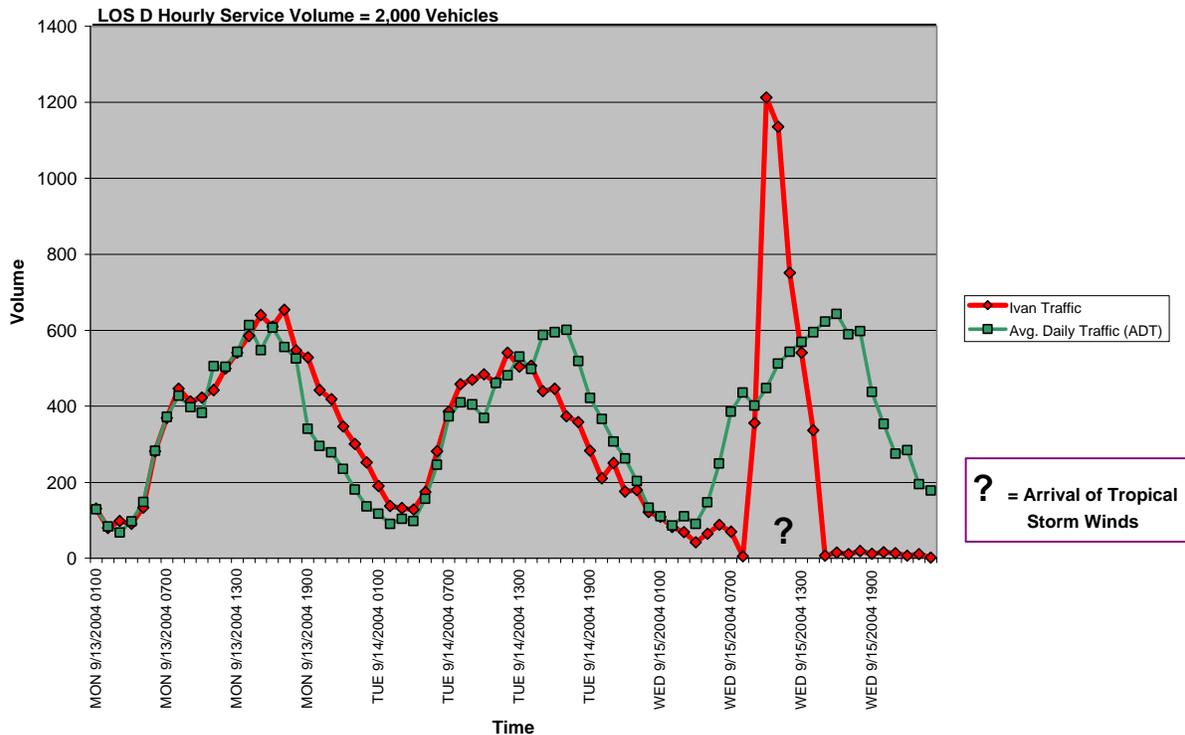
- The final tally of additional vehicles over ADT using the northbound lanes of I-65 in Baldwin County from September 13<sup>th</sup> to 15<sup>th</sup> was approximately 35,100 almost twice the normal counts for that same period.
- The peak hour of traffic volume occurred at 3:00 PM on Tuesday, September 14<sup>th</sup> with a count of 2,907 vehicles, well over the 496 normally on the roadway during that time of the day, and just 293 vehicles under the hourly evacuation service volume of 3,200. Traffic volumes mid-afternoon on Tuesday could have probably been characterized as congested, but certainly there is no evidence of gridlock or traffic queuing, especially without the benefit of average hourly speed data for that site. Traffic attained another high count the next day at 8:00 AM with a count of 1,805 vehicles, almost 4 times the ADT volume of 492 for that time of the day.
- Early on the morning of Wednesday, September 15<sup>th</sup>, 2004, Alabama officials decided to implement a contra-flow plan for the I-65 southbound lane, devoting all capacity in that direction to northbound traffic. The plan was actually implemented on the ground at 8:00 AM, at the same hour that the peak value for the normal northbound lanes was recorded. For the next six hours northbound traffic used the southbound lanes. Traffic on the contra-flow lanes from 10:00 AM to 2:00 PM was greater than the traffic using the normal lanes by a significant margin. By the time the contra-flow lanes were shut down and converted back to normal flow between 2:00 and 3:00 PM, a total of 4,300 vehicles had taken advantage of the additional capacity on I-65.
- The peak hour of traffic in the contra-flow lanes was at 1,213, measured at 10:00 AM. These traffic volumes did not exceed the hourly contra-flow service volume of the roadway which is considerably less than the hourly directional capacity under normal conditions, probably around 2,000 vehicles per hour. It does not appear that congestion would have been a major problem during the contra-flow operation.
- Based on the combined traffic counts of both normal and reverse lanes, which in essence represent the hourly demand for that roadway for that time period, it does not appear that the contra-flow operation was really necessary. The highest vehicle count processed by all the lanes during the contra-flow operation was 2,034 vehicles, which is only 64% of the hourly evacuation service volume for the northbound lanes on I-65.

- The true total of additional vehicles over ADT on I-65 going northbound during the days preceding the landfall of Hurricane Ivan is approximately 39,800 of which 35,100 used the normal northbound lanes. These figures coincide quite well with the ETIS travel demand forecast for I-65 northbound of 36,105 vehicles.
- The clearance times from the Alabama HES and the congestion figures for ETIS are also in reasonably good agreement. Although there were still vehicles in the normal and contra-flow directions at the estimated arrival time of tropical storm force winds, the numbers had already started to wane before the onset of those winds and they continued to drop well below normal volumes soon thereafter.

**Figure 14. Ivan - Alabama - I-65 Northbound in Baldwin Co. at Mile Post 42.8**



**Figure 15. Ivan - Alabama - I-65 Southbound in Baldwin Co. at Mile Post 42.8**

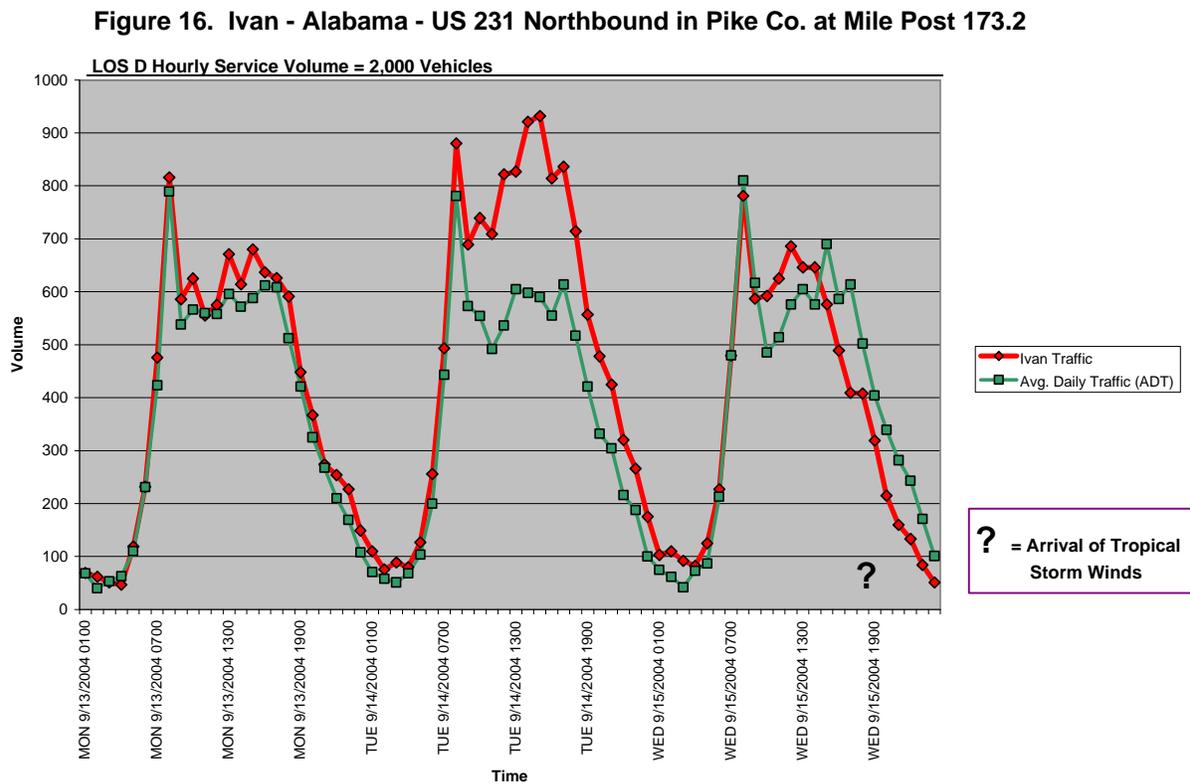


### US 231 Northbound in Pike County

- Although this traffic counter is located at mile post 173 on US 231 in Alabama, most of the traffic over ADT using this roadway in the days prior to the arrival of Hurricane Ivan had Florida license plates. Pike County, in which the city of Troy and this counter are located, is a considerable distance from the coast; some mobile home residents from this and adjoining may have voluntarily decided to evacuate from the storm, but more than like an overwhelming majority of the vehicles began their trips in Florida.
- Beginning on the first hour of Sunday morning, September 12<sup>th</sup> (see Figure 16), traffic using this segment of US 231 was slightly elevated over normal counts from the previous year. This mimics the results recorded at the traffic counter at the state line in Florida on US 231, slightly elevated traffic levels on Sunday. The 887 additional vehicles over ADT measured in Pike County, Alabama, constituted an 11 % increase from the vehicles that traveled northbound on that roadway the year before. The cause of the slightly elevated figures at both locations and whether those figures are at all linked cannot be discerned from the counter data; more additional vehicles were measured at the Florida sensor, but the Pike County counter began registering an increase over normal levels earlier in the day.

- Traffic counts began to increase at the Pike County sensor at 7:00 AM on September 13<sup>th</sup>, 2004, and stayed consistently above ADT levels throughout the day. Only at 11:00 AM and on that day did the observed counts register below the historical volumes of the previous year. The Florida sensor at the state line on US 231 recorded 1,457 vehicles over normal levels on that Monday, whereas the Pike County, Alabama, site measured 763 additional vehicles above ADT.
- Tuesday, September 14<sup>th</sup> saw the vehicle numbers at the Pike County sensor remain consistently above average volumes all day, finally totaling 3,364 additional vehicles, compared to the 7,807 vehicles measured at the Florida location.
- On Wednesday, September 15<sup>th</sup>, the observed traffic began to slacken off but remained higher than historical volumes until 2:00 PM. After that time traffic counts dropped below the normal figures and stayed that way for the duration of the Hurricane Ivan event. The counter recorded 566 vehicles above average volumes between 1:00 AM and 2:00 PM on Wednesday, whereas the Florida sensor tallied 912 additional vehicles.
- In comparing the figures between this counter and the one in Florida near the state border, there appears to be a strong correlation between the two. The start and end times on September 13<sup>th</sup> through the 15<sup>th</sup> for increased traffic volumes coincided almost to the hour and the total daily counts for vehicles over ADT generally matched. For all four days before the arrival of Hurricane Ivan, the counts for this traffic sensor were roughly half of the vehicles that used the road segment in Florida at the state line.
- These figures infer that about 50% of the vehicles that crossed into Alabama on US 231 from Florida either stopped in Dothan or some other community in Southeastern Alabama, or chose an alternate route such as US 431. Although the objective of some of the vehicles counted at the Pike County station may have been Troy, Alabama, the likely destination was Montgomery, Alabama.
- The peak hour of traffic measured at this site occurred at 3:00 PM on Tuesday, the 14<sup>th</sup> of September with a total of 932 vehicles, 342 more than normal counts for that hour for that day, but more than 1,000 less than the hourly evacuation service volume for that road segment. Traffic congestion and other problems may have occurred on that or other road segments on US 231 in Alabama, but it doesn't appear likely.

- During the 54 hours of higher than normal traffic counts for Hurricane Ivan event, approximately 4,700 vehicles over ADT were counted as using this northbound segment of US 231. The ETIS travel demand forecast was in reasonably good agreement with 3,401 vehicles (see Table 3).
- At the time that tropical storm force winds theoretically arrived at the counter location at about 7:00 PM on September 15<sup>th</sup>, the traffic counts were below average levels, but the road was not fully cleared. At 7:00 PM there were 319 vehicles still on the roadway, but the number continued to consistently decrease thereafter.

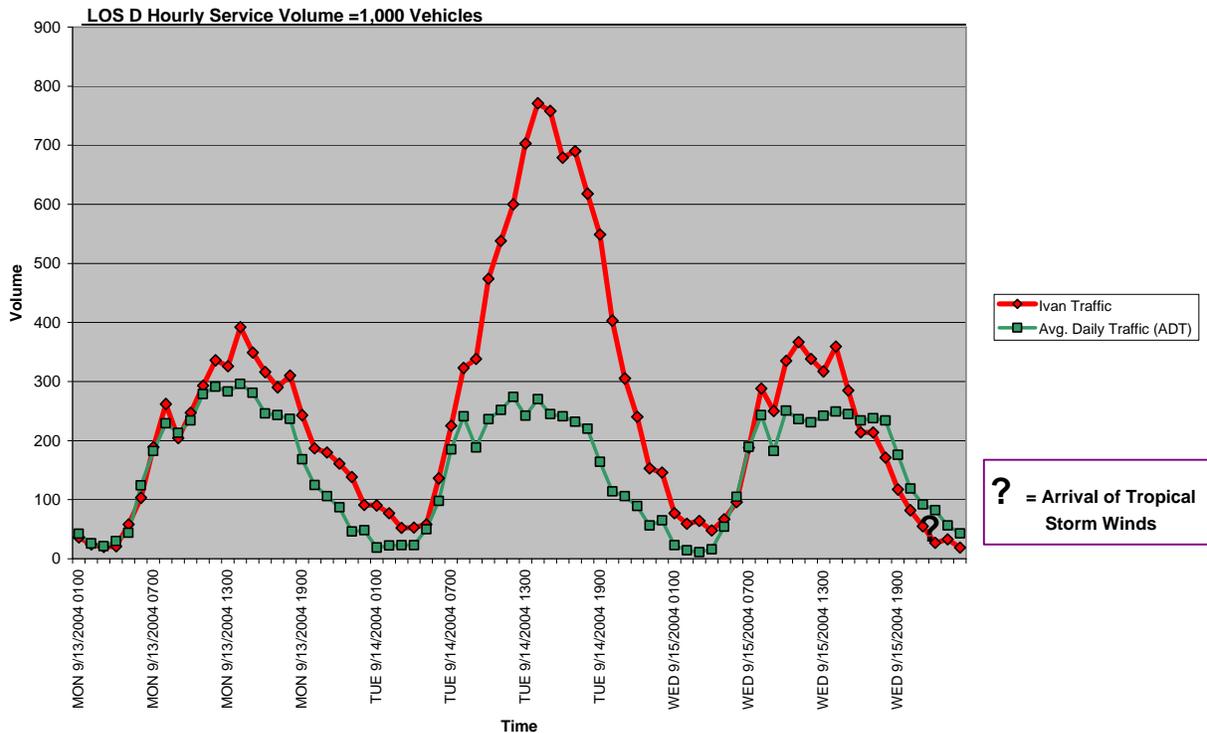


### US 431 Northbound in Barbour County

- Similar to the counter on US 231 in Pike County, this counter on US 431 in Barbour County most likely reflected the evacuation situation for the eastern Panhandle of Florida rather than the local situation in the southeastern inland Alabama counties. Although some local residents may have sought other locations to ride out Hurricane Ivan, probably most of the additional vehicles counted at this site were from Florida.

- The observed traffic volumes (Figure 17 and Table 2) began to consistently increase over ADT levels beginning at noon on Monday, 13 September, 2004. For the next 53 hours with only two exceptions, the hourly traffic counts remained consistently above average volumes, most likely as a result of evacuations in the Florida Panhandle. The only two hours not characterized by having higher than normal vehicle counts were 6:00 and 7:00 AM on Wednesday, September 15<sup>th</sup>.
- The peak hour of traffic during the Hurricane Ivan event occurred at 3:00 PM, September 14 with a total of 932 vehicles. The hourly evacuation service volume for this roadway segment is 1,000 vehicles, which should have been able to accommodate this peak in traffic volume.
- The period of higher than ADT traffic volumes at this counter ended at 3:00 PM on Wednesday, September 15<sup>th</sup> after an additional 7,100 vehicles over normal levels were processed by this roadway segment. By 10:00 PM on the 15<sup>th</sup> of September, when tropical storm winds were estimated to arrive at this counter location, 27 vehicles were counted on this roadway, well below the 82 normally traveling on it at that time and on that day.
- Like the traffic counters on US 231 on the Florida - Alabama state line and in Pike County, Alabama, the start and end times, as well as the peak hours coincided with one another. Again the inference is that the episodes of increased traffic volumes for all these roadway segments were linked to one another at least during Hurricane Ivan; that the traffic entering into Alabama, probably mostly from US 231, was filtering through the roadway network with about 39% traveling on US 231 toward Troy and Montgomery, 59% using US 431 toward Columbus, Georgia, and Phenix City, Alabama and a small proportion possibly remaining in Dothan, Alabama.

**Figure 17. Ivan - Alabama - US 431 Northbound in Barbour Co. at Mile Post 57.7**

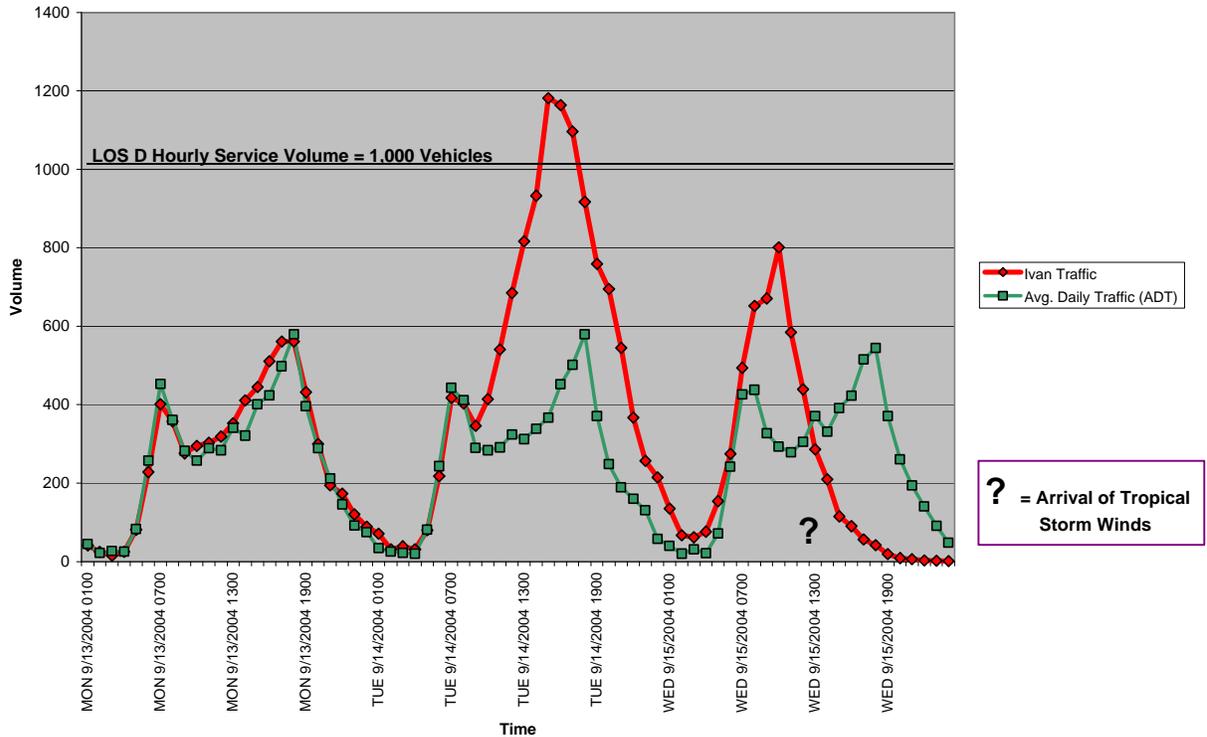


### US 43 Northbound In Mobile County

- The location of this traffic counter is important in that it probably is reasonably representative of what occurred in Mobile County during the evacuations associated with Hurricane Ivan. Most of the vehicles that used the roadway during the days preceding the arrival of the hurricane most likely originated in the city of Mobile with many of the additional trips over ADT occurring in response to the storm.
- Based on the traffic counts recorded by this sensor, the evacuation in Mobile County did not appear to begin in earnest until 9:00 AM on Tuesday, September 14<sup>th</sup>, 2004, one hour before Mobile County reportedly issued a category 3 evacuation order. Between 10:00 AM and 5:00 PM on Monday the 13<sup>th</sup> of September, very few additional vehicles over normal levels traveled northbound on this roadway segment, although the reason for those few additional vehicles is not known. Slightly higher than normal traffic counts occurred during the hours of darkness on Monday night and Tuesday morning. Nonetheless, this very minor amount of movement on Monday only accounted for 357 vehicles or about 4% of the overall number of additional vehicles that used this segment of US 43 in the days leading to Hurricane Ivan's landfall.

- For the next 27 hours, traffic volumes remained well above ADT figures. Once the mass movement of vehicles began on Tuesday, September 14<sup>th</sup>, vehicle counts escalated rapidly to the peak hour of traffic volume at 3:00 PM. At that time 1,182 vehicles were counted at that location, 182 above the hourly evacuation service volume and 815 over the normal number of vehicles for that day and time.
- For three hours until 6:00 PM on the 14<sup>th</sup> of September, traffic remained above the hourly evacuation capacity of that roadway segment. The peak hour count was 18% higher than the hourly service volume which provides a strong indication that traffic flow was not very good at this time. That statement cannot be confirmed without accompanying average speed data, nonetheless anecdotal observations do relate that major problems with congestion occurred in Mobile during Hurricane Ivan evacuation. In fact of all the emergency management offices surveyed during this post-storm effort in Florida, Alabama and Mississippi, only Mobile County used the word gridlock to characterize traffic conditions in their jurisdiction.
- Despite the apparent traffic problems on this roadway on September 14 and 15, by the time tropical storm force winds were estimated to arrive at the counter location, traffic had already dropped below ADT levels and had been steadily and dramatically decreasing since 10:00 AM. At 1:00 PM on September 15<sup>th</sup> as the tropical storm wind ellipse reached the counter location, 286 vehicles were still on the road, but the number continued to drop steadily until single digit counts became the norm from 8:00 PM on.
- During the entire evacuation event, the northbound lanes of US 43 north of Mobile processed a total of 7,954 vehicles over ADT figures. ETIS does not include this roadway in its repertoire of evacuation routes, but the HES travel demand figures for that roadway were in reasonable agreement with the above-normal vehicle counts for the event.

**Figure 18. Ivan - Alabama - US 43 Northbound in Mobile Co. at Mile Post 57.7**



## Mississippi and Louisiana

### I-10 Westbound in Jackson County

- This traffic counter is located just west of the Mississippi - Alabama state line on I-10 and monitors traffic volumes in both directions. Due to its location the data collected for the westbound direction (see Figure 19) is more indicative of the status of evacuations in Alabama rather than Mississippi. The eastbound direction sensor will provide some indications on the course of evacuations in Mississippi.
- For the westbound direction traffic volumes began to increase to levels above ADT beginning at 5:00 AM on Monday, September 13<sup>th</sup>, 2004. For the next 12 hours, until 5:00 PM, the number of vehicles recorded at that station would remain above the average daily traffic figures. The traffic volumes again surpassed normal daily figures on Tuesday, the 14<sup>th</sup> of September from 1:00 AM to 5:00 PM and again from 5:00 to 9:00 AM on Wednesday, September 15<sup>th</sup>. Therefore, the Monday daily traffic volumes account for 17% of the event total, Tuesday was 78% and the Wednesday daily additional vehicle total comprised only 5% of the trips moving westbound on I-10.

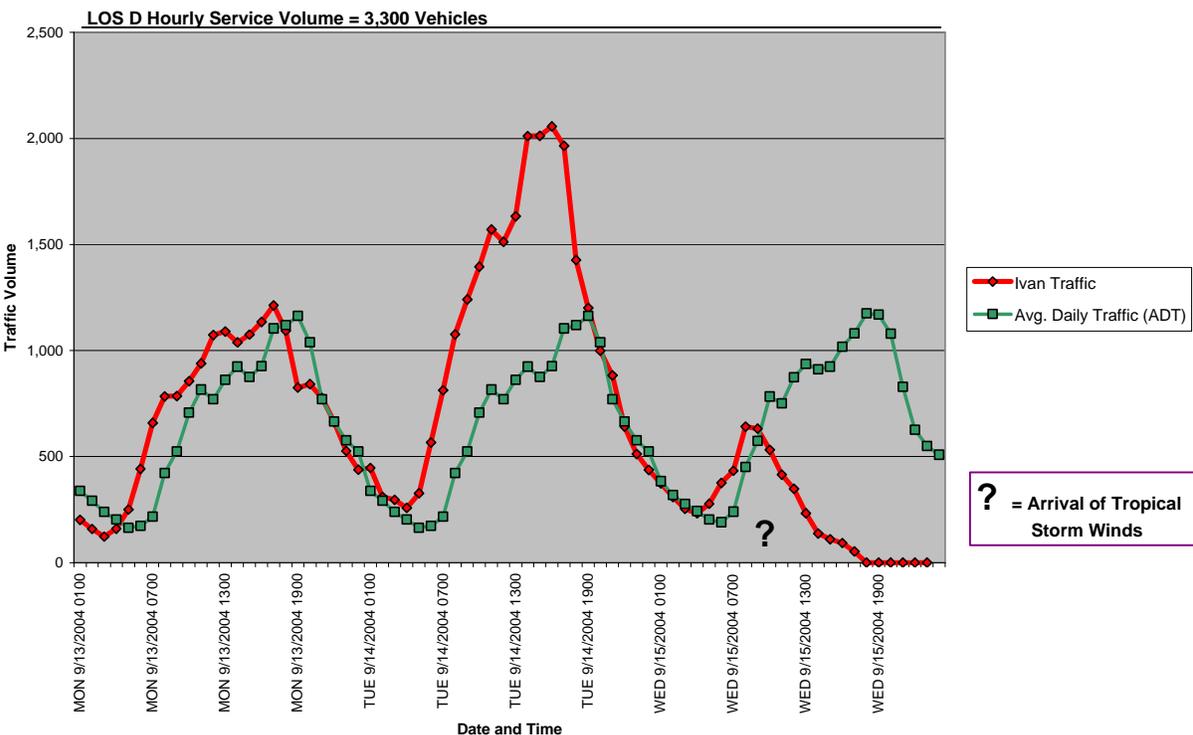
- The peak hour of traffic occurred at 4:00 PM on Tuesday, September 14<sup>th</sup>, just 1 hour after the counter on US 43 north of Mobile, Alabama, and four hours after the I-10 westbound sensor in Baldwin County, Alabama, documented the apex of its traffic volumes for the event. At its zenith, the number of vehicles recorded by the Jackson County, Mississippi, traffic counter reached 2,057, which constitutes only 62% of the hourly evacuation service volume assigned to that roadway. Traffic may have been heavy heading west on I-10, but without the benefit of average speed data it is not really possible to determine the congestion on that segment, or the status of vehicle flow during the Hurricane Ivan event.
- As tropical storm winds were estimated to be arriving in Jackson County, Mississippi, traffic volumes had already started to drop off and were below ADT levels; the 10:00 AM hourly count on September 15<sup>th</sup> was 532 vehicles. By 6:00 PM that evening, no vehicles had used that segment of I-10 traveling westward.
- For the entire storm approximately 12,500 additional vehicles over ADT totals had been processed by this roadway, 1900 less than were counted crossing the traffic counter on I-10 westbound in Baldwin County, Alabama.
- ETIS and the HES assume a very limited number of vehicles will cross from Alabama into Mississippi on I-10 so the figures for that segment are somewhat misleading. However, the using the next road segment westward with respect to comparing vehicle demand figures (see Table 3) may be more appropriate and those HES and ETIS numbers agree quite well with the number of additional vehicles that used that segment of I-10 during Hurricane Ivan.

### **I-10 Eastbound In Jackson County**

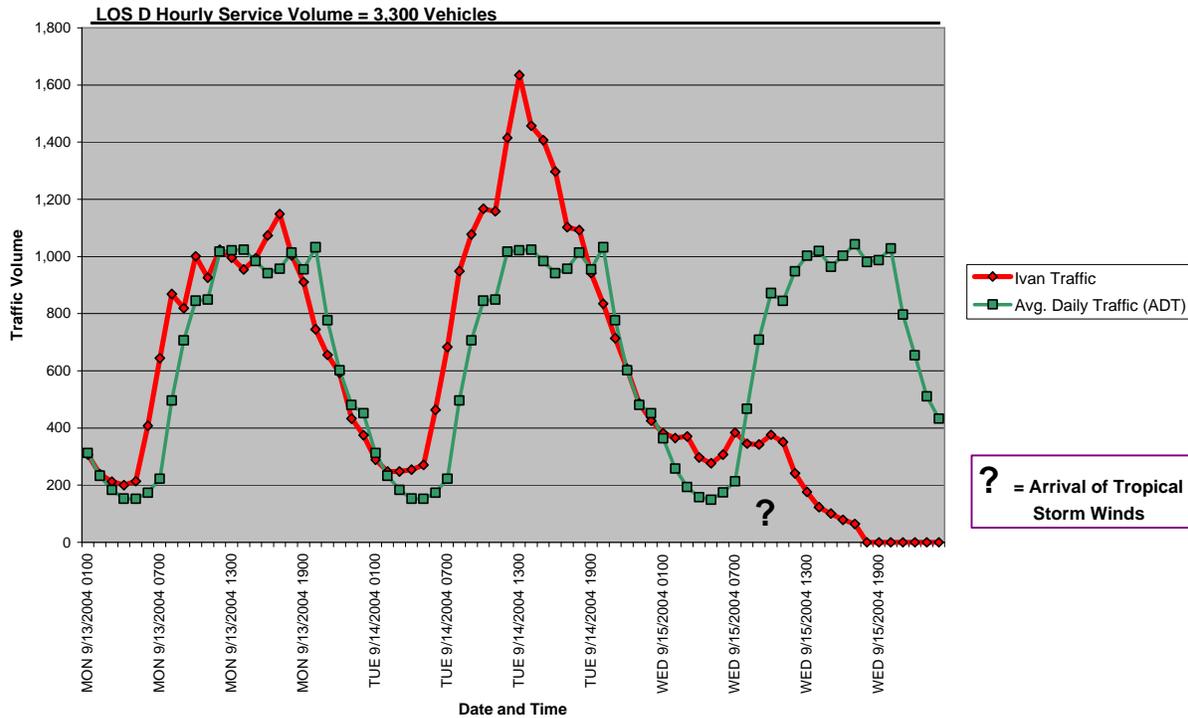
- The eastbound traffic counter (Figure 20) began recording an increase in traffic over normal daily levels as early as 3:00 AM on the morning of September 13, 2004, 12 hours before Jackson County issued their evacuation orders. The bulk of the elevated traffic volumes, probably the result of Hurricane Ivan, were on Tuesday when 65% of all additional vehicles recorded over ADT used this road segment.
- Interestingly, after Jackson County issued evacuation orders, above normal traffic volumes only continued for another two hours; by 5:00 PM on September 13, traffic dropped to below ADT levels for the rest of the day.

- The peak hour of traffic volume on this segment of eastbound I-10 for Hurricane Ivan was at 1:00 PM on Tuesday, September 14<sup>th</sup>. At that time 1,634 vehicles were counted on that segment which only constitutes half of the hourly evacuation service volume for that roadway. Given the excess capacity relative to the peak volume for this event it is not likely that congestion or other impediments to smooth traffic flow were a serious problem during this event.
- The surge of additional traffic over average levels during Hurricane Ivan ended at 7:00 AM on Wednesday, September 15<sup>th</sup>, three hours before the estimated arrival of tropical storm force winds. By 6:00 PM that day the traffic counts fell to 0 and remained there until after Hurricane Ivan made landfall.
- In the 33 hours that this road segment was subjected to elevated levels of traffic during the approach of Hurricane Ivan, a total of 6,540 additional vehicles over normal daily counts were processed. The HES and ETIS vehicle demand figures for this segment are in reasonably good agreement with the additional vehicle totals as is evident in Table 3.

**Figure 19. Ivan - Mississippi - I-10 Westbound in Jackson County**



**Figure 20. Ivan - Mississippi - I-10 Eastbound in Jackson County**



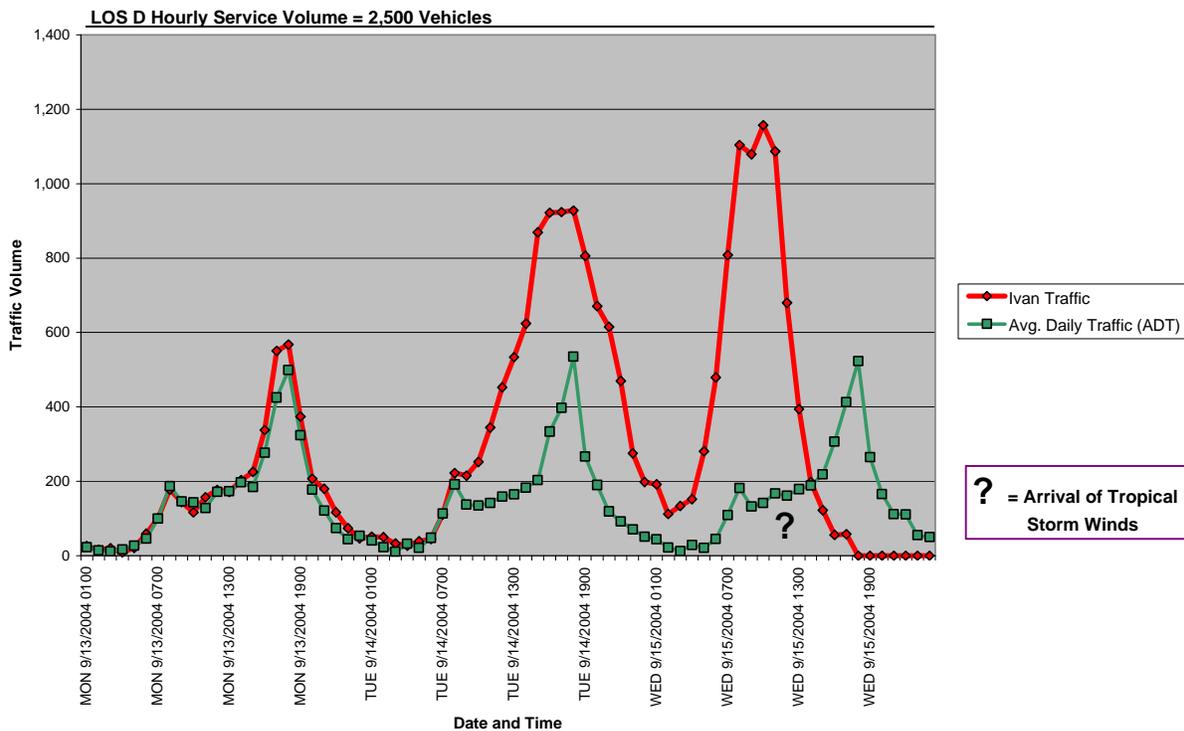
**MS 63 Northbound in Jackson County**

- This traffic counter is located on the major northbound evacuation route in Jackson County just south of the county line with George County.
- Despite some very slightly elevated hourly traffic counts for much of Monday, September 13<sup>th</sup>, the evacuation apparently did get fully underway until 8:00 AM on Tuesday, September 14<sup>th</sup>, 2004. The vehicle counts do increase slightly over normal figures coincidental to the reported issuance of evacuation orders by Jackson County officials, but the daily total for September 13 only accounts for 4% of all recorded vehicles over ADT for the Hurricane Ivan event.
- According to the daily totals for the difference between the recorded and historical vehicle counts, September the 15<sup>th</sup> was when a majority of vehicles traveled northbound on MS 63, presumably to evacuate the coast for Hurricane Ivan. Half the vehicles that would use that roadway in the days prior to Ivan did so on that Wednesday; 46% of all northbound vehicles traveled on Tuesday, September 14<sup>th</sup>.
- The peak hour of traffic on MS 63 occurred at 10:00 AM on September 15<sup>th</sup> when 1,157 vehicles were recorded traveling northbound. This number is not half of the available hourly evacuation capacity of 2,500 vehicles per hour. Without corresponding average speed data at

that counter site it is not possible to definitively state the degree of congestion experienced on the roadway during this period. However, based on the figures recorded by this traffic counter it does not appear that the peak volumes imposed on the roadway were enough to tax its ability to process the vehicle demand.

- It also appears based on a 12:00 PM, September 15<sup>th</sup>, estimated time of arrival for tropical storm force winds at the counter location that 680 vehicles were still on the roadway. The winds arrived only two hours after the peak in traffic volume for the entire event was recorded; the count for the hour starting at 1:00 PM was 394 vehicles. Nonetheless, by 6:00 PM the counters were registering that no vehicles were on the roadway.
- For the days of heavy traffic volumes during the approach of Hurricane Ivan, MS 63 processed a total of 12,789 vehicles over average daily traffic figures. This road is not included in the roadways in ETIS, but the Mississippi HES forecast that approximately 14,000 vehicles would use the road as an evacuation route.

**Figure 21. Ivan - Mississippi - MS 63 Northbound in Jackson County**

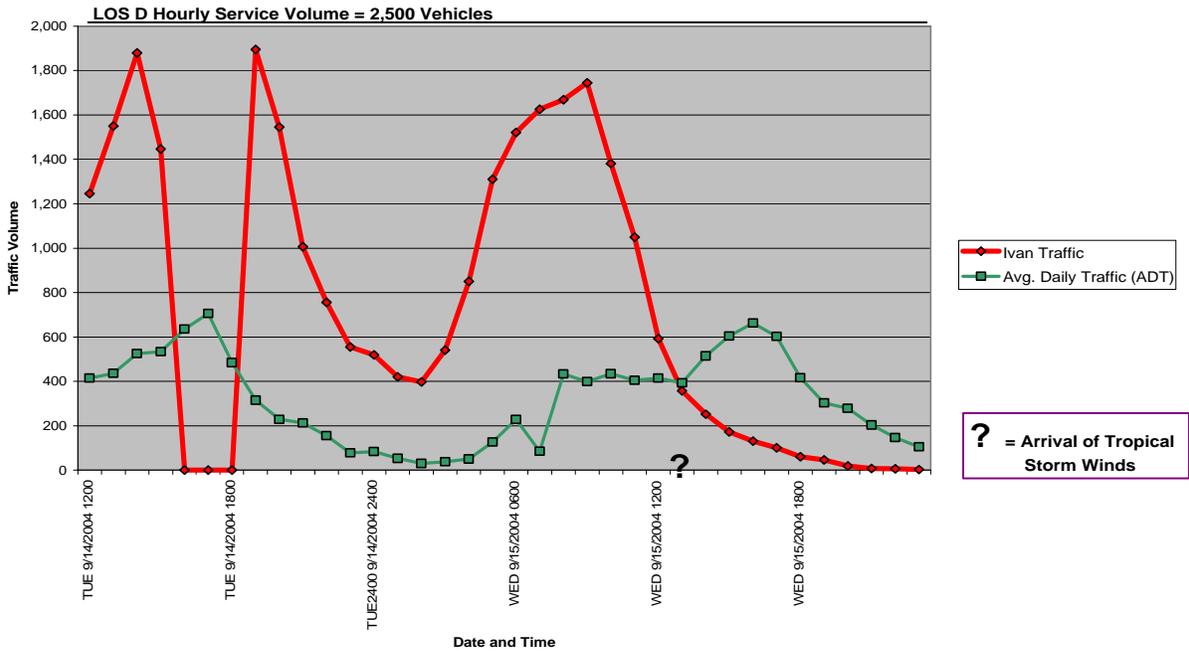


## **US 49 Northbound in Stone County and Rankin County**

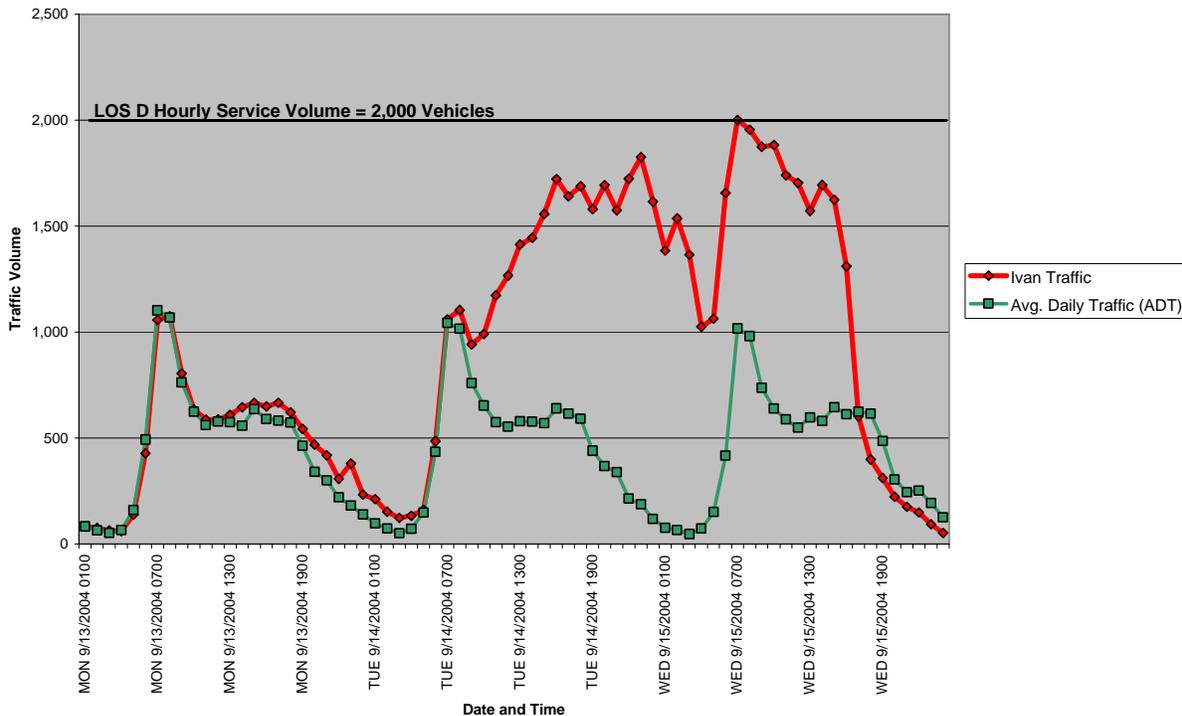
- The traffic counter in Stone County is located just north of the county line with Harrison County while the Rankin County station is north of the county line with Simpson County. The Stone County site is situated at a good location to record the progress of evacuations specifically in Harrison County, and the counter in Rankin County records the traffic volumes just before Jackson which is a likely host shelter area.
- Unfortunately, the traffic counter in Stone County (Figure 22) possibly experienced some technical difficulties and therefore, did not record any counts until Tuesday, September 14<sup>th</sup>, 2004. It again appears that the sensor experienced some additional problems between 4:00 and 6:00 PM on the same day for the reading during those hours is also 0. When the counter was operational starting at 1:00 PM on the 14<sup>th</sup> of September, the number of vehicles traveling northbound on that segment of US 49 was climbing dramatically, and unfortunately the counter went temporarily offline just as the peak was occurring in the traffic flow. Nonetheless, when the traffic counts stopped and then resumed two hours later the figures were 1,875 and 1,895 vehicles; it is impossible to tell how close the actual counts during those hours got to the hourly evacuation service volume of 2,500 vehicles per hour.
- The traffic counter in Rankin indicates that a slightly higher than normal volume was traveling north on US 49 as early as 1:00 PM on Monday, September 13<sup>th</sup>, 2004. The daily total though against all the additional vehicles over ADT for the entire three day period is only 1,148 vehicles or 3.3%. The true onslaught of traffic began registering at the counter starting at 8:00 AM on September 14<sup>th</sup> and continued consistently above normal volumes until 4:00 PM Wednesday afternoon, 32 hours later. September 15<sup>th</sup> was the day that a majority of the traffic traveled northbound on US 49 into the Jackson, Mississippi area, probably as a result of Ivan. That Wednesday accounted for 17,619 vehicles or slightly over 50% of all vehicles over normal values for the days preceding Hurricane Ivan.
- The peak hour of traffic volume at the counter station in Rankin County occurred at 7:00 AM, September 15<sup>th</sup> with 2,001 vehicles, one more than the hourly evacuation service volume for that road segment. The traffic volume alone during the peak hour does not necessarily mean serious traffic congestion occurred during the event, a conclusive determination in that respect requires average speed data during those high volume periods.

- As tropical storm winds were assessed to have reached the traffic counter in Stone County at 1:00 PM on Wednesday September 15th, the number of vehicles traveling on the road had just dropped to below average figures and those counts continued to diminish through that night.
- In the few hours that the traffic counter on US 49 in Stone County was operational for this event, it captured 19,818 vehicles over the normal values for those time periods. Extrapolating those figures to match the same number of hours recorded at the Rankin County station indicates that approximately 41,450 vehicles may have crossed that segment of US 49 in Stone County. The total number of additional vehicles processed on the Rankin County segment of US 49 is 38,122.
- The implications of the above figures relative to the Bi-State Study and ETIS travel demand forecasts (see table 3) are difficult to assess given the incomplete data at the Stone County site. Nonetheless, the actual numbers were considerably higher than what ETIS predicted for the Rankin County segment. Without better data from the Stone County site it is hard to gauge how many of those Rankin County trips originated in Harrison County and along the Mississippi coast, versus some of the inland locations along the route. Nonetheless, one would expect that a large number of those trips leaving the coast and reaching Rankin County would have been intercepted in Hattiesburg, Mississippi, unless all the hotels and other facilities there filled up early leaving the evacuees with no choice but to continue another 75 miles to Jackson, Mississippi.

**Figure 22. Ivan - Mississippi - US 49 Northbound in Stone County**



**Figure 23. Ivan - Mississippi - US 49 Eastbound in Rankin County**



### **I-59 Northbound in Pearl River County and Forrest County**

- I-59 is primarily an evacuation route for Louisiana and not for residents and visitors in Mississippi. It is more of a conduit for evacuees leaving New Orleans, Louisiana, to get into the inland areas away from the coast. Some residents from Hancock County may use that interstate highway, but an overwhelming majority of the vehicles on that roadway during a hurricane evacuation scenario will be from Mississippi's neighbor to the south and west.
- The traffic counter on the northbound lanes of I-59 in Pearl River County, Mississippi, (Figure 24) is located just north of the Mississippi state line with Louisiana. In that respect, this traffic counter especially only has utility for assessing the conduct of evacuations in Louisiana.
- The I-59 traffic sensor in Forrest County (see Figure 25) is north of Hattiesburg, Mississippi, a likely destination for a large portion of the evacuees using that interstate highway. Again like its counterpart to the south this traffic counter probably is more useful for monitoring the status of evacuations in Louisiana rather than in Mississippi.
- For the Pearl River station, traffic began to increase slowly on Monday the 13<sup>th</sup> of September, 2004 in the mid afternoon. By 4:00 PM of that day the recorded traffic volume exceeded the average traffic volumes historically seen at that site and did not return to

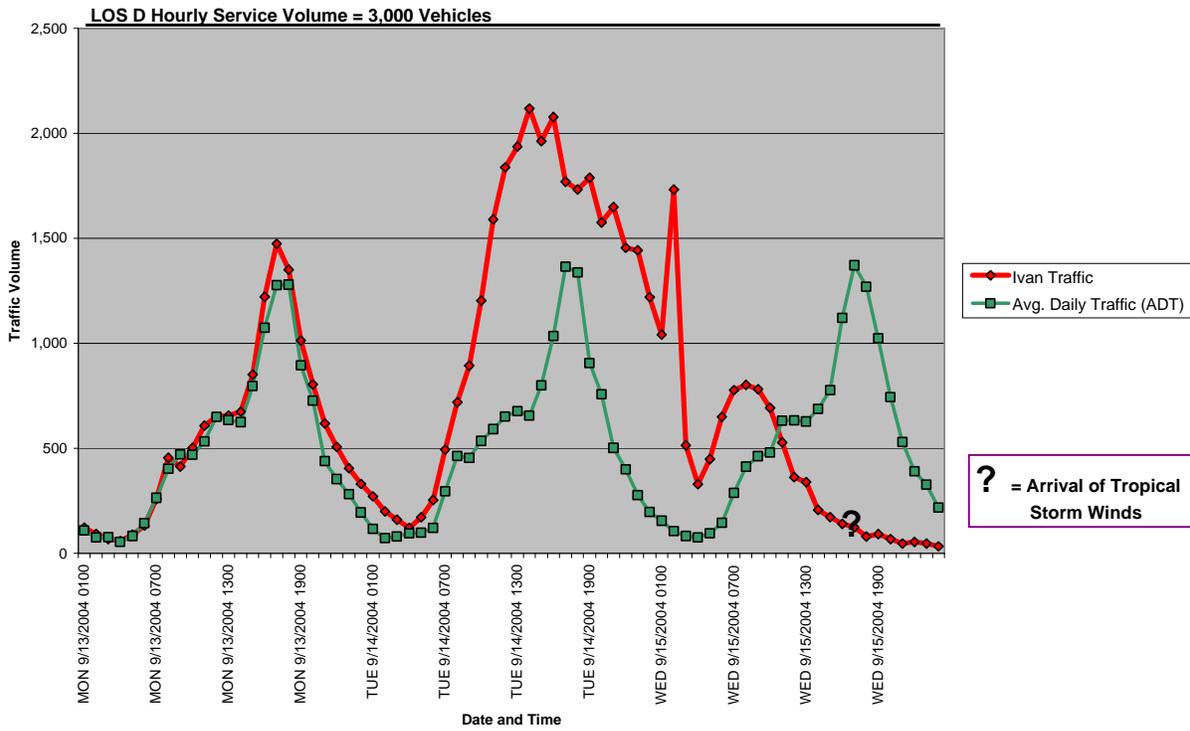
normal values until 10:00 AM on Wednesday, September 15<sup>th</sup>. The first day only accounts for about 7% of the total vehicles over ADT recorded at the site over the three days leading up to the landfall of Hurricane Ivan. Tuesday, September 14<sup>th</sup> constitutes the majority of the additional traffic volume measured at this site at 16,163 vehicles or 70% of the total for the event.

- Correspondingly, the traffic counter near Hattiesburg on I-59 records its first hour of higher than normal vehicle counts at 8:00 PM on Monday, September 13<sup>th</sup>, and with one exception remains at above average volumes for the next 44 hours.
- The peak hours at both sites remain well below the hourly evacuation service volumes. At 2:00 PM on Tuesday, September 14<sup>th</sup> at the height of evacuation traffic at the Pearl River County site only uses two thirds of the capacity of that roadway segment is used by the mass of vehicles. The Forrest County station records its peak volume one hour after the Pearl River County counter, but at less than half of its available hourly evacuation capacity of 3,000 vehicles per hour.
- Unfortunately, without average speed data it is not possible to discern the reasons for some of the dramatic hourly fluctuations in the traffic counts at either of these locations. At 2:00 AM on Wednesday, September 15<sup>th</sup>, at the Pearl River counter, the vehicle count jumps more than 700 vehicles over the number at that site an hour before and in the next hour plummets over 1,200 vehicles. It is not apparent from the data whether some restriction in the flow caused the number to drop at 1:00 AM of the 15<sup>th</sup> and once the incident was cleared an hour later the volume surged to compensate for the reduced through-put, or some other circumstance not directly related to traffic conditions caused a temporary surge of vehicles. At the Forrest County traffic counter the dramatic fluctuation seen during 11:00 PM on September 14<sup>th</sup>, two hours before the same phenomenon becomes apparent at the counter further south could be the result of a normal reduction in the number of vehicles or congestion slowing down traffic, and thus reducing the number of cars that are processed at that link during that hour. Regardless of the reasons, both traffic counters documented extended periods of relatively high traffic volumes that alone could have eventually resulted in traffic jams and slowdowns.
- By 10:00 AM on Wednesday, September 15<sup>th</sup> the Pearl River counter registered its final hour of above average traffic volumes and four hours later the hourly totals at the Forrest County site also dropped below average levels. As the tropical storm force winds were reaching both

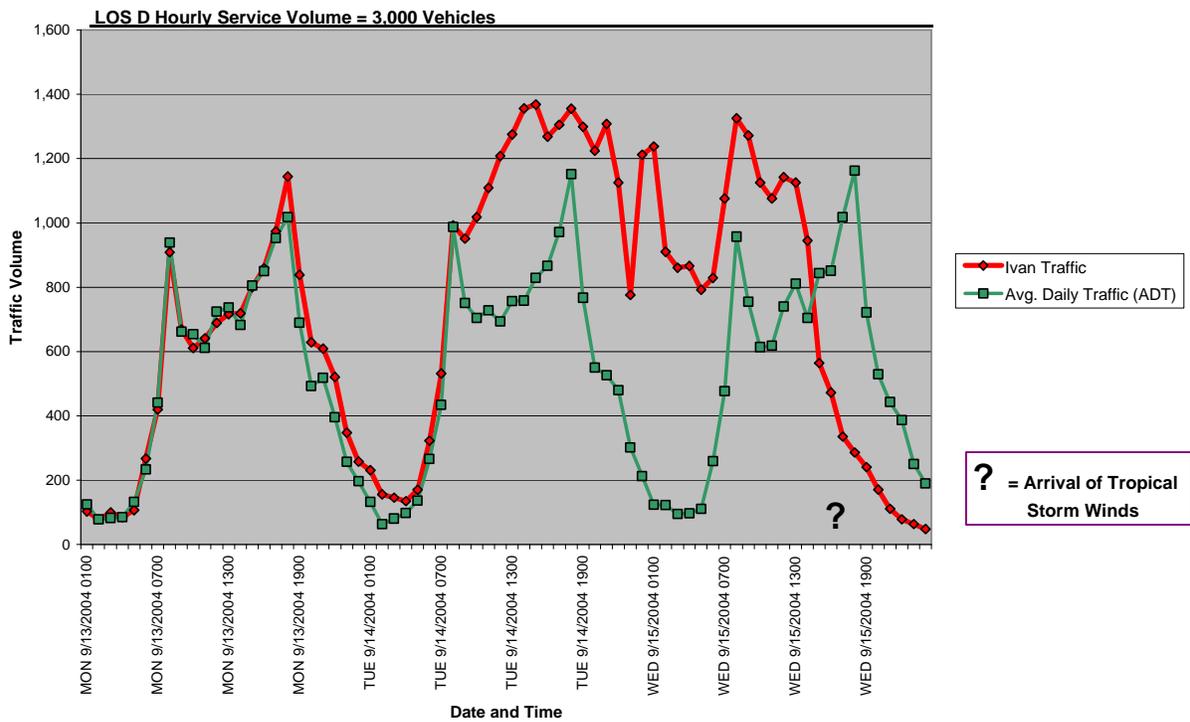
counter locations at about 5:00 PM, the traffic levels had waned significantly and relatively few cars were on the roadways.

- Over the course of the entire Hurricane Ivan evacuation event, the traffic counter in Pearl River County recorded that 22,800 additional vehicles over ADT, probably mostly from Louisiana, used that segment of I-59. On the other hand the Forrest County sensor counted approximately 17,500 vehicles above average traffic volumes, which indicates that possibly as many as 5,300 of them ended their evacuation trips in Hattiesburg, Mississippi.
- Using these vehicle figures on I-59 to assess ETIS and the Bi-State Models information does not provide any definitive answers. Based on the description of what areas were evacuated in Louisiana, the scenarios chosen to represent the kind of evacuation that really happened during this storm appear to be low compared to the numbers that were actually generated. The description of the areas requested to evacuate in many Parishes in Louisiana do not coincide with the type of response they got from the public. This underassessment of the level of evacuation and participation rates from Louisiana parishes would lead to the numerous observations from local officials there that the traffic congestion and volumes experienced during Ivan were not anticipated. In table 3 below the scenario used to determine the Bi-State numbers based on the survey information from local officials yielded a forecast of 11,798 vehicles (for a low occupancy, slow cat 1/fast cat 2 scenario). It appears that the numbers documented by the traffic counter in Pearl River County, Mississippi, indicate that a slow cat 2 / fast cat 3 with low tourist occupancy may have been a more appropriate choice for selecting the numbers to use. If that is indeed the case, then there is reasonably good agreement between the numbers in the Bi-State Model and the traffic counter figures. Unfortunately, using the higher scenario in the Bi-State model results in forecast numbers much higher north of Hattiesburg than were actually recorded at the Forrest County traffic site.

**Figure 24. Ivan - Mississippi - I-59 Northbound in Pearl River County**



**Figure 25. Ivan - Mississippi - I-59 Northbound in Forrest County**

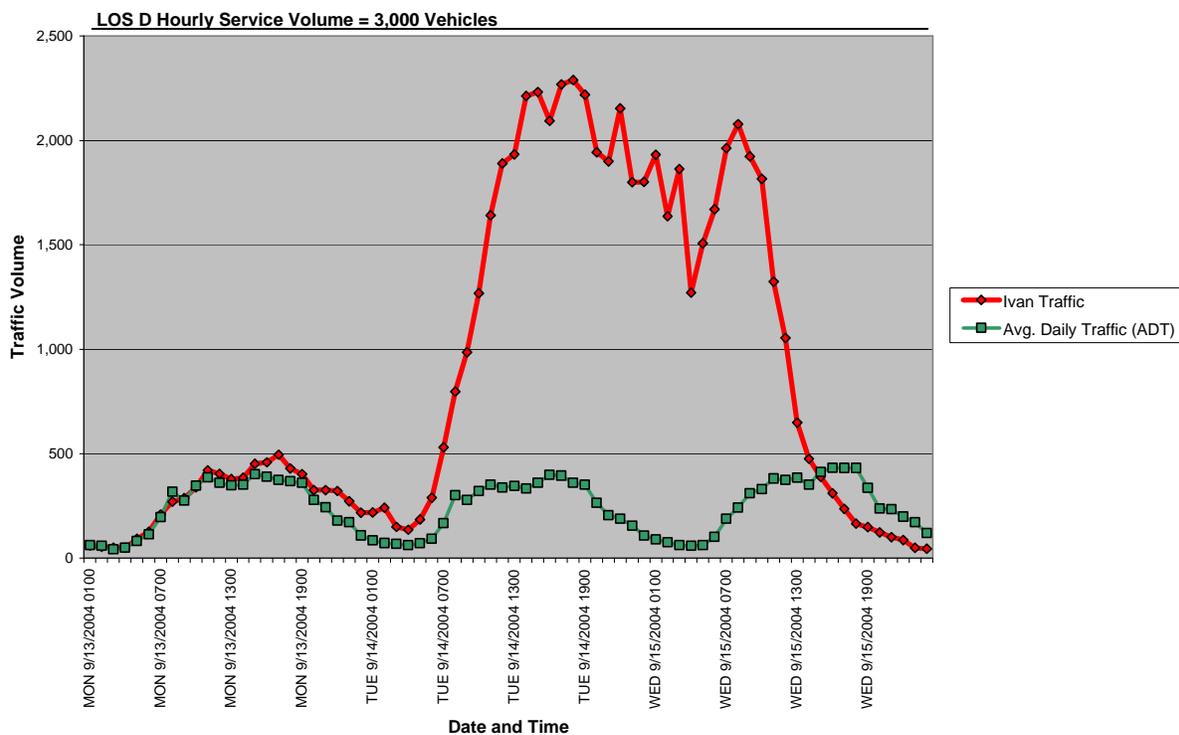


**I-55 Northbound in Pike County**

- Like I-59, I-55 is an evacuation route primarily used by evacuees from the parishes in southeast Louisiana. Although this counter which is located just north of the Mississippi – Louisiana border in Pike County, it data reveals more about the situation that occurred in the neighboring state than it does about the state in which it is located.
- Similar to the traffic loading schemes evidenced at almost all other traffic counters in Mississippi, increases to traffic volumes over normal levels was apparent, but the overall number relative to entire mass of vehicles was very small. Nonetheless, a discernable increase in the number of vehicles over average daily traffic was evident beginning at 11:00 AM on September 13. This small increase occurred approximately three hours before the same small increases became apparent on I-59. Once the traffic volumes surpassed the ADT levels at this counter on I-55 they remained very elevated until 2:00 PM on September 15<sup>th</sup>, 2004.
- At 5:00 AM on Tuesday, September 14<sup>th</sup> the hourly count of vehicles at this traffic counter started to grow geometrically. From that time to noon on the same day, hourly vehicle counts went from 289 to 1,933 and by 6:00 PM that evening they had risen still further to peak at 2,289. Of the next 18 hours, ending at 8:00 AM on Wednesday, September 15<sup>th</sup>, eight of them had vehicle totals of 2,000 vehicles or more per hour. That figure, although not high relative to the hourly evacuation service volume for that roadway, did constitute approximately two-thirds of that capacity. The duration of these high volume hours may well have resulted in congestion and other problems with traffic flow at this location. However, that cannot be confirmed without the average speed data for this counter site.
- By 3:00 PM on September 15<sup>th</sup>, the hourly vehicle totals dropped to levels below normal daily averages and they remained that way for the rest of the day. Had tropical storm winds actually arrived at the counter location, the vehicles totals would have been below normal levels.
- During the 47 hours of higher than normal vehicle counts during Hurricane Ivan, this counter tallied 46,400 additional vehicles over ADT figures, the highest total of any counter in all three states.
- As with the sites on I-59, the vehicle totals recorded at this site were very high relative to the numbers forecasted for that roadway segment in the Bi-State and ETIS models. As discussed earlier these discrepancies (see Table 3) may be more a function of the level of evacuation

and participation rates estimates as opposed to an inherent problem with the study or modeling methodology. Based on the description by local officials regarding what areas were directed to evacuate, there were few counties or parishes that actually evacuated to the level that was probably warranted by the hurricane itself. Furthermore, there was little apparent consensus among local governments regarding to what level their populations should evacuate. It appears that this situation caused the public to make their own decisions regarding their protective actions, so they evidently decided to evacuate before they were probably directed to and they did not seem to heed what areas were supposed to evacuate. These situational wild cards are difficult for most models to emulate, especially when the information used for the inputs is not complete.

**Figure 26. Ivan - Mississippi - I-55 Northbound in Pike County**



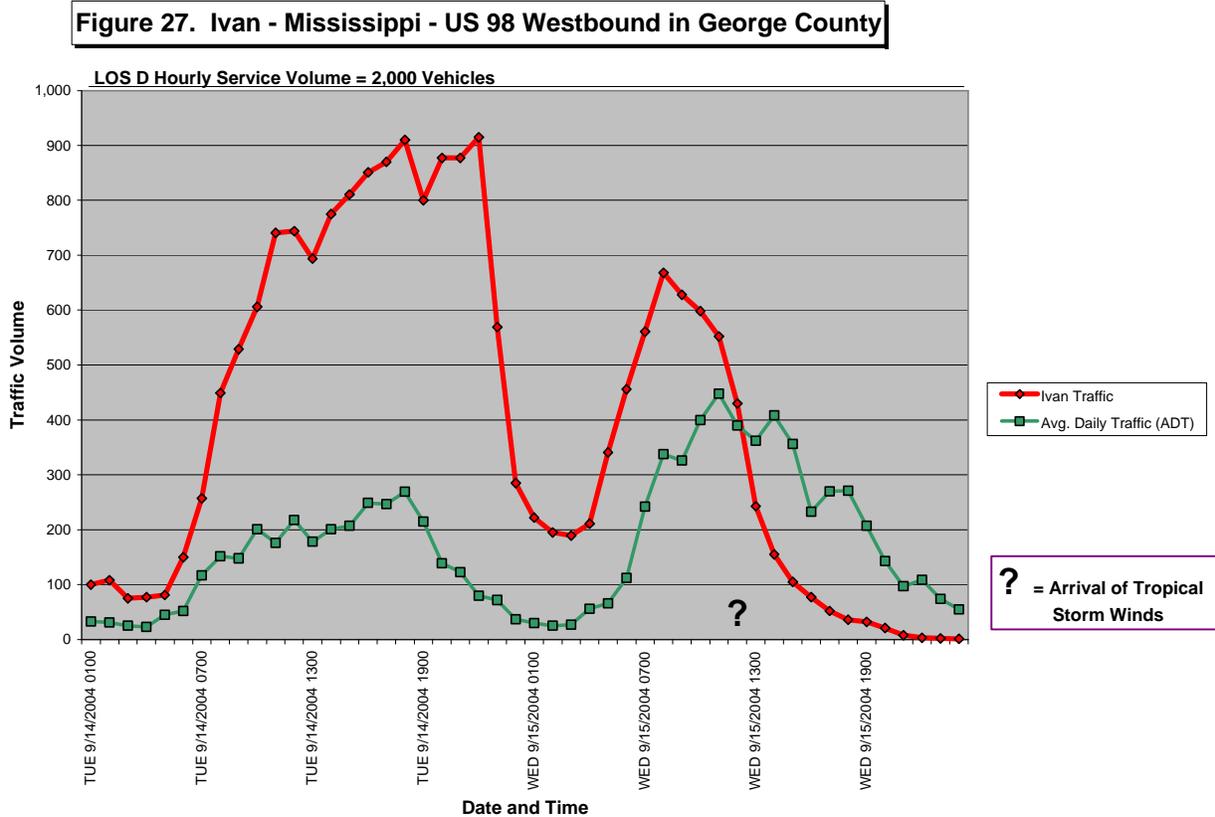
### US 98 Westbound in George County

- This traffic counter in the westbound lanes of US 98 in George County (see Figure 27), like the sensors on I-59 and I-55 does not provide information on evacuations in Mississippi. Rather, its location is more conducive to ascertaining the status on evacuations in another

state, this time the neighboring state to the east – Alabama. In fact, the site of this sensor is just to the west of the Mississippi – Alabama state line on US 98 and is therefore well situated to monitor the status of traffic leaving the city of Mobile on that roadway. Almost no vehicles starting their evacuation trip in Mississippi would have the opportunity to use the roadway segment covered by this traffic counter.

- According to the data collected at this station on the days preceding the arrival of Hurricane Ivan, the evacuation may have already been partially underway when it became operational at 1:00 AM on Tuesday, September 14<sup>th</sup>, 2004. Almost immediately upon being activated the sensor recorded that 67 more vehicles than the average daily traffic counts were using that portion of westbound US 98 in the first hour. From that point on until noon on Wednesday, September 15<sup>th</sup>, the measured traffic volumes remained higher than the hourly average values.
- The observed traffic volumes starting at 5:00 AM on Tuesday, September 14<sup>th</sup> began to depart dramatically from the normal ADT figures, rising from 81 to 741 vehicles an hour by 11:00 AM. The peak hour of traffic volume occurred at 10:00 PM that same evening with a reading of 915 vehicles. This peak value complimented another nearly as high hourly volume of 910 vehicles measured four hours earlier at 6:00 PM.
- Without average hourly traffic data to accompany the hourly traffic volumes a definitive statement regarding the flow of traffic during these heavy travel demand hours cannot be made. Traffic volumes and the duration of those high values could combine to hinder the free flow of traffic on this particular segment of roadway, but there is no concrete data to that effect from the sensor information at hand. The eight hours of traffic volumes at 80% of the hourly evacuation service volume may have indeed made the passage of vehicles difficult during that time, but there is no evidence to that effect.
- The traffic volumes had already started to wane by the time the tropical storm force winds were estimated to reach the location of that traffic counter. Noon on Wednesday, September 15<sup>th</sup> was the last hour of above average traffic volumes and also the arrival time of the winds. Traffic continued to decrease until it reached single digit counts at 9:00 PM on the 15<sup>th</sup>.
- Unfortunately, the total number of vehicles that used this segment of US 98 is not complete since it is missing all of the elevated figures that were probably evident on Monday, September 13<sup>th</sup>. Like the other counters though, it is likely that a majority of the vehicles that used this roadway to evacuate from Hurricane Ivan did so on Tuesday and Wednesday. In

that respect, at least 12,504 vehicles over ADT figures crossed into Mississippi on US 98 from Alabama. For the entire three day period around Hurricane Ivan, the ETIS travel demand forecast was 28,408 total vehicles, but without Monday's traffic counts it is not possible to see how close those figures were to the actual values collected at the site.



### A Special Note about Louisiana Traffic Data

- Unfortunately, traffic counter data for Louisiana during Hurricane Ivan was not available at the time this report was prepared. Therefore, the only data to relate is anecdotal information provided by the local emergency management officials during the associated post storm surveys. Based on the information from the parishes, although I-10 was contra-flowed westbound between New Orleans and Baton Rouge, it does not appear that it helped greatly in reducing congestion during the evacuation period before Hurricane Ivan. This assertion cannot be supported with any empirical data regarding traffic volumes on Louisiana's evacuation roadway network.. Furthermore there were reports of many other problematic roadways with respect to traffic flow and levels of congestion, but again these characterizations of traffic conditions on the other roadways cannot be corroborated with any hard data.

- The information from the traffic sensors in Mississippi on I-59 and I-55 shed some light on the general conduct of evacuations in Louisiana. From the data it does appear that a major evacuation occurred in that state, one that exceeded the expectations of local officials in the parishes. Although special traffic management operations were employed in Louisiana on I-10 westbound, none of the interstate highways between that state and Mississippi were contra-flowed or otherwise modified to enhance capacity during the evacuations for Hurricane Ivan.
- Local emergency management officials surveyed for this study effort noted that among the designated evacuation routes certain routes were noteworthy for their high volumes and other traffic flow issues. Although the characterizations are subjective, the traffic conditions reported below for the Hurricane Ivan event shed the only insight into those problematic roadway segments in the Southeastern Louisiana evacuation roadway network.
  - SR 39 in Plaquemines and St. Bernard Parishes was heavy.
  - SR 23 in Plaquemines Parish was described as having heavy traffic.
  - SR 46 in St. Bernard Parish was also described as having heavy traffic.
  - SR 47 was congested in St. Bernard Parish.
  - SR 1 was described as having heavy traffic in LaFourche Parish and as congested in Ascension Parish, but Assumption Parish in between the two indicated that traffic was light on their portion.
  - SR 308, an associated road to SR 1 was also characterized as experiencing heavy traffic in LaFourche Parish.
  - US 90 westbound was gridlocked according to St. James and LaFourche Parish officials, but only experienced heavy traffic conditions in Assumption Parish.
  - By the descriptions US 61 westbound alternated from gridlock in St Charles Parish to congested traffic conditions in St John the Baptist to St. James Parish where volumes were described as only heavy. Finally the situation was reported to have worsened and reverted back to gridlock conditions in Ascension Parish.
  - I-10 between Orleans Parish and St. John the Baptist Parish was described as gridlocked, whereas St. James Parish reported their portion was only congested. Unfortunately, the situation on that route reportedly reverted back to gridlock conditions in Ascension Parish. Interestingly, the parishes through which the I-10 west contraflow plan was implemented had the most critical characterizations for traffic conditions during the

event. Meanwhile, the next county after the terminus of the contraflow plan indicated that the traffic was congested, but not gridlocked.

- Orleans Parish reported that I-55 was gridlocked, but St. John the Baptist, in which the roadway is actually located, described the situation in their parish as congested. St Tammany also indicated that their perception of conditions on I-55, although in their Parish, were no more than heavy traffic.
- No parishes that were surveyed in Louisiana, even St. Tammany in which the roadway is located, noted any traffic issues on I-59. On the other hand, both of the surveyed Mississippi counties that have I-59 in their jurisdictions indicated that traffic was congested (Pearl River) or gridlocked (Forrest).
- I-12 was clearly impacted by this event and conveyed traffic volumes that were described as congested by St. Tammany Parish, in which the roadway is actually located, to gridlocked as reported by Orleans Parish.

#### **COMPARISON OF ETIS TRAVEL DEMAND AND CONGESTION LEVEL FORECASTS TO TTMS COUNTER DATA DURING HURRICANE IVAN**

- 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 Ivan.
- 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 Ivan 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 Ivan. 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 Ivan. 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.
- 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 Ivan, 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 Ivan. 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 Ivan:
  - 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 13<sup>th</sup>, 2004.
  - Other reasons for the discrepancies between the HES / ETIS roadway segment travel demand figures and the traffic counter totals during Hurricane Ivan 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 IVAN - FLORIDA Traffic Counter Timelines

Date	Advisory	Time	Situation / Conditions	0348	0359	0050	0328	0156	0156	0287	0218	0220	0238	0109	
				NB	NB	NB	NB	WB	EB	EB	EB	EB	EB	EB	EB
				US 29 Near Century	US 231 Near Fountain	US 231 Near AL Line	SR 71 Near Wewa-hitchka	I-10 Near AL Line	I-10 Near AL Line	I-10 Near Defuniak Springs	I-10 Near Marianna	I-10 Near Quincy	I-10 Near Live Oak	I-10 Near Baldwin	
Sunday September 12, 2004	Adv # 39 Cat 4	12:00 AM													
		1:00 AM													
		2:00 AM													
		3:00 AM													
		4:00 AM													
	Adv # 40 Cat 4	5:00 AM											71		
		6:00 AM					67						70		
		7:00 AM					68						72		
		8:00 AM					68						71		
		9:00 AM					68						73		
		10:00 AM					68						73		
	Adv # 41 Cat 4	11:00 AM	<ul style="list-style-type: none"> <li>Tropical Storm Watch issued from Marathon to Dry Tortugas, Cat 4</li> </ul>				68						73		
		12:00 PM					69						73		
		1:00 PM					68						74		
		2:00 PM					68						73		
		3:00 PM					69						74		
		4:00 PM					68						75		
	Adv # 42 Cat 4	5:00 PM					68						74		
		6:00 PM					68						75		
		7:00 PM					65					a	73	a	
8:00 PM						66					a	72	a		
9:00 PM						65					a	73	a		
Adv # 43 Cat 5	10:00 PM					64					a	72	a		
	11:00 PM	<ul style="list-style-type: none"> <li>Hurricane Ivan becomes a cat 5 with 160 MPH sustained winds</li> <li>72- hour forecast location is just off coast of Destin, FL as a cat 3</li> </ul>				64						74	72	73	
Monday September 13, 2004	Adv # 43 Cat 5	12:00 AM				64				b		74	71	72	
		1:00 AM				65				b		74	70	73	
		2:00 AM				64				b		74	70	71	
		3:00 AM				64				b		73	69	71	

Table 3a.

HURRICANE IVAN - FLORIDA Traffic Counter Timelines

Date	Advisory	Time	Situation / Conditions	0348	0359	0050	0328	0156	0156	0287	0218	0220	0238	0109	
				NB	NB	NB	NB	WB	EB	EB	EB	EB	EB	EB	EB
				US 29 Near Century	US 231 Near Fountain	US 231 Near AL Line	SR 71 Near Wewa-hitchka	I-10 Near AL Line	I-10 Near AL Line	I-10 Near Defuniak Springs	I-10 Near Marianna	I-10 Near Quincy	I-10 Near Live Oak	I-10 Near Baldwin	
Monday September 13, 2004	Adv # 44	4:00 AM				65			b		74	70	72		
	Cat 5 Adv # 44	5:00 AM				64			b		73	71	72		
		6:00 AM	• 72- hour forecast location shifted to AL/FL state line as a cat 3			65			b		72	72	72		
		7:00 AM				65			b		74	71	74		
		8:00 AM				66			b		73	70	73		
		9:00 AM			b	65	66		b	b	73	72	71	74	
		10:00 AM			b	66	67	60	b	b	74	73	70	74	
	Adv # 45 Cat 5	11:00 AM			b	65	66	60	b	b	74	74	71	74	
		12:00 PM	❖ Escambia County Issues Cat 5 Evacuation Order	❖ b	65	66	60		❖ b	b	73	72	71	74	
		1:00 PM		b	66	67	59		b	b	72	74	71	74	
		2:00 PM	❖ Bay County Issues Cat 3 Evacuation Order	b	❖ 65	67	59		b	b	73	73	71	73	
		3:00 PM		b	65	67	60		b	b	73	74	71	66	
		4:00 PM		b	67	68	60		b	b	73	74	72	73	
	Adv # 46 Cat 5	5:00 PM			b	65	67	60	b	b	73	74	73	75	
		6:00 PM			b	66	66	61	b	b	74	74	72	74	
		7:00 PM			b	64	65	58	b	b	73	74	72	74	a
		8:00 PM	• Hurricane Ivan brushes western tip of Cuba as a cat 5 (160 MPH)	b	64	64	56		b	b	71	72	73	73	a
		9:00 PM		b	65	65	59		b	b	73	68	73	71	a
10:00 PM			b	65	64	61		b	b	73	73	71	75	a	
Adv # 47	11:00 PM	• Hurricane Watch issued for St. Marks, FL to Point Chevreuil, LA	b	64	65	59		b	b	73	75	72	74	a	
Tuesday September 14, 2004	Adv # 47 Cat 5	12:00 AM		b	64	65	63	b	b	73	75	72	73	71	
		1:00 AM		b	64	64	53	b	b	73	75	72	73	71	
		2:00 AM		b	64	63	61	b	b	72	74	72	73	73	
		3:00 AM		b	62	62	58	b	b	72	75	73	73	72	
		4:00 AM		b	65	64	57	b	b	73	75	72	73	72	

Table 3a.

HURRICANE IVAN - FLORIDA Traffic Counter Timelines

Date	Advisory	Time	Situation / Conditions	0348	0359	0050	0328	0156	0156	0287	0218	0220	0238	0109
				NB	NB	NB	NB	WB	EB	EB	EB	EB	EB	EB
				US 29 Near Century	US 231 Near Fountain	US 231 Near AL Line	SR 71 Near Wewa-hitchka	I-10 Near AL Line	I-10 Near AL Line	I-10 Near Defuniak Springs	I-10 Near Marianna	I-10 Near Quincy	I-10 Near Live Oak	I-10 Near Baldwin
Tuesday September 14, 2004	Adv # 48 Cat 4	5:00 AM		b	64	65	58	b	b	69	72	71	73	73
		6:00 AM		b	65	66	58	b	b	70	74	72	72	72
		7:00 AM		b	65	66	59	b	b	72	73	72	73	73
		8:00 AM	• Hurricane Ivan downgraded to cat 4	b	65	66	60	b	b	72	73	71	74	73
		9:00 AM		b	65	67	61	b	b	72	72	72	74	72
		10:00 AM		b	63	66	58	b	b	72	70	71	74	72
	Adv # 49 Cat 4	11:00 AM		b	64	67	58	b	b	72	68	70	73	71
		12:00 PM		b	65	66	58	b	b	69	68	68	73	70
		1:00 PM		b	64	67	60	b	b	70	65	66	72	71
		2:00 PM		b	66	66	58	b	b	68	66	64	73	71
		3:00 PM		b	65	67	61	b	b	44	63	52	74	68
	4:00 PM		b	66	66	60	b	b	40	64	31	74	68	
	Adv # 50 Cat 4	5:00 PM	<ul style="list-style-type: none"> <li>Hurricane Warning posted for Apalachicola, FL to Port Fourchon, LA</li> <li>Hurricane Watch issued for Port Fourchon, LA to Point Chevreuil, LA</li> <li>Tropical Storm Warning from St. Marks, FL to Crystal River, FL</li> </ul>	b	66	67	59	b	b	71	57	35	71	67
		6:00 PM		b	65	66	59	b	b	72	67	46	69	69
		7:00 PM		b	64	64	59	b	b	71	69	39	70	72
		8:00 PM		b	64	65	59	b	b	70	70	33	69	71
9:00 PM			b	64	64	59	b	b	71	69	27	65	71	
10:00 PM			b	64	63	59	b	b	72	69	10	66	70	
11:00 PM			b	64	64	61	b	b	71	71	59	65	71	
Wednesday September 15, 2004	Adv # 51 Cat 4	12:00 AM		b	63	64	54	b	b	71	72	68	69	69
		1:00 AM		b	64	64	65	b	b	70	72	69	70	56
		2:00 AM		b	62	63	55	b	b	71	72	69	72	70
		3:00 AM		b	66	63	64	b	b	71	72	70	72	72
		4:00 AM		b	65	65	60	b	b	71	73	69	71	72

Table 3a.

HURRICANE IVAN - FLORIDA Traffic Counter Timelines

Date	Advisory	Time	Situation / Conditions	0348	0359	0050	0328	0156	0156	0287	0218	0220	0238	0109	
				NB	NB	NB	NB	WB	EB	EB	EB	EB	EB	EB	EB
				US 29 Near Century	US 231 Near Fountain	US 231 Near AL Line	SR 71 Near Wewa-hitchka	I-10 Near AL Line	I-10 Near AL Line	I-10 Near Defuniak Springs	I-10 Near Marianna	I-10 Near Quincy	I-10 Near Live Oak	I-10 Near Baldwin	
Wednesday September 15, 2004	Adv # 52 Cat 4	5:00 AM	• Tropical Storm force winds arrive at mouth of the Mississippi River	b	65	65	58			70	72	70	71	73	
		6:00 AM		b	64	65	60			70	71	70	72	71	
		7:00 AM		b	63	66	59			71	71	71	72	71	
		8:00 AM	• Tropical Storm force winds arrive at Baldwin Co., AL and Escambia Co., FL	b	63	66	60			71	70	70	72	72	
		9:00 AM		b	63	65	59			71	71	69	73	72	
		10:00 AM		b	64	66	58			71	70	69	73	71	
	Adv # 53 Cat 4	11:00 AM	• Entire coast in Hurricane Warning area under Tropical Storm wind conditions	b	63	66	59			71	70	69	73	70	
		12:00 PM				66	59			69	69	68	73	71	
		1:00 PM								70	69	73	70		
		2:00 PM									70	73	71		
		3:00 PM									70	74			
		4:00 PM										74			
	Adv # 54 Cat 4 Adv # 54 Cat 4	5:00 PM	• Hurricane force winds arrive at mouth of the Mississippi River • 58 MPH winds arrive at Baldwin Co., AL and Escambia Co., FL												
		6:00 PM													
		7:00 PM	• Hurricane force winds arrive at Baldwin Co., AL												
		8:00 PM													
		9:00 PM	• Hurricane force winds arrive at Escambia Co., FL												
		10:00 PM													
Adv # 55	11:00 PM														

Table 3a.

HURRICANE IVAN - FLORIDA Traffic Counter Timelines

Date	Advisory	Time	Situation / Conditions	0348	0359	0050	0328	0156	0156	0287	0218	0220	0238	0109
				NB	NB	NB	NB	WB	EB	EB	EB	EB	EB	EB
				US 29 Near Century	US 231 Near Fountain	US 231 Near AL Line	SR 71 Near Wewa-hitchka	I-10 Near AL Line	I-10 Near AL Line	I-10 Near Defuniak Springs	I-10 Near Marianna	I-10 Near Quincy	I-10 Near Live Oak	I-10 Near Baldwin
Thursday September 16, 2004	Adv # 55 Cat 4 to 3	12:00 AM												
		1:00 AM												
		2:00 AM												
		3:00 AM	<ul style="list-style-type: none"> <li>Hurricane Ivan makes landfall at Dauphin Island, AL as a cat 3 (130 MPH)</li> </ul>											
		4:00 AM												
	Adv # 56 Cat 3 to 1	5:00 AM	<ul style="list-style-type: none"> <li>Eye over Baldwin Co., AL as a cat 3 (115 MPH)</li> </ul>											
		6:00 AM												
		7:00 AM												
		8:00 AM	<ul style="list-style-type: none"> <li>Eye over Clark Co., AL as a cat 1 (80 MPH)</li> </ul>											
		9:00 AM												
	Adv # 57 Tropical Storm	10:00 AM												
		11:00 AM	<ul style="list-style-type: none"> <li>Eye over Wilcox Co., AL as a cat 1 (75 MPH)</li> <li>Hurricane Warning dropped for Tropical Storm Watch from Pearl River to Apalachicola, FL</li> </ul>											
		12:00 PM												
		1:00 PM												
		2:00 PM	<ul style="list-style-type: none"> <li>Ivan downgraded to Tropical Storm</li> <li>Center over Perry Co., AL</li> </ul>											
	Adv # 58 Tropical Storm	3:00 PM												
4:00 PM														
5:00 PM		<ul style="list-style-type: none"> <li>Center over Bibb Co., AL</li> </ul>												
6:00 PM														
		7:00 PM												
		8:00 PM												

**Table 3a.**

**HURRICANE IVAN - FLORIDA Traffic Counter Timelines**

Date	Advisory	Time	Situation / Conditions	0348	0359	0050	0328	0156	0156	0287	0218	0220	0238	0109
				NB	NB	NB	NB	WB	EB	EB	EB	EB	EB	EB
				US 29 Near Century	US 231 Near Fountain	US 231 Near AL Line	SR 71 Near Wewa-hitchka	I-10 Near AL Line	I-10 Near AL Line	I-10 Near Defuniak Springs	I-10 Near Marianna	I-10 Near Quincy	I-10 Near Live Oak	I-10 Near Baldwin
Thursday September 16, 2004	Adv # 58	9:00 PM												
		10:00 PM												
	Adv # 59	11:00 PM	<ul style="list-style-type: none"> <li>Ivan downgraded to Tropical Depression</li> <li>Center over Marshall Co., AL</li> </ul>											
Total Number of Hours Above Average Daily Traffic (ADT) Volume				50	48	47	40	34	31	47	52	65	53	37
Hourly Evacuation Directional Service Volume (X 1,000 Vehicles per Hour)				1.9	1.9	1.9	.8	3.4	3.4	3.0	3.0	3.0	3.0	3.2
ADT Volume for Evacuation Period (X 1,000 Vehicles)				7.8	9.7	17.7	2.5	22.8	12.0	16.8	22.8	27.5	18.7	31.8
Total Number of Vehicles Recorded During Evacuation period (X 1,000 Vehicles)				19.8	19.4	29.8	4.5	33.2	14.6	53.9	62.1	65.3	43.8	43.9
Difference Between Recorded and ADT Volume During Evacuation (X 1,000 Vehicles)				12.0	9.8	12.1	2.0	10.4	2.6	37.1	39.3	37.8	25.1	12.1

- Light green = recorded hourly value for traffic counter above hourly average daily traffic (ADT) figures, but not above standard deviation.
- Green boxes = traffic counter recorded hourly value above standard deviation for (ADT) figures.
- Red boxes = recorded peak at traffic counter for event.
- Shaded green boxes indicate hours when average speed dropped substantially lower than posted speed limit.
- ❖ This symbol in the boxes indicates when an evacuation order was issued that directly impacted the readings at that traffic counter.
- Blue boxes in each counter column indicate the hour tropical storm force winds arrived at the specific counter location according to the NHC advisories and HURREVAC. No boxes in the counter columns indicate that tropical storm force winds probably did not arrive at the counter location.

a Traffic sensor not operational, but indications exist that higher than ADT traffic volumes may have been prevalent during period  
 b Figures not provided since this segment of I-65 was reversed lane and there are no ADT figures for that scenario.

**Table 3b.**

**HURRICANE IVAN - ALABAMA Traffic Counter Timelines**

Date	Advisory	Time	Situation / Conditions	I-10 WB in Baldwin Co.	I-10 EB in Baldwin Co.	I-65 NB in Baldwin Co.	I-65 SB in Baldwin Co.	US 231 NB In Pike Co.	US 431 NB In Barbour Co.	US 43 NB In Mobile Co.
Sunday September 12, 2004	Adv # 39 Cat 4	12:00 AM								
		1:00 AM								
		2:00 AM								
		3:00 AM								
		4:00 AM								
	Adv # 40 Cat 4	5:00 AM								
		6:00 AM								
		7:00 AM								
		8:00 AM								
		9:00 AM								
	Adv # 41 Cat 4	10:00 AM								
		11:00 AM	<ul style="list-style-type: none"> <li>• Tropical Storm Watch issued from Marathon to Dry Tortugas, Cat 4</li> </ul>							
		12:00 PM								
		1:00 PM								
		2:00 PM								
	Adv # 42 Cat 4	3:00 PM								
		4:00 PM								
		5:00 PM								
		6:00 PM								
		7:00 PM								
		8:00 PM								

**Table 3b.**

**HURRICANE IVAN - ALABAMA Traffic Counter Timelines**

Date	Advisory	Time	Situation / Conditions	I-10 WB in Baldwin Co.	I-10 EB in Baldwin Co.	I-65 NB in Baldwin Co.	I-65 SB in Baldwin Co.	US 231 NB in Pike Co.	US 431 NB in Barbour Co.	US 43 NB in Mobile Co.
Sunday September 12, 2004	Adv # 43 Cat 5	11:00 PM	<ul style="list-style-type: none"> <li>Hurricane Ivan becomes a cat 5 with 160 MPH sustained winds</li> <li>72- hour forecast location is just off coast of Destin, FL as a cat 3</li> </ul>							
Monday September 13, 2004	Adv # 43 Cat 5	12:00 AM								
		1:00 AM								
		2:00 AM								
		3:00 AM								
		4:00 AM								
	Adv # 44 Cat 5 Adv # 44 Cat 5	5:00 AM								
		6:00 AM	<ul style="list-style-type: none"> <li>72- hour forecast location shifted to AL/FL state line as a cat 3</li> </ul>							
		7:00 AM								
		8:00 AM								
		9:00 AM								
	Adv # 45 Cat 5	10:00 AM								
		11:00 AM								
		12:00 PM								
		1:00 PM								
		2:00 PM								
	Adv # 46 Cat 5	3:00 PM								
		4:00 PM								
		5:00 PM								
6:00 PM										
7:00 PM										
Adv # 47 Cat 5	8:00 PM	<ul style="list-style-type: none"> <li>Hurricane Ivan brushes western tip of Cuba as a cat 5</li> </ul>								
	9:00 PM									
	10:00 PM									
	11:00 PM	<ul style="list-style-type: none"> <li>Hurricane Watch issued for St. Marks, FL to Point Chevreuil, LA</li> </ul>								
Tuesday September 14, 2004	Adv # 47 Cat 5	12:00 AM								
		1:00 AM								
		2:00 AM								

Table 3b.

HURRICANE IVAN - ALABAMA Traffic Counter Timelines

Date	Advisory	Time	Situation / Conditions	I-10 WB In Baldwin Co.	I-10 EB In Baldwin Co.	I-65 NB In Baldwin Co.	I-65 SB In Baldwin Co.	US 231 NB In Pike Co.	US 431 NB In Barbour Co.	US 43 NB In Mobile Co.	
Tuesday September 14, 2004	Adv # 47 Cat 5	3:00 AM									
		4:00 AM									
	Adv # 48 Cat 4	5:00 AM									
		6:00 AM									
		7:00 AM									
		8:00 AM	<ul style="list-style-type: none"> <li>Hurricane Ivan downgraded to cat 4</li> </ul>								
		9:00 AM									
	Adv # 49 Cat 4	10:00 AM	<ul style="list-style-type: none"> <li>❖ Mobile County, AL, Issues Cat 3 Evacuation Order</li> </ul>								
		11:00 AM									
		12:00 PM									
		1:00 PM									
		2:00 PM									
		3:00 PM									
	Adv # 50 Cat 4	4:00 PM									
		5:00 PM	<ul style="list-style-type: none"> <li>Hurricane Warning posted for Apalachicola, FL to Port Fourchon, LA</li> <li>Hurricane Watch issued for Port Fourchon, LA to Point Chevreuil, LA</li> <li>Tropical Storm Warning from St. Marks, FL to Crystal River, FL</li> </ul>								
		6:00 PM									
		7:00 PM									
8:00 PM											
9:00 PM											
Adv # 51	10:00 PM										
	11:00 PM										
Wednesday September 15, 2004	Adv # 51 Cat 4	12:00 AM									
		1:00 AM									
		2:00 AM									
		3:00 AM									
	4:00 AM										
Adv # 52 Cat 4	5:00 AM	<ul style="list-style-type: none"> <li>Tropical Storm force winds arrive at mouth of the Mississippi River</li> </ul>									

**Table 3b.**

**HURRICANE IVAN - ALABAMA Traffic Counter Timelines**

Date	Advisory	Time	Situation / Conditions	I-10 WB In Baldwin Co.	I-10 EB In Baldwin Co.	I-65 NB In Baldwin Co.	I-65 SB In Baldwin Co.	US 231 NB In Pike Co.	US 431 NB In Barbour Co.	US 43 NB In Mobile Co.
Wednesday September 15, 2004	Adv # 52 Cat 4	6:00 AM	<ul style="list-style-type: none"> <li>Alabama Reverse Lane Operation Order Issued</li> </ul>							
		7:00 AM								
		8:00 AM	<ul style="list-style-type: none"> <li>Tropical Storm force winds arrive at Baldwin Co., AL and Escambia Co., FL</li> </ul>							
		9:00 AM	<ul style="list-style-type: none"> <li>Alabama Reverse Lane Operation Traffic Begins</li> </ul>							
	Adv # 53 Cat 4	10:00 AM								
		11:00 AM	<ul style="list-style-type: none"> <li>Entire coast in Hurricane Warning area under Tropical Storm wind conditions</li> </ul>							
		12:00 PM								
		1:00 PM								
		2:00 PM	<ul style="list-style-type: none"> <li>Alabama Reverse Lane Operation Traffic Ended</li> </ul>							
		3:00 PM								
	Adv # 54 Cat 4	5:00 PM	<ul style="list-style-type: none"> <li>Hurricane force winds arrive at mouth of the Mississippi River</li> <li>58 MPH winds arrive at Baldwin Co., AL and Escambia Co., FL</li> </ul>							
		6:00 PM								
		7:00 PM	<ul style="list-style-type: none"> <li>Hurricane force winds arrive at Baldwin Co., AL</li> </ul>							
		8:00 PM								
9:00 PM		<ul style="list-style-type: none"> <li>Hurricane force winds arrive at Escambia Co., FL</li> </ul>								
Adv # 55	10:00 PM									
Thursday September 16, 2004	Adv # 55 Cat 4 to 3	12:00 AM								
		1:00 AM								
		2:00 AM								
	Adv # 56	3:00 AM	<ul style="list-style-type: none"> <li>Hurricane Ivan makes landfall at Dauphin Island, AL as a cat 3 (130 MPH)</li> </ul>							
		4:00 AM								
		5:00 AM	<ul style="list-style-type: none"> <li>Eye over Baldwin Co., AL as a cat 3 (115 MPH)</li> </ul>							
	6:00 AM									

**Table 3b.**

**HURRICANE IVAN - ALABAMA Traffic Counter Timelines**

Date	Advisory	Time	Situation / Conditions	I-10 WB In Baldwin Co.	I-10 EB in Baldwin Co.	I-65 NB In Baldwin Co.	I-65 SB in Baldwin Co.	US 231 NB In Pike Co.	US 431 NB In Barbour Co.	US 43 NB In Mobile Co.
Thursday September 16, 2004	Adv # 56 Cat 3 to 1	7:00 AM								
		8:00 AM	• Eye over Clark Co., AL as a cat 1 (80 MPH)							
		9:00 AM								
		10:00 AM								
	Adv # 57 Tropical Storm	11:00 AM	• Eye over Wilcox Co., AL as a cat 1 (75 MPH) • Hurricane Warning dropped for Tropical Storm Watch from Pearl River to Apalachicola, FL							
		12:00 PM								
		1:00 PM								
		2:00 PM	• Ivan downgraded to Tropical Storm • Center over Perry Co., AL							
		3:00 PM								
	Adv # 58 Tropical Storm	4:00 PM								
		5:00 PM	• Center over Bibb Co., AL							
		6:00 PM								
		7:00 PM								
		8:00 PM								
	Adv # 59	9:00 PM								
10:00 PM										
	Adv # 59	11:00 PM	• Ivan downgraded to Tropical Depression • Center over Marshall Co., AL							
Total Number of Hours Above Average Daily Traffic (ADT) Volume				45	51	48	3	54	51	27
Hourly Evacuation Directional Service Volume (In Thousands of Vehicles per Hour)				3.2	3.2	3.2	3.2	2.0	1.0	1.0
ADT Volume for Evacuation Period (X 1,000 Vehicles)				20.2	19.1	17.7	<sup>a</sup>	20.1	9.5	7.4
Total Number of Vehicles Recorded During Evacuation period (X 1,000 Vehicles)				34.5	24.5	53.8	4.3	25.4	16.6	15.3
Difference Between Recorded and ADT Volume During Evacuation (X 1,000 Vehicles)				14.4	4.7	35.1	<sup>a</sup>	4.7	7.1	8.0

- Green boxes = traffic counter recorded hourly value above hourly average daily traffic (ADT) figures.
- Red boxes = recorded peak at traffic counter for event.
- Blue boxes in each counter column indicate the hour tropical storm force winds arrived at the specific counter location according to the NHC advisories and HURREVAC. No boxes in the counter columns indicate that tropical storm force winds probably did not arrive at the counter location.

a Figures not provided since this segment of I-65 was reversed lane and there are no ADT figures for that scenario.

Table 3c.

HURRICANE IVAN - MISSISSIPPI Traffic Counter Timelines

Date	Advisory	Time	Situation / Conditions	I-10 WB In Jackson Co.	I-10 EB In Jackson Co.	MS 63 NB In Jackson Co.	US 49 NB In Stone Co.	US 49 NB In Rankin Co.	I-59 NB In Pearl River Co.	I-59 NB In Forrest Co.	I-55 NB In Pike Co.	US 98 WB In George Co.	
Sunday September 12, 2004	Adv # 39 Cat 4	12:00 AM											
		1:00 AM											
		2:00 AM											
		3:00 AM											
		4:00 AM											
	Adv # 40 Cat 4	5:00 AM											
		6:00 AM											
		7:00 AM											
		8:00 AM											
		9:00 AM											
	Adv # 41 Cat 4	10:00 AM											
		11:00 AM	<ul style="list-style-type: none"> <li>Tropical Storm Watch issued from Marathon to Dry Tortugas, Cat 4</li> </ul>										
		12:00 PM											
		1:00 PM											
		2:00 PM											
	Adv # 42 Cat 4	3:00 PM											
		4:00 PM											
		5:00 PM											
		6:00 PM											
		7:00 PM											
Adv # 43 Cat 5	8:00 PM												
	9:00 PM												
	10:00 PM												
Monday September 13, 2004	Adv # 43 Cat 5	11:00 PM	<ul style="list-style-type: none"> <li>Hurricane Ivan becomes a cat 5 with 160 MPH sustained winds</li> <li>72- hour forecast location is just off coast of Destin, FL as a cat 3</li> </ul>										
		12:00 AM											
		1:00 AM											
		2:00 AM											
		3:00 AM											

Table 3c.

HURRICANE IVAN - MISSISSIPPI Traffic Counter Timelines

Date	Advisory	Time	Situation / Conditions	I-10 WB In Jackson Co.	I-10 EB In Jackson Co.	MS 63 NB In Jackson Co.	US 49 NB In Stone Co.	US 49 NB In Rankin Co.	I-59 NB In Pearl River Co.	I-59 NB In Forrest Co.	I-55 NB In Pike Co.	US 98 WB In George Co.	
Monday September 13, 2004	Adv # 43	4:00 AM											
	Adv # 44 Cat 5	5:00 AM											
		6:00 AM	<ul style="list-style-type: none"> <li>72- hour forecast location shifted to AL/FL state line as a cat 3</li> </ul>										
		7:00 AM											
		8:00 AM											
		9:00 AM											
		10:00 AM											
	Adv # 45 Cat 5	11:00 AM											
		12:00 PM											
		1:00 PM											
		2:00 PM											
		3:00 PM	<ul style="list-style-type: none"> <li>Jackson County, MS, Issues Cat 3 Evacuation Order</li> </ul>	❖	❖	❖							
	4:00 PM												
	Adv # 46 Cat 5	5:00 PM											
		6:00 PM											
		7:00 PM											
		8:00 PM	<ul style="list-style-type: none"> <li>Hurricane Ivan brushes western tip of Cuba as a cat 5</li> </ul>										
9:00 PM													
Adv # 47 Cat 5	10:00 PM												
Adv # 47 Cat 5	11:00 PM	<ul style="list-style-type: none"> <li>Hurricane Watch issued for St. Marks, FL to Point Chevreuil, LA</li> </ul>										a	
Tuesday September 14, 2004	Adv # 47 Cat 5	12:00 AM						a					
		1:00 AM					a						
		2:00 AM					a						
		3:00 AM					a						
		4:00 AM					a						
	Adv # 48 Cat 4	5:00 AM						a					
		6:00 AM						a					
		7:00 AM						a					
		8:00 AM	<ul style="list-style-type: none"> <li>Hurricane Ivan downgraded to cat 4</li> </ul>					a					
9:00 AM							a						

Table 3c.

HURRICANE IVAN - MISSISSIPPI Traffic Counter Timelines

Date	Advisory	Time	Situation / Conditions	I-10 WB In Jackson Co.	I-10 EB In Jackson Co.	MS 63 NB In Jackson Co.	US 49 NB In Stone Co.	US 49 NB In Rankin Co.	I-59 NB In Pearl River Co.	I-59 NB In Forrest Co.	I-55 NB In Pike Co.	US 98 WB In George Co.
Tuesday September 14, 2004	Adv # 48	10:00 AM					a					
	Adv # 49 Cat 4	11:00 AM										
		12:00 PM	❖ Harrison County, MS, Issues Cat 5 Evacuation Order					❖				
		1:00 PM										
		2:00 PM	• Louisiana One Way Operation on I-10 WB Begins									
		3:00 PM						a				
		4:00 PM						a				
	Adv # 50 Cat 4	5:00 PM	<ul style="list-style-type: none"> <li>Hurricane Warning posted for Apalachicola, FL to Port Fourchon, LA</li> <li>Hurricane Watch issued for Port Fourchon, LA to Point Chevreuil, LA</li> <li>Tropical Storm Warning from St. Marks, FL to Crystal River, FL</li> </ul>					a				
		6:00 PM										
		7:00 PM										
		8:00 PM										
		9:00 PM										
		10:00 PM										
Adv # 51	11:00 PM											
Wednesday September 15, 2004	Adv # 51 Cat 4	12:00 AM										
		1:00 AM										
		2:00 AM										
		3:00 AM										
		4:00 AM										
	Adv # 52 Cat 4	5:00 AM	• Tropical Storm force winds arrive at mouth of the Mississippi River									
		6:00 AM										
		7:00 AM										
		8:00 AM	• Tropical Storm force winds arrive at Baldwin Co., AL and Escambia Co., FL									
		9:00 AM										

Table 3c.

HURRICANE IVAN - MISSISSIPPI Traffic Counter Timelines

Date	Advisory	Time	Situation / Conditions	In Jackson Co. I-10 WB	In Jackson Co. I-10 EB	In Jackson Co. MS 63 NB	In Stone Co. US 49 NB	In Rankin Co. US 49 NB	In Pearl River Co. I-59 NB	In Forrest Co. I-59 NB	In Pike Co. I-55 NB	In George Co. US 98 WB	
Wednesday September 15, 2004	Adv # 52	10:00 AM											
	Adv # 53 Cat 4	11:00 AM	<ul style="list-style-type: none"> <li>Entire coast in Hurricane Warning area under Tropical Storm wind conditions</li> </ul>										
		12:00 PM											
		1:00 PM											
		2:00 PM											
		3:00 PM											
		4:00 PM											
	Adv # 54 Cat 4	5:00 PM	<ul style="list-style-type: none"> <li>Hurricane force winds arrive at mouth of the Mississippi River</li> <li>58 MPH winds arrive at Baldwin Co., AL and Escambia Co., FL</li> </ul>										
		6:00 PM											
		7:00 PM	<ul style="list-style-type: none"> <li>Hurricane force winds arrive at Baldwin Co., AL</li> </ul>										
		8:00 PM											
9:00 PM		<ul style="list-style-type: none"> <li>Hurricane force winds arrive at Escambia Co., FL</li> </ul>											
Adv # 55	10:00 PM												
	Adv # 55	11:00 PM											
Thursday September 16, 2004	Adv # 55 Cat 4 to 3	12:00 AM											
		1:00 AM											
		2:00 AM											
		3:00 AM	<ul style="list-style-type: none"> <li>Hurricane Ivan makes landfall at Dauphin Island, AL as a cat 3 (130 MPH)</li> </ul>										
		4:00 AM											
	Adv # 56 Cat 3 to 1	5:00 AM	<ul style="list-style-type: none"> <li>Eye over Baldwin Co., AL as a cat 3 (115 MPH)</li> </ul>										
		6:00 AM											
		7:00 AM											
		8:00 AM	<ul style="list-style-type: none"> <li>Eye over Clark Co., AL as a cat 1 (80 MPH)</li> </ul>										
		9:00 AM											
		10:00 AM											

**Table 3c.**

**HURRICANE IVAN - MISSISSIPPI Traffic Counter Timelines**

Date	Advisory	Time	Situation / Conditions	I-10 WB In Jackson Co.	I-10 EB In Jackson Co.	MS 63 NB In Jackson Co.	US 49 NB In Stone Co.	US 49 NB In Rankin Co.	I-59 NB In Pearl River Co.	I-59 NB In Forrest Co.	I-55 NB In Pike Co.	US 98 WB In George Co.	
Thursday September 16, 2004	Adv # 57 Tropical Storm	11:00 AM	<ul style="list-style-type: none"> <li>Eye over Wilcox Co., AL as a cat 1 (75 MPH)</li> <li>Hurricane Warning dropped for Tropical Storm Watch from Pearl River to Apalachicola, FL</li> </ul>										
		12:00 PM											
		1:00 PM											
		2:00 PM	<ul style="list-style-type: none"> <li>Ivan downgraded to Tropical Storm</li> <li>Center over Perry Co., AL</li> </ul>										
		3:00 PM											
	Adv # 58 Tropical Storm	4:00 PM											
		5:00 PM	<ul style="list-style-type: none"> <li>Center over Bibb Co., AL</li> </ul>										
		6:00 PM											
		7:00 PM											
		8:00 PM											
	Adv # 59 Tropical Depression	9:00 PM											
10:00 PM													
		11:00 PM	<ul style="list-style-type: none"> <li>Ivan downgraded to Tropical Depression</li> <li>Center over Marshall Co., AL</li> </ul>										
Total Number of Hours Above Average Daily Traffic (ADT) Volume				38	33	46	22	46	42	44	47	36 <sup>a</sup>	
Hourly Evacuation Directional Service Volume (In Thousands of Vehicles per Hour)				3.3	3.3	2.5	2.5	2.0	3.0	3.0	3.0	2.0	
ADT Volume for Evacuation Period (X 1,000 Vehicles)				16.8	23.3	7.3	7.2	22.8	21.3	23.3	11.2	5.7	
Total Number of Vehicles Recorded During Evacuation period (X 1,000 Vehicles)				29.3	29.9	20.1	26.3	57.3	44.1	40.7	57.6	18.2	
Difference Between Recorded and ADT Volume During Evacuation (X 1,000 Vehicles)				12.5	6.5	12.8	19.1	34.4	22.8	17.5	46.4	12.5	

- Green boxes = traffic counter recorded hourly value above hourly average daily traffic (ADT) figures.
- Red boxes = recorded peak at traffic counter for event.
- Blue boxes in each counter column indicate the hour tropical storm force winds arrived at the specific counter location according to the NHC advisories and HURREVAC. No boxes in the counter columns indicate that tropical storm force winds probably did not arrive at the counter location.

a Traffic sensor not operational, but indications exist that higher than ADT traffic volumes may have been prevalent during period

Table 4. HURRICANE IVAN ETIS / HES TO COUNTER COMPARISONS								
Roadway Segment With Traffic Counter	HES / ETIS Service Volume (in Vehicles per Hour)	HES / ETIS Forecast Vehicle Demand	Additional Number of Vehicles Over ADT During Event	Total Number of Vehicles Recorded During Event	HES / 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
<b>ALABAMA</b>								
<b>I-10 Westbound in Baldwin Co.</b>								
US 29 in Florida to SR 59 in Loxley	3,200 / 3,000	12,730 / 24,766			4.0 / 8			
SR 59 in Loxley to I-65 in Mobile	3,200 / 3,000	19,639 / 25,770	14,365	34,529	6.1 / 9	45	4.8	11.5
I-65 in Mobile to AL / MS line	3,200 / 3,000	19,639 / 0			6.1 / 0			
<b>I-10 Eastbound in Baldwin Co.</b>								
AL / MS line to I-65 in Mobile	3,200 / 3,000	19,822 / 5,380			4 / 5			
I-65 in Mobile to SR 59 in Loxley	3,200 / 3,000	8,284 / 3,562	4,670	24,458	2.6 / 1	51	1.6	8.2
SR 59 in Loxley to From US 29 in Florida	3,200 / 3,000	10,150 / 3,562			3.1 / 1			
<b>I-65 Northbound</b>								
From I-10 South of Mobile to US 45 in Mobile	5,000 / 6,000	16,220 / 40,164			3.2 / 7			
US 45 in Mobile to US 43 South of Creola	5,000 / 6,000	17,293 / 13,170			2			
US 43 South of Creola to SR 59 North of Bay Minette	3,200 / 3,000	37,407 / 24,190			11.7 / 8			
SR 59 North of Bay Minette to SR 113 South of Barnett Crossroads	3,200 / 3,000	52,149 / 36,105	39,436 <sup>3</sup>	57,125 <sup>3</sup>	16.3 / 12	48 + 3	13.1	19.0
SR 113 South of Barnett Crossroads to SR 41 S of Range	2 / 3,000	52,149 / 44,388			2 / 15			
SR 41 S of Range to I-85 in Montgomery	2 / 3,000	2 / 47,204			2 / 16			

Table 4. HURRICANE IVAN ETIS / HES TO COUNTER COMPARISONS								
Roadway Segment With Traffic Counter	HES / ETIS Service Volume (in Vehicles per Hour)	HES / ETIS Forecast Vehicle Demand	Additional Number of Vehicles Over ADT During Event	Total Number of Vehicles Recorded During Event	HES / 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
<b>ALABAMA (Continued)</b>								
<b>US 231 Northbound</b>								
AL/FL Line to US 84 in Dothan	2 / 3,000	2 / 13,703			2 / 7			
US 84 in Dothan to I-85 East of Montgomery	2 / 3,000	2 / 3,401	4,738	25,440	2 / 1	54	1.6	8.5
<b>US 431 Northbound</b>								
US 84 in Dothan to US 27 West of Columbus, GA	2 / 1,000	2 / 12,263	7,091	16,631	2 / 12	51	7.1	16.6
<b>US 43 Northbound</b>								
SR 5 to I-65	1,850 / 1,000	5,514 / 0	7,954	15,345	3.0 / 0	27	8.0	15.3
<b>FLORIDA</b>								
<b>US 29 Northbound</b>								
I-10 to FL / AL Line <sup>4</sup>	1,850 / 2,000	19,517 <sup>4</sup> / 15,206	11,953	19,801	10.3 / 8	50	6.0	9.9
<b>US 231 Northbound</b>								
US 98 to I-10 <sup>4</sup>	1,890 / 2,000	11,501 <sup>4</sup> / 19,929	9,824	21,089	8.1 / 10	48	4.9	10.5
I-10 to FL / AL Line	2 / 2,000	2 / 13,703	12,070	29,804	2 / 7	47	6.0	14.9
<b>SR 71 Northbound</b>								
US 98 to SR 20	800 / 1,000	3,200 / 3,129	2,049	4,509	7.3 / 3	40	2.0	4.5
SR 20 to I-10	800 / 1,000	3,200 / 3,129			7.3 / 3			
<b>I-10 Westbound</b>								
SR 71 to US 231	2 / 3,000	2 / 2,603			2 / 1			

Table 4. HURRICANE IVAN ETIS / HES TO COUNTER COMPARISONS								
Roadway Segment With Traffic Counter	HES / ETIS Service Volume (in Vehicles per Hour)	HES / ETIS Forecast Vehicle Demand	Additional Number of Vehicles Over ADT During Event	Total Number of Vehicles Recorded During Event	HES / 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
<b>FLORIDA (Continued)</b>								
US 231 to SR 77	<sup>2</sup> / 3,000	<sup>2</sup> / 5,501			<sup>2</sup> / 2			
SR 77 to SR 79	<sup>2</sup> / 3,000	<sup>2</sup> / 5,501			<sup>2</sup> / 2			
SR 79 to US 331	<sup>2</sup> / 3,000	<sup>2</sup> / 5,501	N/A <sup>6</sup>	N/A <sup>6</sup>	<sup>2</sup> / 2	N/A <sup>6</sup>	N/A <sup>6</sup>	N/A <sup>6</sup>
US 331 to SR 85	<sup>2</sup> / 3,000	<sup>2</sup> / 7,390			<sup>2</sup> / 2			
SR 85 to SR 87	<sup>2</sup> / 3,000	<sup>2</sup> / 15,985			<sup>2</sup> / 5			
SR 87 to US 29	<sup>2</sup> / 3,000	<sup>2</sup> / 18,628			<sup>2</sup> / 5			
US 29 in Florida to SR 59 in Loxley	3,200 / 3,000	5,296 / 24,766	10,552	33,155	5.0 / 8	34	3.5	11.1
<b>I-10 Eastbound</b>								
SR 59 in Loxley to US 29 in Florida	3,200 / 3,000	10,150 / 5,096	2,620	11,981	3.1 / 2	31	0.9	4.0
US 29 to SR 87	3,350 / 3,000	4,891 / 10,653			4.8 / 4			
SR 87 to SR 85	3,350 / 3,000	<sup>2</sup> / 13,997			<sup>2</sup> / 5			
SR 85 to US 331	3,350 / 3,000	<sup>2</sup> / 26,536			<sup>2</sup> / 9			
US 331 to SR 79	3,350 / 3,000	<sup>2</sup> / 31,288	37,080	53,894	<sup>2</sup> / 10	47	12.4	18.0
SR 79 to SR 77	<sup>2</sup> / 3,000	<sup>2</sup> / 31,288			<sup>2</sup> / 10			
SR 77 to US 231	<sup>2</sup> / 3,000	<sup>2</sup> / 31,288			<sup>2</sup> / 10			
US 231 to SR 71	<sup>2</sup> / 3,000	<sup>2</sup> / 31,288			<sup>2</sup> / 11			
SR 71 S to R 65	<sup>2</sup> / 3,000	<sup>2</sup> / 31,536			<sup>2</sup> / 11			

Table 4. HURRICANE IVAN ETIS / HES TO COUNTER COMPARISONS								
Roadway Segment With Traffic Counter	HES / ETIS Service Volume (in Vehicles per Hour)	HES / ETIS Forecast Vehicle Demand	Additional Number of Vehicles Over ADT During Event	Total Number of Vehicles Recorded During Event	HES / 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
<b>FLORIDA (Continued)</b>								
<b>I-10 Eastbound (Continued)</b>								
SR 65 to SR 267	3,240 / 3,000	<sup>2</sup> / 31,536			<sup>2</sup> / 11			
SR 267 to US 319	3,240 / 3,000	<sup>2</sup> / 31,536	39,305	62,122	<sup>2</sup> / 11	52	13.1	20.7
US 319 to US 19	3,240 / 3,000	<sup>2</sup> / 16,906			<sup>2</sup> / 6			
US 19 to SR 145	<sup>2</sup> / 3,000	<sup>2</sup> / 16,906			<sup>2</sup> / 6			
SR 145 to SR 51	<sup>2</sup> / 3,000	<sup>2</sup> / 16,906			<sup>2</sup> / 6			
SR 51 to I-75	<sup>2</sup> / 3,000	<sup>2</sup> / 16,906	25,079	43,825	<sup>2</sup> / 6	65	8.3	14.6
I-75 to SR 100	<sup>2</sup> / 3,000	<sup>2</sup> / 4,523			<sup>2</sup> / 2			
SR 100 to SR 121	<sup>2</sup> / 3,000	<sup>2</sup> / 4,523			<sup>2</sup> / 2			
SR 121 to US 301	<sup>2</sup> / 3,000	<sup>2</sup> / 4,523			<sup>2</sup> / 2			
US 301 to I-295	3,230 / 3,000	<sup>2</sup> / 4,523	12,090	43,928	<sup>2</sup> / 2	37	4.0	14.6
<b>LOUISIANA <sup>7</sup></b>								
<b>I-10 Westbound (New Orleans to Baton Rouge) <sup>7</sup></b>								
US 90 Business to the Lake Pontchartrain Causeway	3,000 / 3,000	<sup>2</sup> / 7,118			<sup>2</sup> / 1.4			
Lake Pontchartrain Causeway to I-310 NW of Kenner	3,000 / 3,000	<sup>2</sup> / 7,118			<sup>2</sup> / 1.4			
I-310 NW of Kenner to I-55 North of LaPlace	3,000 / 3,000	11,105 / 8,340			<sup>2</sup> / 1.7			

Table 4. HURRICANE IVAN ETIS / HES TO COUNTER COMPARISONS								
Roadway Segment With Traffic Counter	HES / ETIS Service Volume (in Vehicles per Hour)	HES / ETIS Forecast Vehicle Demand	Additional Number of Vehicles Over ADT During Event	Total Number of Vehicles Recorded During Event	HES / 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
<b>LOUISIANA (Continued) <sup>7</sup></b>								
<b>I-10 Westbound (New Orleans to Baton Rouge) - Continued <sup>7</sup></b>								
I-55 North of LaPlace to SR 641 North of Lutchter	3,000 / 3,000	7,263 / 5,809			9.5 / 1.2			
SR 641 North of Lutchter to SR 30 West of Gonzalez	3,000 / 3,000	7,263 / 5,921			9.5 / 1.2			
SR 30 West of Gonzalez to I-12 in Baton Rouge	3,000 / 3,000	7,263 / 6,544			9.5 / 1.2			
I-12 in Baton Rouge to I-110 in Baton Rouge	3,000 / 3,000	8,280 / 16,173			5.9 / 4.9			
I-110 in Baton Rouge to SR 77 in Grosse Tete	3,000 / 3,000	<sup>2</sup> / 634			<sup>2</sup> / <1			
SR 77 in Grosse Tete to SR 105 in Cecilia	3,000 / 3,000	<sup>2</sup> / 634			<sup>2</sup> / <1			
<b>I-10 / I-12 Westbound (Mississippi to Baton Rouge) <sup>7</sup></b>								
I-10 from LA /MS line to I-10 / I-59 Interchange	3,000 / 3,000	<sup>2</sup> / 4,588			<sup>2</sup> / 2			
I-12 from I-10 / I-59 Interchange to SR 25 South of Covington	3,000 / 3,000	8,763 / 4,893			6.1 / 2			
I-12 from SR 25 South of Covington to I-55 SW of Hammond	3,000 / 3,000	9,540 / 5,045			6.3 / 2			
I-12 from I-55 SW of Hammond to SR 16 South of Denham Springs	3,000 / 3,000	6,311 / 3,374			7.2 / 1			
I-12 from SR 16 South of Denham Springs to I-10 In Baton Rouge	3,000 / 3,000	6,311 / 3,374			7.2 / 1			

Table 4. HURRICANE IVAN ETIS / HES TO COUNTER COMPARISONS								
Roadway Segment With Traffic Counter	HES / ETIS Service Volume (in Vehicles per Hour)	HES / ETIS Forecast Vehicle Demand	Additional Number of Vehicles Over ADT During Event	Total Number of Vehicles Recorded During Event	HES / 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
<b>LOUISIANA (Continued) <sup>7</sup></b>								
<b>I-110 Northbound <sup>7</sup></b>								
I-10 to US 190	<sup>2</sup> / 2,300	<sup>2</sup> / 2,888			<sup>2</sup> / 1.3			
<b>I-55 Northbound <sup>7</sup></b>								
I-10 to I-12	3,000 / <sup>1</sup>	5,143 / <sup>1</sup>			4.8 / <sup>1</sup>			
I-12 to LA/ MS	3,000 / 3,000	11,314 / 5,080			7.0 / 2			
<b>Lake Pontchartrain Causeway <sup>7</sup></b>								
I-10 to I-12	2,500 / <sup>1</sup>	1,368 / <sup>1</sup>			7.6 / <sup>1</sup>			
<b>I-12 Eastbound <sup>7</sup></b>								
Baton Rouge to I-55	3,000 / <sup>1</sup>	8,763 / <sup>1</sup>			5.2 / <sup>1</sup>			
I-55 to Lake Pontchartrain Casueway	3,000 / <sup>1</sup>	9,540 / <sup>1</sup>			3.5 / <sup>1</sup>			
Lake Pontchartrain Casueway to I-10/I-59	3,000 / <sup>1</sup>	6,311 / <sup>1</sup>			3.9 / <sup>1</sup>			
<b>SR 23 Northbound <sup>7</sup></b>								
SR 5 to I-10	<sup>2</sup> / 1,760	<sup>2</sup> / 5,658			<sup>2</sup> / 2.5			
<b>MISSISSIPPI</b>								
<b>I-10 Westbound</b>								
MS / AL Line to SR 57 North of Pascagoula	3,270 / 3,000	3,113 <sup>8</sup> / 0	12,488	29,264	<1 <sup>8</sup> / 0	38	4.16	9.8

Table 4. HURRICANE IVAN ETIS / HES TO COUNTER COMPARISONS								
Roadway Segment With Traffic Counter	HES / ETIS Service Volume (in Vehicles per Hour)	HES / ETIS Forecast Vehicle Demand	Additional Number of Vehicles Over ADT During Event	Total Number of Vehicles Recorded During Event	HES / 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
<b>MISSISSIPPI (Continued)</b>								
<b>I-10 Westbound (Continued)</b>								
SR 57 North of Pascagoula to US 49 North of Gulfport	3,270 / 3,000	12,652 / 8,955			3.9 / 3			
US 49 North of Gulfport to CR 603 South of Diamondhead	3,270 / 3,000	9,193 / 2,641			2.8 / 1			
CR 603 South of Diamondhead to I-12 in Louisiana	3,270 / 3,000	5,473 / 4,588			1.67 / 2			
<b>I-10 Eastbound</b>								
I-12 in Louisiana to CR 603 South of Diamondhead	3,270 / 3,000	646 / 1,779			<1 / 1			
CR 603 South of Diamondhead to US 49 North of Gulfport	3,270 / 3,000	5,979 / 4,160			1.8 / 1			
US 49 North of Gulfport to SR 57 North of Pascagoula	3,270 / 3,000	5,325 / 3,800			1.6 / 1			
SR 57 North of Pascagoula to MS / AL Line	3,270 / 3,000	4,259 / 5,380	6,540	29,877	1.3 / 2	33	1.8	9.1
<b>MS 63 Northbound</b>								
US 90 to George County Line	2,500 / <sup>1</sup>	14,014 / <sup>1</sup>	12,789	20,138	5.6 / <sup>1</sup>	46	5.6	8.1
<b>US 49 Northbound <sup>7</sup></b>								
I-10 at Gulfport to US 98 South of Hattiesburg	2,500 / 2,000	30,463 / 22,547	19,088	26,280	12.7 / 11	22	7.6	10.5

Table 4. HURRICANE IVAN ETIS / HES TO COUNTER COMPARISONS								
Roadway Segment With Traffic Counter	HES / ETIS Service Volume (in Vehicles per Hour)	HES / ETIS Forecast Vehicle Demand	Additional Number of Vehicles Over ADT During Event	Total Number of Vehicles Recorded During Event	HES / 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
<b>MISSISSIPPI (Continued)</b>								
<b>US 49 Northbound <sup>7</sup></b>								
US 98 South of Hattiesburg to I-59 North of Hattiesburg	<sup>2</sup> / 2,000	<sup>2</sup> / 0			<sup>2</sup> / 0			
I-59 North of Hattiesburg to I-20 South of Jackson	<sup>2</sup> / 2,000	<sup>2</sup> / 9,243	34,435	57,275	<sup>2</sup> / 5	46	17.2	28.6
<b>I-59 Northbound <sup>7</sup></b>								
SR 21/SR 41 in Louisiana to Poplarville	3,000 / 3,000	11,798 / 2,663	22,831	44,132	7.6 / 1	42	7.6	14.7
Poplarville to US 49 North of Hattiesburg	3,000 / 3,000	12,998 / 2,663			7.6 / 1			
US 98 South of Hattiesburg US 49 North of Hattiesburg	3,000 / 3,000	15,277 / 11,136			8.4 / 4			
US 49 North of Hattiesburg to I-20 West of Meridian	3,000 / 3,000	14,759 / 1,893	17,466	40,771	8.2 / 1	44	5.8	13.6
<b>I-55 Northbound <sup>7</sup></b>								
MS / LA state line to McComb	3,000 / 3,000	10,773 / 5,080	46,422	57,585	6.8 / 2	47	15.5	19.2
McComb to Hazelhurst	3,000 / 3,000	11,273 / 5,080			7.0 / 2			
Hazelhurst to Jackson	3,000 / 3,000	10,329 / 5,080			6.6 / 2			
<b>US 98 Westbound</b>								
MS / AL Line to SR 57 East of Bexley	<sup>2</sup> / 3,000	<sup>2</sup> / 28,408	12,504	18,202	<sup>2</sup> / 14	36	4.2	7.9
<b>MISSISSIPPI (Continued)</b>								

Table 4. HURRICANE IVAN ETIS / HES TO COUNTER COMPARISONS								
Roadway Segment With Traffic Counter	HES / ETIS Service Volume (in Vehicles per Hour)	HES / ETIS Forecast Vehicle Demand	Additional Number of Vehicles Over ADT During Event	Total Number of Vehicles Recorded During Event	HES / 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
<b>US 98 Westbound (Continued)</b>								
SR 57 East of Bexley to US 49 South of Hattiesburg	<sup>2</sup> / 3,000	<sup>2</sup> / 28,408			<sup>2</sup> / 14			
US 49 South of Hattiesburg to I-59 West of Hattiesburg	<sup>2</sup> / 3,000	<sup>2</sup> / 10,253			<sup>2</sup> / 5			
<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 Road segment or travel demand data not included in ETIS.</p> <p>2 Road segment not included in HES.</p> <p>3 Figures include 4,334 vehicles which traveled north on southbound lane during one-way operation.</p> <p>4 Figures based on 2004 Escambia Co. ATM or the 2004 Bay Co. ATM</p> <p>5 Counter only operational for portion of Wednesday, 9/15/04</p> <p>6 Traffic counts recorded during the event were below average daily directional totals.</p> <p>7 HES Figures from Bi-State Study</p> <p>8 Assumes no west bound evacuees entering from Alabama</p>								

## CONCLUSIONS

1. Nearly one million vehicles in Florida, Alabama and Mississippi were recorded by the traffic counters arrayed throughout the evacuation roadway networks in all three states. The cumulative total volume of additional trips over the entire four day period leading up to Hurricane Ivan's landfall was almost 469,000 vehicles. Other than the trips recorded on I-59 in Mississippi, which does not consider this to be a major evacuation route for their residents, these figures do not include most of the vehicles that evacuated in Louisiana.
  - a. From Sunday, September 12 to Thursday, September 16, 2004, an additional 203,900 vehicles over the average daily directional trips for a total figure of 402,600, used the major evacuation routes out of the Florida, coastal areas. The average number of hours that all activated traffic counters on the Florida evacuation roadway network recorded above average volumes was 35.4 hours.
  - b. In Alabama, From Sunday, September 12 to Thursday, September 16, 2004, an additional 76,700 vehicles over the average daily directional trips, or 174,400 total vehicles used the major evacuation routes out of the coastal areas. The average number of hours that all activated traffic counters on the Alabama evacuation roadway network recorded above average volumes was 40 hours.
  - c. Mississippi evacuation roadways during the same time period conveyed a total of 323,500 vehicles or 188,200 over the average daily directional trips. The average number of hours that all activated traffic counters on that state's evacuation roadway network recorded above average volumes was 39.8 hours.
  - d. Unfortunately, the traffic counter data for Louisiana during Hurricane Ivan was not available for this report. Therefore any quantitative analysis regarding the progress of evacuations in that state is not possible. Nonetheless, the survey data for the impacted counties do provide some insight into the overall success of the operation.
2. In looking at the traffic counter data in all three of the states which provided data, the increase in traffic volumes to rates above the average daily trips (ADT) on the State routes and US Highways most likely to convey local evacuation trips coincided with the times that evacuation orders were issued by those local governments. The hourly volumes on US 29

and I-10 Westbound in Escambia Co., FL; US 43 north of Mobile, AL; MS 63 in Jackson Co, MS; US 49 in Harrison Co, MS; and US 231 in Bay County, FL all increased significantly over the normal daily figures in most cases within the hour that the evacuation orders were reportedly issued.

3. Although none of the local governments in Louisiana surveyed for this effort provided the effective times for their evacuation decisions, the activity observed by Mississippi's traffic counters on I-55 and I-59 may provide some insight into the progress of the evacuation. Both of these interstate highways are not considered by the State of Mississippi to be evacuation routes for their residents.
  - a. On I-55, a total of 46,400 additional vehicles, many probably evacuating from Louisiana activated the traffic counter in Pike County, traveling northbound. The increase in the hourly number of vehicles began at 4:00 pm on Monday, September 13<sup>th</sup> and continued until 2:00 pm on September 15<sup>th</sup>. The high traffic volumes on this highway continued for 47 hours.
  - b. Based on the traffic counters on I-59, the evacuation traffic from Louisiana appeared to begin before 4:00 pm on September 13<sup>th</sup> and continued for 42 hours, ending mid-morning on September the 15<sup>th</sup>. By the end of the evacuation event, nearly 23,000 vehicles over the ADT for that segment, many of them probably from Louisiana, had evacuated into the interior of Mississippi. The beginning and ending times for the high traffic volumes recorded on both I-55 and I-59 coincided closely providing a strong indication of when the evacuations actually began in Louisiana.
4. A universal observation by every emergency management official surveyed for this effort was that heavy traffic and congestion were overriding problems during the Hurricane Ivan evacuation. Twenty one of the 32 counties surveyed in all four states indicated that heavy traffic was a major issue during the evacuation while half (16 of 32) specifically sited congestion as an issue. Of the 32 surveyed counties, 13 indicated that they experienced traffic jams on their roadways while 4 counties characterized their roadway conditions as gridlock. The counties that defined their evacuation situation as gridlock were mostly highly urban locations, namely Mobile and the counties around New Orleans.

5. Although they have the benefit of the Bi-State Model, which indicates a significant number of evacuating vehicles would be generated in a storm of this magnitude, half of the parishes in Louisiana indicated the volumes they experienced during Hurricane Ivan were unanticipated. In the survey responses from Louisiana, most of the parishes in that state issued evacuation orders for flood prone areas and other less defined portions of their jurisdictions. It appears however that a major portion of the populace in these parishes responded as if Hurricane Ivan were at least a major hurricane event. The numbers recorded at the traffic counters on I-55 and I-59 northbound in Mississippi are reasonably consistent with the figures in the Bi-State Model for a higher level of evacuation than seemingly was called for in most of the Louisiana parishes.
  - a. Based on the level of evacuation indicated by many of the Louisiana parishes, 10,773 vehicles should have crossed the segment on I-55 in the Bi-State model, whereas more than twice used that roadway indicating a Fast Cat 3/4 response (56,508 vehicles). The actual total number of vehicles recorded during the evacuation was 57,600.
  - b. The traffic counter on I-59 indicated that a total of 44,100 vehicles used the segment in Pearl River during the hours of probable evacuation during Hurricane Ivan. The Bi-State Model for a Fast Cat 3/4 forecast a total volume of 69,444.
6. The Bi-State Model also provides vehicle forecasts for US 49 from Gulfport to Jackson, Mississippi. For a category 5 evacuation, low tourist occupancy, the model forecasts 40,418 vehicles will use that roadway for evacuation purposes, whereas the counters show a total of 26,300 vehicles were recorded on that segment. Harrison County indicated that they issued evacuation orders for category 5 evacuation zones, but did not provide their estimates for the participation rates. A reconciliation of the two figures indicates either that the participation rate for Harrison County and adjoining counties was approximately 65% during Hurricane Ivan or that the Bi-State model overestimates the travel demand for that roadway segment by 33%. Given the circumstances surrounding the Hurricane Ivan evacuations and other evacuation throughout the country, the former conclusion is logical and realistic.
7. In assessing the Bi-State vehicles per roadway segment numbers against the data collected at each of the appropriate traffic counters, only the traffic counter data in Mississippi was

available. Consequently there were only five roadway segments that could be used to conduct the analysis. Generally there was 58% agreement using the difference between the Bi-State and counter figures relative to the overall number of vehicles that actually used the segment. Of course the largest amount of deviation between the two figures was attributable to routes from Louisiana where the information provided relative to local evacuation decisions and participation levels were nebulous at best. In that respect it was difficult to select the evacuation scenario in the Bi-State model that most closely approximated reality during the hurricane event.

8. 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.
  - a. In Florida the evacuation routes closest to landfall (US 29 northbound and I-10 eastbound) were almost clear of most evacuation traffic within a few hours of the arrival time of tropical storm force winds in Escambia County. Although US 29 hourly volumes dropped below the average daily trips five hours after the arrival of tropical storm force winds at the coast, the traffic counter located approximately 50 miles inland was clear well in advance of the onset of hurricane force winds.
  - b. Alabama's roadway network was mostly clear of evacuation traffic within 8 hours of tropical storm force winds arriving in Baldwin County, but still well before hurricane conditions arrived on the Alabama Coastline.
  - c. The Mississippi traffic counters closest to the landfall location registered that the traffic dropped below ADT for I-10 in both directions just as tropical storm winds arrived at that location. Additionally, the hourly directional volumes on every other route in Mississippi were below normal daily averages at the advent of tropical storm force winds.
9. The performance of ETIS in determining the cumulative evacuation travel demand for the entire region's roadway network is mixed. Of the segments with traffic counters, the ETIS travel demand figures were within 60% of the recorded values, 9 of them higher and 14 of them lower. Unfortunately, there are no obvious reasons in the data for the discrepancies between the observed and the forecast values. During the storm, incomplete information about local protective action decisions, their timing and participation rates can certainly

affect the accuracy of the ETIS travel demand forecasts for certain roadway segments.

Even after the storm the information collected from local emergency management can have major implications for the accuracy of the scenario used to assess the program which in turn can have a dramatic impact on the program's results. ETIS relies heavily on the accuracy of local information, and the results from the program are greatly influenced by the quality of that data. Unfortunately, the collection of local evacuation related data is the most difficult part of the ELT mission. Nonetheless, ETIS would benefit greatly from a concerted effort to update socio-economic, behavioral, roadway capacity and other data used to generate the travel demand figures and clearance times.

10. The reverse lane operations in Alabama and Louisiana although successfully implemented and operated in both states did not appear to resolve any of the congestion issues on I-65 northbound or I-10 westbound.
  - a. The I-65 plan was not implemented until the final day of the evacuation, September 15, 2004, when the traffic volumes in the northbound direction were not critical. At the height of the operation at 10:00 am the combined hourly number of vehicles in both directions was 2,034, well below the HES hourly service volume of 3,200 for the northbound lane alone. Therefore the 4,334 vehicles that traveled north on the southbound lanes between 9:00 am and 3:00 pm could have easily remained in the regular lanes without taxing that roadway's hourly capacity.
  - b. The Louisiana plan on I-10 westbound has no traffic counter data to assist in assessing the utility of the operation. Based on the anecdotal reports from the emergency managers who participated in the surveys, the operation was needed and did allow more vehicles to travel westbound on I-10 during the Hurricane Ivan evacuation. Nonetheless, it does not appear that the operation actually alleviated the reports of traffic congestion on I-10. Apparently, although traffic flowed smoothly in the normal and contra-flow lanes the crossovers at the termini were the sites of congestion due to lane shifting and lane compression.
  - c. Despite the mixed results achieved in both operations, it is not likely that the data in the applicable HESs, the Bi-State Model or in ETIS would have had any major impact on the outcomes during this particular event.

11. Despite reports of traffic congestion specifically attributed to many of the evacuation routes on which traffic counters were located, the instances where the hourly volumes on the evacuation roadways reached saturation or otherwise degraded to a traffic queuing situation were rare. Only the traffic counters on I-10 near DeFuniak Springs, FL, and Quincy, FL, documented situations where the hourly traffic volume and the average speeds were significantly reduced. All of the traffic counters in Florida indicated that the evacuation roadways even peak volume hours were able to convey traffic at the normal average posted speed limit. In other states, only one traffic counter on I-10 in Baldwin County during the afternoon of September 14<sup>th</sup> even approached the hourly evacuation service volume of 3,200 vehicles. Unfortunately, only the counter data in Florida includes average speed data with the hourly traffic counts. Without average speed data any conclusions of congestion, gridlock or other problems on evacuation roadways is not as conclusive. This does not mean that there were not isolated incidences of traffic congestion or even gridlock, only that those conditions were not apparent at the traffic counter locations.