FINAL REPORT

to

THE FLORIDA DEPARTMENT OF TRANSPORTATION
SYSTEMS PLANNING OFFICE

On Project

"Modeling, Implementation, and Validation of Arterial Travel Time Reliability"

FDOT Contract BDK77 977-20

November 30, 2013

Submitted by
The University of Florida
Kittelson and Associates, Inc.

DISCLAIMER

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METRIC CONVERSION CHART

U.S. UNITS TO METRIC (SI) UNITS

LENGTH

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
in	inches	25.4	millimeters	mm
ft.	feet	0.305	meters	m
yd.	yards	0.914	meters	m
mi	miles	1.61	kilometers	km

METRIC (SI) UNITS TO U.S. UNITS

LENGTH

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft.
m	meters	1.09	yards	yd.
km	kilometers	0.621	miles	mi

TECHNICAL REPORT DOCUMENTATION PAGE

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16. Abstract

Previous research funded by Florida Department of Transportation (FDOT) developed a method for estimating travel time reliability for arterials. This method was not initially implemented or validated using field data. This project evaluated and refined these initially developed models using field data, and implemented them on the arterial portion of the Strategic Intermodal System (SIS). The research team first implemented and evaluated the previously developed travel time estimation models using data from four selected arterials in Jacksonville, Florida. Field travel time data for the four selected arterials was collected through a BlueTOAD database. The comparison between the model estimated travel time and field data showed that the original models greatly overestimated arterial travel times. Thus, a new set of models was developed using CORSIM, and it was concluded that the newly developed models provided travel times that are closer to the field data for the four arterials studied in this project. Using these revised models, a 2011 statewide arterial reliability database was developed to obtain reliability performance measures for all arterials in the SIS. The results were aggregated by county and provided in this report. Travel time reliability results are also provided for SIS arterials in the vicinity of major ports and airports in Florida.

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EXECUTIVE SUMMARY

Travel time reliability has been proposed as a new concept that allows agencies to evaluate the performance of a facility beyond just the peak hour, and to consider operations over a longer period of time, thus incorporating the non-recurring events. Furthermore, the concept of travel time reliability has been widely recognized as one of, if not the, most important performance measures for evaluating highway traveler perceptions. Previous research funded by FDOT developed a method for estimating travel time reliability for arterials. This method was not initially implemented or validated using field data. This project evaluated and refined these initially developed models using field data, and implemented them on the arterial portion of the Strategic Intermodal System (SIS).

The research team first implemented and evaluated the travel time estimation models developed in a previous project (FDOT Contract BDK77 977-10) using data from four selected arterials in Jacksonville, Florida. Field travel time data for the four selected arterials was collected through BlueTOAD database. The comparison between the model-estimated travel time and field data showed that the original models greatly overestimated arterial travel times. One of the reasons for this discrepancy was the assumption initially used regarding the flashing yellow during the early morning hours along arterial streets. In the field, travel time was not reduced as significantly as originally assumed during those times. Another reason for the discrepancy was that the initial simulations implemented pre-timed signal control. However, all intersections at the study sites used actuated control. Therefore, the research team developed a new travel time estimation model based on actuated control.

The CORSIM^{TM} traffic microsimulator was used, and a total of 504 scenarios were simulated considering several factors (number of lanes, number of signals per mile, demand, Free-Flow Speed (FFS), incident duration, percent of lanes blocked by incident, and quality of progression) which affect travel time along arterials. Regression models were developed seperately for undersaturated and oversaturated conditions using IBM SPSS Statistics. The resulting adjusted R-square values indicated a good fit for both models, and the format of the equations was consistent with the preliminary analysis of the simulation results.

Travel times were also estimated for the four selected arterials using the new models. Comparison between the field travel times and the estimated travel times using the two models showed that:

- Travel times estimated using the newly developed models were consistently lower than the travel times estimated using the original models, and were closer to the field data for the four arterials studied in this project.
- For the time periods when traffic demand was very low (early morning and late night), the model estimated travel time was very close to the field data. However, for the remaining time periods, the new model still overestimated the travel time, especially for the morning and afternoon peak hours.

One possible reason for the overestimation of the new model is the assumptions made in calculating average hourly volume, which was used as input in the travel time estimation process. Since demand field data are not available, hourly traffic volume was calculated using AADTs and the corresponding hourly K factor. However, these K factors are based on undersaturated conditions, and they may not necessarily be accurate for congested conditions.

Next, a 2011 statewide arterial reliability database was developed to implement the revised models and to obtain reliability performance measures for all arterials in the SIS. The results were aggregated by county and provided in this report. Travel time reliability results are also provided for SIS arterials in the vicinity of major ports and airports in Florida. One of the issues that should be addressed in the future is that for short segment lengths the speed estimates are very low and thus the measures obtained may be unreasonable.

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1 INTRODUCTION

1.1 Background

The goal of the Strategic Intermodal System (SIS) is to provide a transportation system that efficiently serves Florida's citizens, businesses, and visitors: a transportation system that helps Florida become a worldwide economic leader; enhances economic prosperity and competitiveness; enriches quality of life; and reflects responsible environmental stewardship. The SIS consists of transportation facilities and services of statewide and interregional significance, including freeways, multilane highways, and arterials. Traditionally, agencies have concentrated on mitigating recurring congestion by comparing demand and capacity during the peak periods and by removing those bottlenecks. However, congestion is often due to other sources, such as crashes, work zones, and adverse weather conditions. Therefore, new approaches and performance measures are needed to mitigate congestion considering those non-recurring events.

Travel time reliability has been proposed as a new concept that allows agencies to evaluate the performance of a facility beyond just the peak hour, and to consider operations over a longer period of time considering non-recurring events. Furthermore, the concept of travel time reliability has been widely recognized as one of, if not the, most important performance measures to evaluate highway traveler perceptions.

Previous research funded by FDOT on travel time reliability developed, implemented, and evaluated tools for estimating travel time reliability for freeways. These can predict travel time reliability along the entire freeway portion of the SIS as a function of various changes in the system, such as incident removal times, and work zone occurrences, as well as selected Intelligent Transportation System (ITS) programs and initiatives (such as the road rangers). Previous research also developed a method for estimating travel time reliability for arterials. This method was not initially implemented or validated using field data. This project evaluated and refined these initially developed models using field data, and implemented them on the arterial portion of the SIS.

1.2 Objectives

The objectives of this research are to a) evaluate, validate, and adjust as necessary, the existing travel time estimation models for arterials using field data; b) use Florida's crash data to update our travel time estimates for incident-related scenarios on arterials, and c) implement the arterial travel time estimation models in a database for the entire arterial portion of the SIS.

1.3 Research Approach and Report Organization

The research was conducted by the University of Florida in collaboration with Kittelson and Associates, Inc. (KAI). KAI has assisted FDOT in developing databases for assessing the Level of Service (LOS) on freeway facilities, and also participated with UF in previous research projects that led to the development and implementation of the existing travel time reliability tools. Those same databases were also used in this project.

First, the research team assembled relevant field data from four arterial corridors in Florida. Chapter 2 provides a summary of the field data obtained. Next, we assembled crash data and developed a process and suitable assumptions for incorporating the impact of incidents on arterial travel time estimation models. This process is documented in Chapter 3. Based on the findings of the previous two tasks, we compared the field travel times to those estimated by the previously developed models. To address discrepancies between the two sets of values, the models were adjusted so that they more closely match the field data. Chapter 4 summarizes the validation effort and presents the revised models. The final models and methods were implemented in a database to estimate travel time reliability for the arterial portion of the SIS. An overview of this effort as well as resulting estimates are provided in Chapter 5, while Chapter 6 provides conclusions and recommendations from the research.

2 Field Travel Time Data

2.1 Field Travel Time Data Assembly

Field travel time data from various arterial sections in Florida were obtained in order to compare them to the estimated arterial travel times. The measured travel time data are from the BlueTOAD database in FDOT District Two (Jacksonville area). BlueTOAD is an acronym for Bluetooth Travel-time Origination and Destination. This advanced traffic monitoring technology can detect anonymous Bluetooth signals from passing vehicles. Matching of subsequent detections by BlueTOAD devices along the road through rigorous filtering and integrated processing can be utilized to determine travel times, road speeds, and route behaviors.

The validation of the BlueTOAD data was performed by comparing the information generated from existing vehicle detection units to the BlueTOAD devices. The Pennsylvania Department of Transportation (PennDOT) and the Transportation Management Center in Sarasota County, Florida conducted evaluation projects and they concluded that the travel time and speed information these devices provide are accurate and dependable. PennDOT compared the BlueTOAD with toll tag readers (EZPass) along the Schuylkill Expressway (I-76) in Philadelphia (KMJ Consulting, 2010). They concluded that the travel times produced by the Bluetooth technology and the BlueTOAD device are comparable to those produced by the EZPass tag readers. They also concluded that in term of costs, BlueTOAD is cheaper and the installation is much easier and takes less time. Similar conclusions were drawn from Sarasota County (PBS&J, 2010). They concluded that speeds from the floating car data, Sarasota County Nu-Metric devices and the BlueTOAD devices showed that the BlueTOAD speeds and travel times are comparable to actual travel conditions along the corridor. In addition, they indicated that the total costs of BlueTOAD devices are less than half the cost of comparable toll pass readers and less than one tenth of the cost of license plate readers (LPRs).

The BlueTOAD devices and database are provided by TrafficCast. The North Florida Transportation Planning Organization (NFTPO) purchased 140 BlueTOAD units that can provide interlaced data for all four counties in northeast Florida (FDOT Traffic Engineering and Operations Newsletter, 2012). Approximately 300 miles of roadway data are available with regard to travel times, speeds, and origin/destination information. Figure 2-1 shows all the active BlueTOAD devices in the NFTPO region.

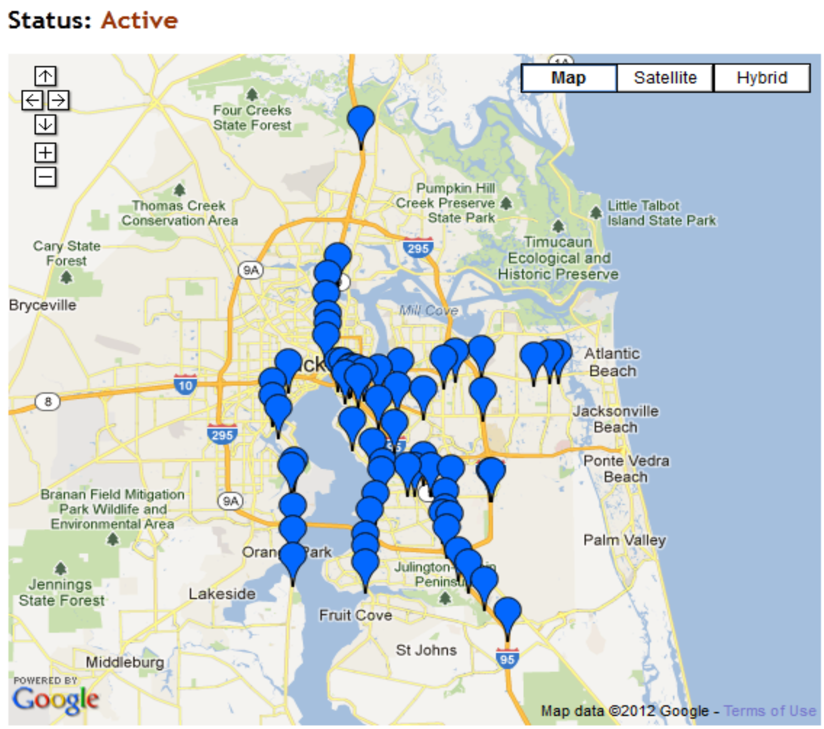

Figure 2-1 BlueTOAD Device Map from NFTPO

The BlueTOAD data are viewable via the TrafficCast web server. Device pairing information was firstly used to select the arterial corridors for further analysis. Each two pairings consist of the two directions for each corridor. Table 2-1 provides the list of corridors we identified for this project, which consist primarily of arterials with a length over 2 miles. The road lane count and signal locations were then obtained from Google Map, and the number of signals per mile was calculated for each corridor. Four arterial corridors (San Jose Boulevard between University Boulevard and Baymeadows Road, Beach Boulevard between University Boulevard and I-295, Atlantic Boulevard between University Boulevard and Southside Boulevard, and San Jose Boulevard between Baymeadows Road and I-295) were selected for further data collection. These corridors have different number of lanes and different number of signals/mile. These corridors are described in Table 2-1 and shown in the map of Figure 2-2. The red dots identify the signal locations while the green lines represent the beginning and end of each corridor.

Table 2-1 List of Sites

Pairing	Miles	Starting Point	Ending Point	Direction	# lanes	# signals	#signals/mile
3701	2.5	Atlantic Blvd & Southside Blvd (u1163)	Atlantic Blvd & University Blvd (u1173)	West Bound	2	8	3.20
3702	2.5	Atlantic Blvd & University Blvd (u1173)	Atlantic Blvd & Southside Blvd (u1163)	East Bound	2	8	3.20
3721	2.3	Baymeadows Rd & Southside Blvd (u1237)	Baymeadows Rd & SR9A (u1105)	East Bound	2	6	2.61
3722	2.3	Baymeadows Rd & SR9A (u1105)	Baymeadows Rd & Southside Blvd (u1237)	West Bound	2	6	2.61
4280	3.22	San Jose and Julington Creek (u1147)	San Jose Blvd & I-295 (u1191)	North Bound	3	9	2.80
4281	3.22	San Jose Blvd & I-295 (u1191)	San Jose and Julington Creek (u1147)	South Bound	3	9	2.80
4282	3.62	San Jose Blvd & I-295 (u1191)	Baymeadows Rd & SR13 (u1238)	North Bound	3	12	3.31
4283	3.62	Baymeadows Rd & SR13 (u1238)	San Jose Blvd & I-295 (u1191)	South Bound	3	12	3.31
4284	3.68	Baymeadows Rd & SR13 (u1238)	San Jose Blvd & University Blvd (u1174)	North Bound	2	6	1.63
4285	3.68	San Jose Blvd & University Blvd (u1174)	Baymeadows Rd & SR13 (u1238)	South Bound	2	6	1.63
4286	3.1	San Jose Blvd & University Blvd (u1174)	Hendricks Ave & San Marco Blvd (u1155)	North Bound	2	9	2.90
4287	3.1	Hendricks Ave & San Marco Blvd (u1155)	San Jose Blvd & University Blvd (u1174)	South Bound	2	9	2.90
4288	2.77	Baymeadows Rd & SR13 (u1238)	Baymeadows Rd & I-95 (u1103)	East Bound	2	8	2.89
4289	2.77	Baymeadows Rd & I-95 (u1103)	Baymeadows Rd & SR13 (u1238)	West Bound	2	8	2.89
4292	2.1	Beach and San Mateo (u1195)	Beach and University (u1151)	East Bound	2	8	3.81
4293	2.1	Beach and University (u1151)	Beach and San Mateo (u1195)	West Bound	2	8	3.81
4295	4.9	Beach and University (u1151)	Beach and SR9A(I295) (u1150)	East Bound	3	16	3.27
4296	4.9	Beach and SR9A(I295) (u1150)	Beach and University (u1151)	West Bound	3	16	3.27
4299	5.04	Beach and SR9A(I295) (u1150)	Beach and San Pablo (u1192)	East Bound	3	11	2.18
4300	5.04	Beach and San Pablo (u1192)	Beach and SR9A(I295) (u1150)	West Bound	3	11	2.18
4302	2.25	Atlantic Blvd & Southside Blvd (u1163)	Atlantic Blvd & St Johns Bluff Rd (u1171)	East Bound	3	9	4.00
4303	2.25	Atlantic Blvd & St Johns Bluff Rd (u1171)	Atlantic Blvd & Southside Blvd (u1163)	West Bound	3	9	4.00
4304	4.43	Atlantic Blvd & St Johns Bluff Rd (u1171)	Atlantic Blvd & San Pablo Rd (u1168)	East Bound	3	9	2.03
4305	4.43	Atlantic Blvd & San Pablo Rd (u1168)	Atlantic Blvd & St Johns Bluff Rd (u1171)	West Bound	3	9	2.03

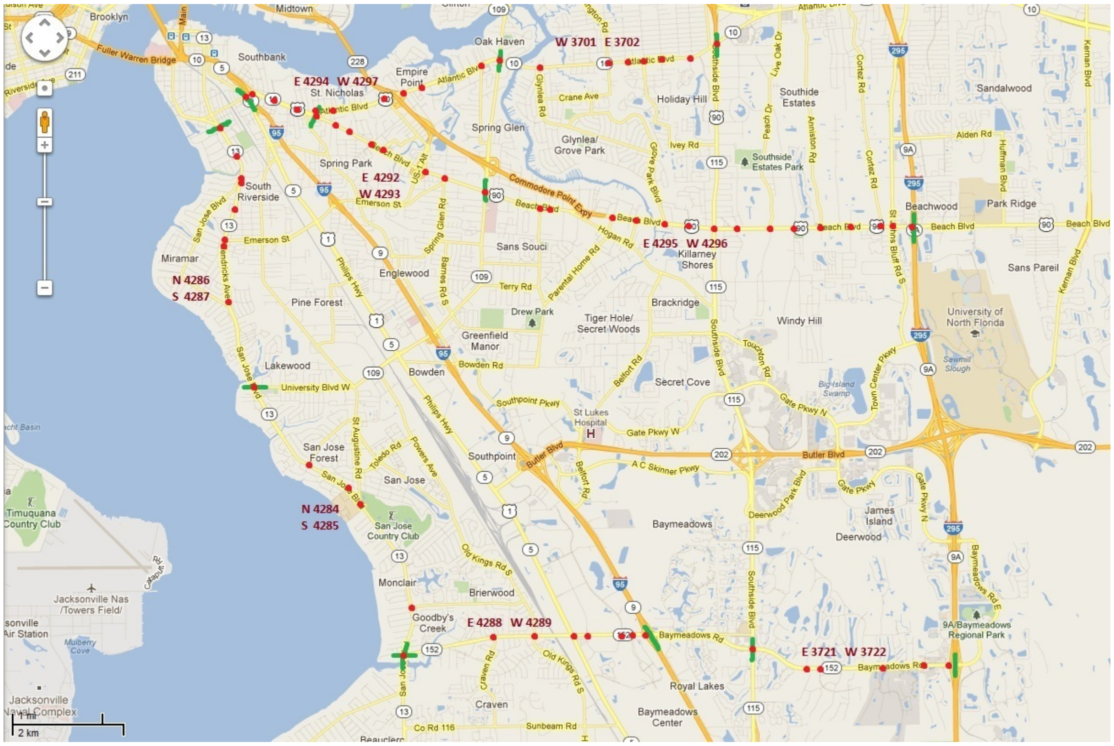

Figure 2-2 Map with Two Corridor Locations and Their Signals

There are two different types of travel time information available for each 15 minute interval. One is based on Realtime Smoothed Speeds (RS data); the other is based on Filtered Individual Speeds (FI data). By examining the sample data, we found the RS data are much more complete than the FI data. Therefore, RS data were selected for additional analyses.

2.2 Summary of the Field Travel Time Data

Weekday field travel time data for the four selected arterial corridors (San Jose Boulevard between University Boulevard and Baymeadows Road, Beach Boulevard between University Boulevard and I-295, Atlantic Boulevard between University Boulevard and Southside Boulevard, and San Jose Boulevard between Baymeadows Road and I-295) were collected for the year of 2012 from the BlueTOAD database. The BlueTOAD data provides the average travel time for each 15 minute interval.

The BlueTOAD data for these four corridors have different reporting durations. For San Jose Boulevard, the devices started collecting data on February 11th, 2012. For Beach Boulevard, the devices started collecting data on February 16th, 2012, and for Atlantic Boulevard on

February 9th, 2012. For all the facilities, all of the available data for the year of 2012 has been obtained.

Weekday data were obtained and were plotted to identify trends and patterns for those corridors. Figure 3-3 through Figure 3-6 present the weekday travel time plots for the four selected arterial corridors. Each color represents a different direction.

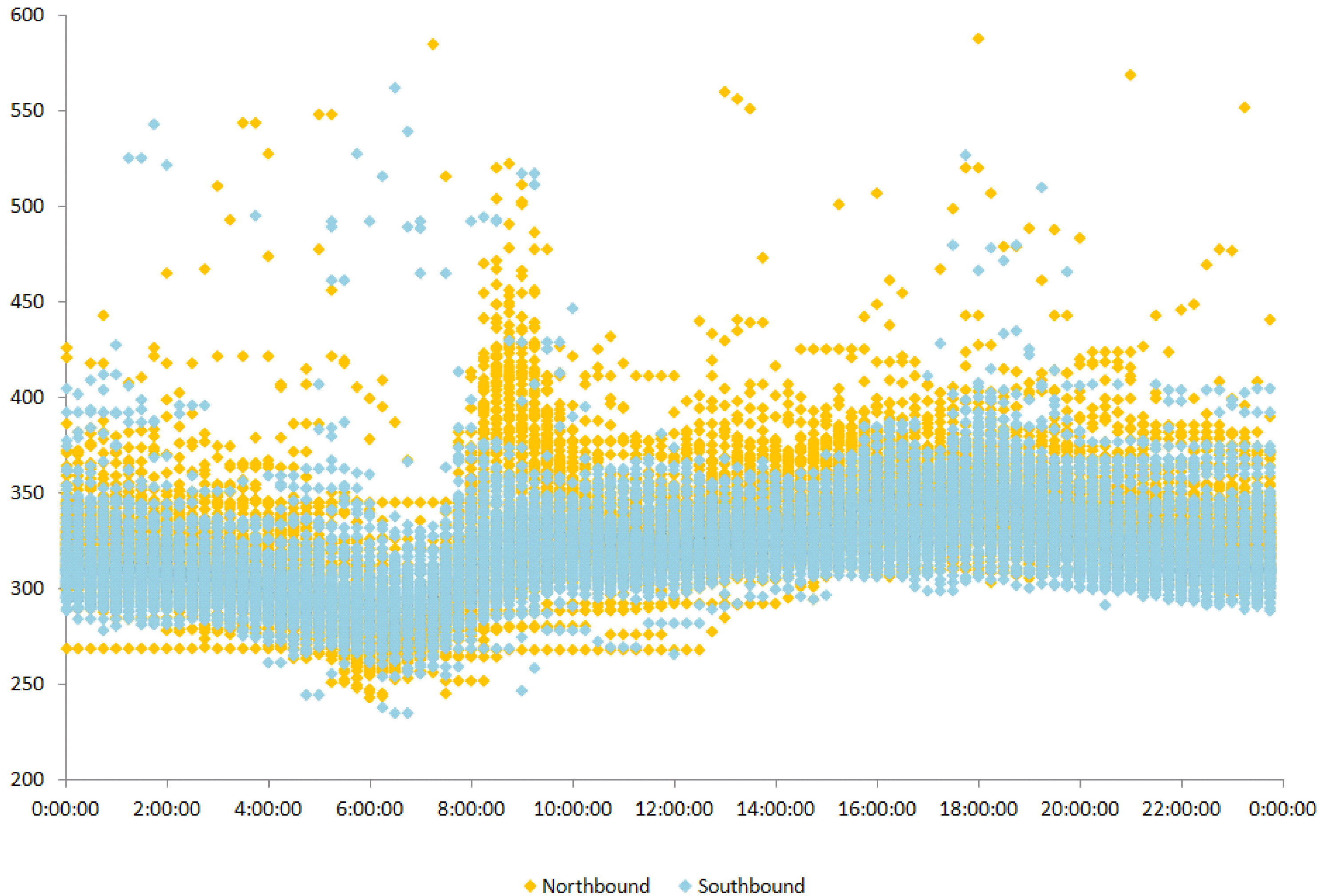

Figure 2-3 BlueTOAD Travel Time Data for San Jose Boulevard

Between University Boulevard and Baymeadows Road (High Value Outliers Excluded)

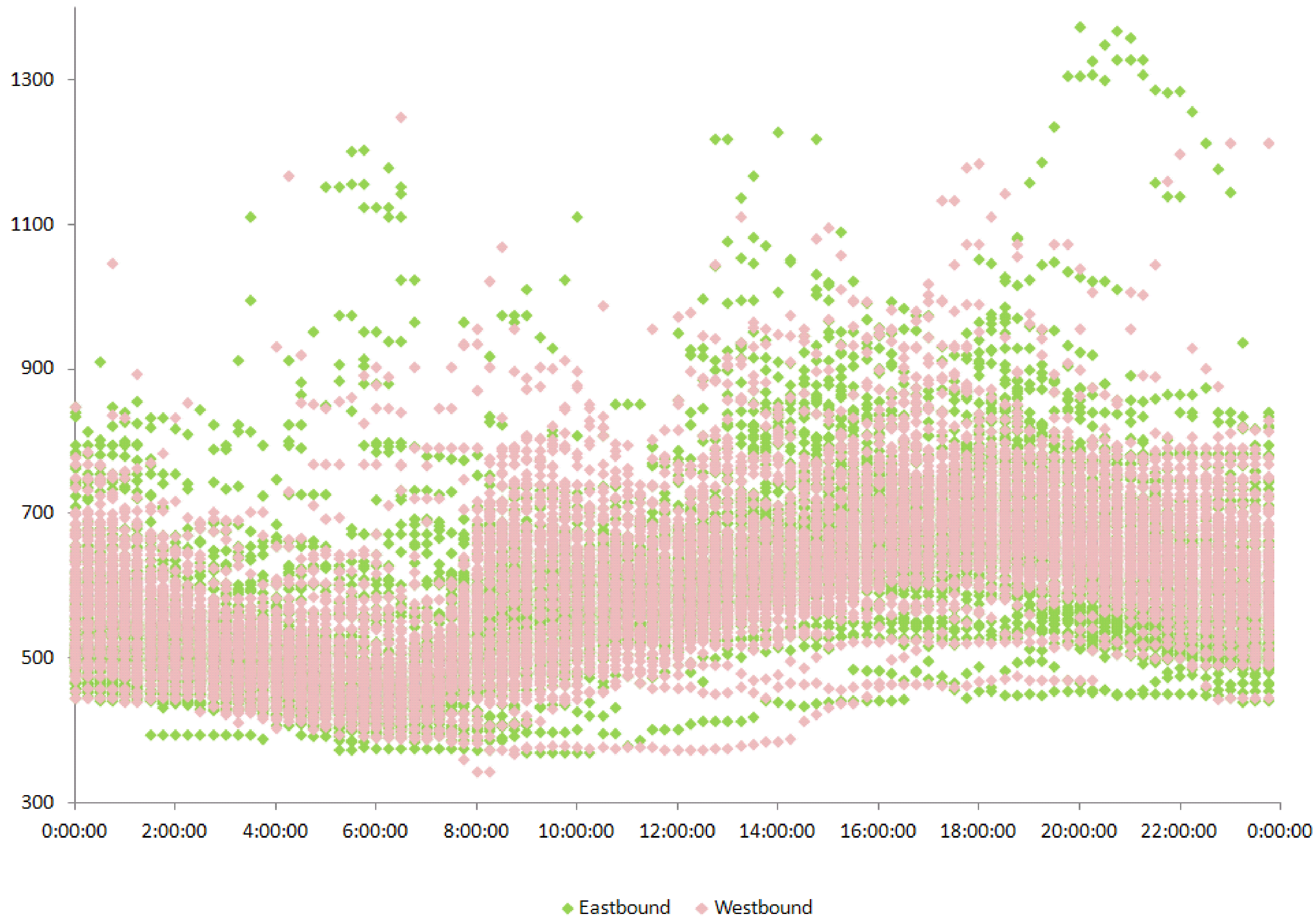

Figure 2-4 BlueTOAD Travel Time Data for Beach Boulevard Between University Boulevard and I-295 (High Value Outliers Excluded)

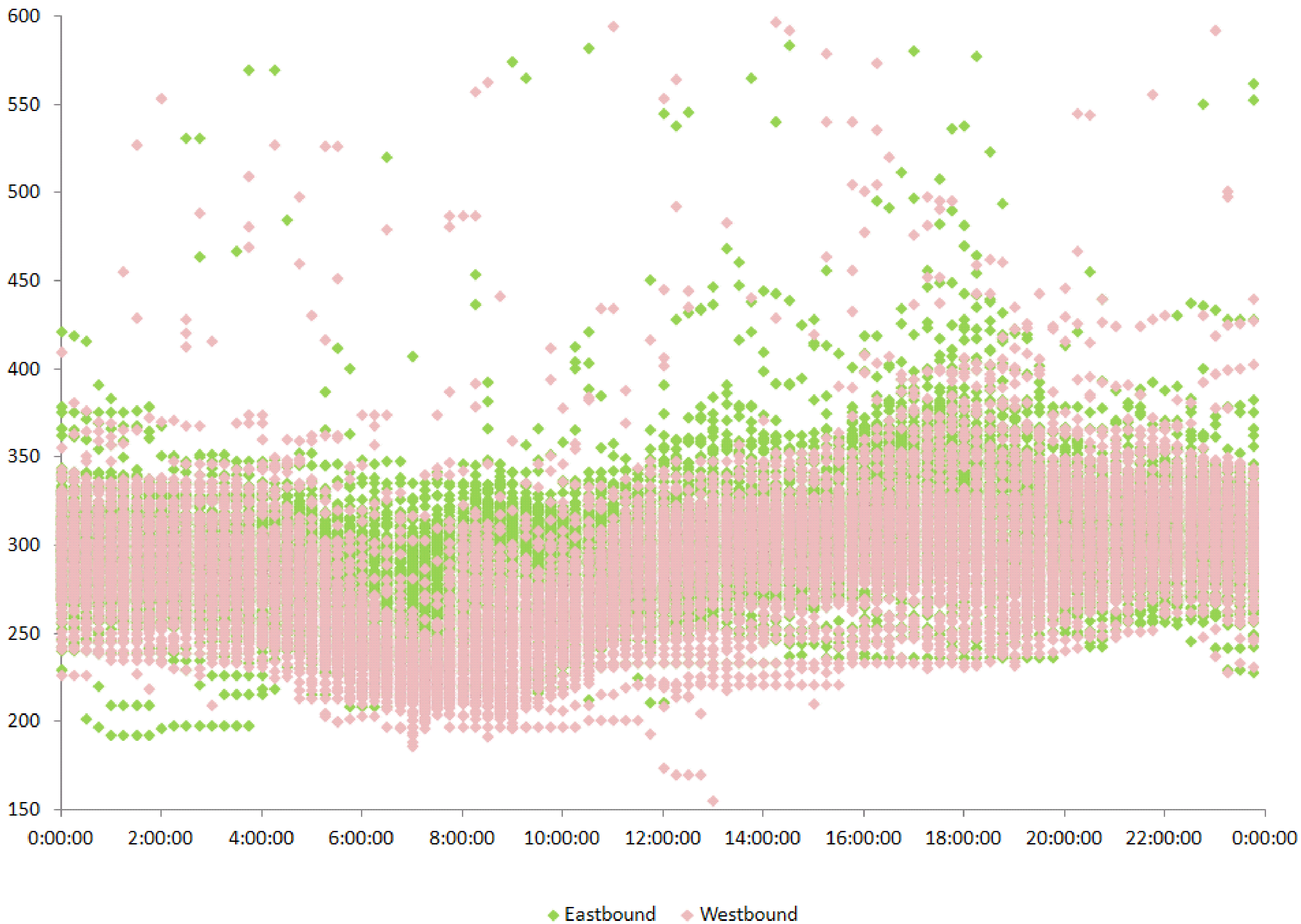

Figure 2-5 BlueTOAD Travel Time Data for Atlantic Boulevard Between University Boulevard and Southside Boulevard (High Value Outliers Excluded)

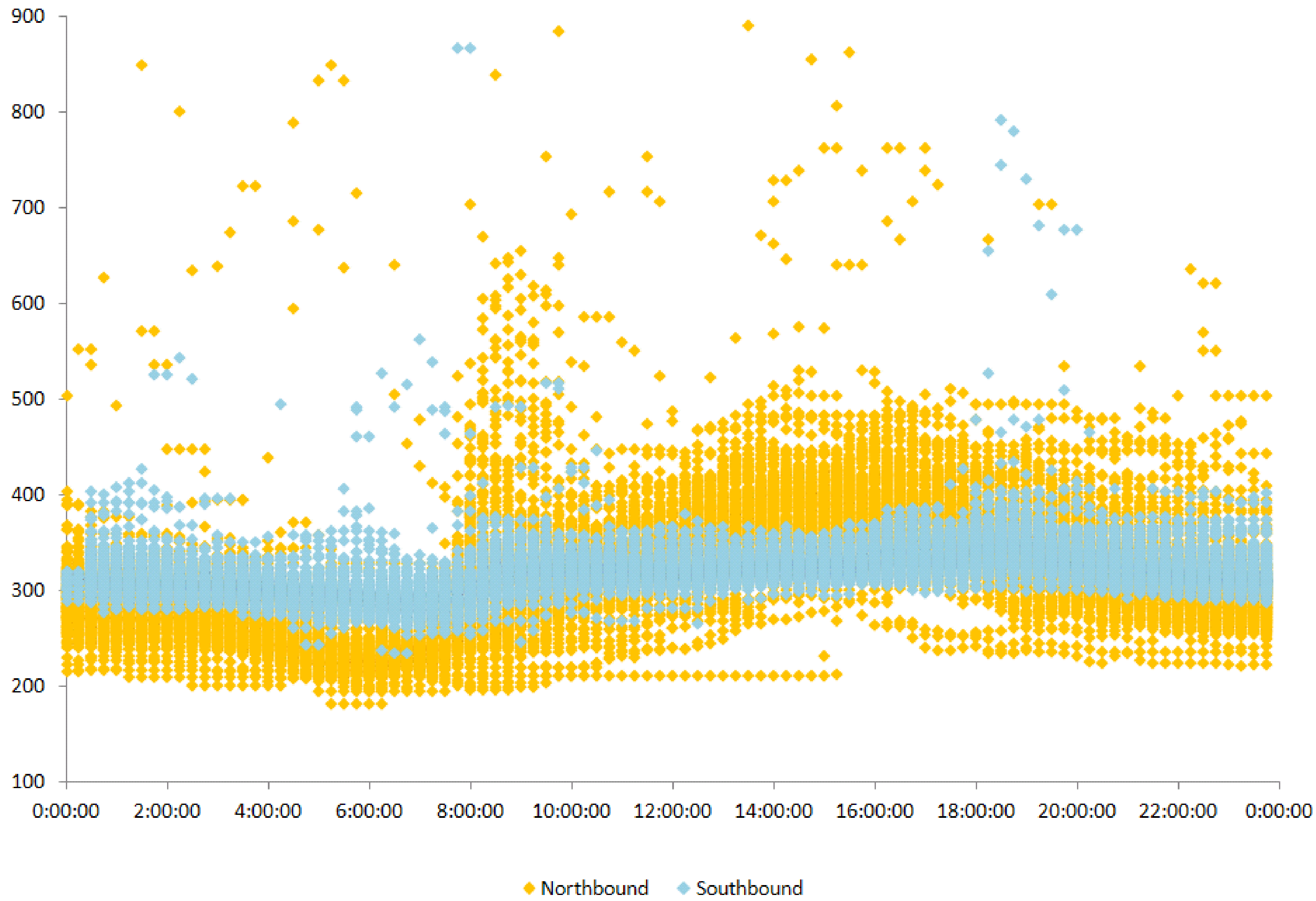

Figure 2-6 BlueTOAD Travel Time Data for San Jose Boulevard Between Baymeadows Road and I-295 (High Value Outliers Excluded)

As shown in Figure 2-3 and 2-6, for San Jose Boulevard, travel time for the opposite directions of the same corridor have significantly different trends and pattern. For the section between University Boulevard and Baymeadows Road, travel times of the northbound are higher than the southbound direction, especially during the morning peak time (8:00 am-10:00 am) when the northbound has significantly higher travel times than the other time periods of the day. The afternoon peak time is 4:00 pm- 7:00 pm, but there is no significant increase in travel time during this time period. For the arterial section between Baymeadows Road and I-295, travel times of the northbound direction fluctuate significantly during the day, while the fluctuation of southbound travel times is minimal. The morning peak for the corridor is 8:00 am-10:00 am, and during this time period, a noticeable number of very high travel times occurs in the northbound direction. This may be because the traffic demand during this time period is very high and results in congestion. The afternoon peak time occurs 2:00 pm- 6:00 pm for the northbound and 6:00 pm- 8:00 pm for the southbound.

As shown in Figure 2-4, opposite directions of Beach Boulevard have similar patterns and peaking times. The morning peak is 8:00 am- 10:00 am, and the afternoon peak time is 4:00 pm- 7:00 pm. Travel time in the afternoon peak is higher than the other time periods of the day.

For Atlantic Boulevard, shown in Figure 2-5, travel times for the eastbound are slightly higher than the westbound direction, but the difference is very small. Morning peak time for this arterial corridor is 7:00 am- 10:00 am, and evening peak time is 4:00 pm- 8:00 pm. The travel time during the afternoon peak is the highest of the day.

3 INCOPORATION OF INCIDENT DATA IN ARTERIAL TRAVEL TIME RELIABILITY METHODS

In the previous arterial travel time reliability project (FDOT Contract BDK77 977-10), we used several assumptions related to incident occurrence at arterial corridors. For this project, we obtained the statewide crash data on the State Highway System (SHS) from 2005 to September 2012 from the FDOT State Safety Office and have analyzed these so we can use them within the travel time reliability calculations. The crash data for 2011 for the four selected arterial corridors (San Jose Boulevard between University Boulevard and Baymeadows Road; Beach Boulevard between University Boulevard and I-295; Atlantic Boulevard between University Boulevard and Southside Boulevard; and San Jose Boulevard between Baymeadows Road and I-295) were inserted into the spreadsheet. First, the number of the crashes and the associated time of occurrence were identified for each corridor. Then, probabilities for each incident category (1-lane blocked incidents and 2-lane blocked incidents) were calculated and used as inputs in the spreadsheet calculations. Use of these incident data is discussed separately for each of the corridors in the following subsections.

3.1 Use of the Incident Data for San Jose Boulevard Between University Boulevard and Baymeadows Road

This arterial corridor has two lanes in each direction. Therefore, all incidents occurring along this corridor were assumed to be 1-lane blocked incidents. Calculations of the probability of incident are presented in Table 3-1.

Table 3-1 Calculations of the Probability of Incident for San Jose Boulevard between University Boulevard and Baymeadows Road

Time Period		Number of Incidents		Hourly Incident Percentage	Number of Incidents	Probability of Incidents
		Entire Corridor	Studied Section			
12:00-1:00	am	3	0	0.063	0.288	0.079%
1:00-2:00	am	3	0	0.008	0.288	0.079%
2:00-3:00	am	4	0	0.030	0.385	0.105%
3:00-4:00	am	4	0	0.016	0.385	0.105%
4:00-5:00	am	2	0	0.010	0.192	0.053%
5:00-6:00	am	1	0	0.006	0.096	0.026%
6:00-7:00	am	2	0	0.022	0.192	0.053%
7:00-8:00	am	15	1	0.032	1.442	0.395%
8:00-9:00	am	12	1	0.038	1.154	0.316%
9:00-10:00	am	5	0	0.022	0.481	0.132%
10:00-11:00	am	14	2	0.030	1.346	0.369%
11:00-12:00	am	14	1	0.038	1.346	0.369%
12:00-1:00	pm	18	0	0.061	1.731	0.474%
1:00-2:00	pm	21	2	0.047	2.019	0.553%
2:00-3:00	pm	19	2	0.087	1.827	0.501%
3:00-4:00	pm	18	1	0.069	1.731	0.474%
4:00-5:00	pm	23	4	0.071	2.212	0.606%
5:00-6:00	pm	22	4	0.063	2.115	0.580%
6:00-7:00	pm	15	2	0.063	1.442	0.395%
7:00-8:00	pm	11	0	0.067	1.058	0.290%
8:00-9:00	pm	14	3	0.047	1.346	0.369%
9:00-10:00	pm	5	1	0.036	0.481	0.132%
10:00-11:00	pm	7	0	0.045	0.673	0.184%
11:00-12:00	pm	8	1	0.030	0.769	0.211%
Total		260	25			

The hourly number of crashes was first identified for the studied arterial section (Column 3 in Table 3-1). However, the probabilities of incidents are too low because the length of the section (3.68 miles) is too short. Only about half of the 24 time periods have recorded crashes. In order to better capture the hourly incident distribution, hourly numbers of crashes for the entire arterial corridor (San Jose Blvd) were also identified (Column 2 in Table 3-1). Figure 3-1 shows the daily distribution for both the entire corridor and the study section based on the crash data. The figure shows that using the section data only does not show a clear trend in the probability of an incident by hour.

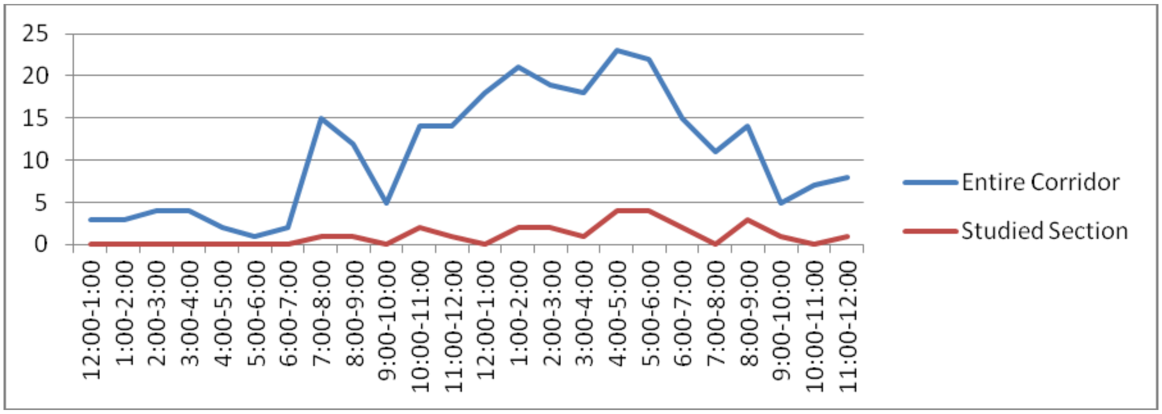

Figure 3-1 Daily Incident Distribution for the Entire Corridor and the Study Section (San Jose Boulevard)

In order to take into account these hourly trends, the following steps were followed in Table 3-1. First, hourly incident percentages for the entire corridor (Column 4) were calculated using the corresponding hourly number of incidents (Column 2) divided by the total number of incident for the entire corridor (260). Then, the number of incidents for the studied section was estimated by multiplying the hourly incident percent by the total number of section incidents (25). After that, the probability of an incident was calculated using the number of incidents divided by 365. The last column in the table provides the final calculation results which were inserted into the spreadsheet (Column Q of the Arterial Inputs tab).

<u>Example</u>

The calculation of the probability of an incident for 4:00 pm to 5:00 pm is presented below as an example to illustrate the calculation method discussed above.

First, given the total number of incidents for the entire corridor and the hourly number of incidents, the hourly incident percentage for this time period is:

$$Hourly\ Incident\ Percentage = \frac{Total\ Num.of\ Incidents\,(Entire\ Corridor)}{Hourly\ Number\ of\ Incidents} = \frac{23}{260} = 0.088 \quad (1)$$

Then, the number of incidents for the studied section during 4:00 pm to 5:00 pm is calculated as follows:

$$\begin{aligned} Number\ of\ Incidents &= Total\ Num.of\ Incidents\,(Section) \times Hourly\ Incident\ Factor \\ &= 25 \times 0.088 = 2.212 \end{aligned} \quad (2)$$

The probability for the studied time period can be calculated as:

$$\Pr ob.of\ \ Incidents = \frac{Number\,of\ \ Incidents}{365} = \frac{2.212}{365} = 0.606\% \qquad (3)$$

3.2 Use of the Incident Data for Beach Blvd. Between University Blvd. and I-295

This arterial corridor has three lanes in each direction. Therefore, both one-lane blocked incidents and two-lane blocked incidents were considered. The SHS crash data did not provide any lane blockage information, but accidents were divided into 7 categories based on the injury severity. The categorization is illustrated in Table 3-2.

Table 3-2 Categorization of Incidents Based on SHS

Accident Category	Injury Severity
0	Unknown
1	None
2	Possible
3	Non-Incapacitating
4	Incapacitating
5	Fatal (Within 30 Days)
6	Non-Traffic Fatality

Based on the injury severity, we assume that incidents of category 0-3 cause one-lane blockage and incidents of category 4, 5 and 6 cause two-lane blockage. Based on the categorization of the incidents, calculations of the probability of each incident category are presented in Table 3-3.

Table 3-3 Calculations of the Probability of Incident for Beach Boulevard between University Boulevard and I-295

Total # of incidents	ACCISEV >=4	2-Lane-Blocked to Total Incidents Ratio
84	8	0.095238095

Time Period		Number of Incidents		Probability of Incidents	Prob. of 1-Lane-Blocked Incidents	Prob. of 2-Lane-Blocked Incidents
		Entire Corridor	Studied Section			
12:00-1:00	am	15	1	0.274%	0.248%	0.0261%
1:00-2:00	am	8	2	0.548%	0.496%	0.0522%
2:00-3:00	am	15	3	0.822%	0.744%	0.0783%
3:00-4:00	am	5	0	0.100%	0.090%	0.0095%
4:00-5:00	am	3	0	0.100%	0.090%	0.0095%
5:00-6:00	am	2	1	0.274%	0.248%	0.0261%
6:00-7:00	am	4	3	0.822%	0.744%	0.0783%
7:00-8:00	am	15	2	0.548%	0.496%	0.0522%
8:00-9:00	am	16	5	1.370%	1.239%	0.1305%
9:00-10:00	am	13	2	0.548%	0.496%	0.0522%
10:00-11:00	am	16	5	1.370%	1.239%	0.1305%
11:00-12:00	am	30	6	1.644%	1.487%	0.1566%
12:00-1:00	pm	19	2	0.548%	0.496%	0.0522%
1:00-2:00	pm	32	3	0.822%	0.744%	0.0783%
2:00-3:00	pm	28	4	1.096%	0.992%	0.1044%
3:00-4:00	pm	34	8	2.192%	1.983%	0.2087%
4:00-5:00	pm	40	11	3.014%	2.727%	0.2870%
5:00-6:00	pm	25	7	1.918%	1.735%	0.1826%
6:00-7:00	pm	33	5	1.370%	1.239%	0.1305%
7:00-8:00	pm	19	4	1.096%	0.992%	0.1044%
8:00-9:00	pm	25	4	1.096%	0.992%	0.1044%
9:00-10:00	pm	19	2	0.548%	0.496%	0.0522%
10:00-11:00	pm	9	2	0.548%	0.496%	0.0522%
11:00-12:00	pm	15	2	0.548%	0.496%	0.0522%

Compared to San Jose Boulevard discussed in the previous subsection, this arterial section is longer (4.9 miles) and has more incidents in each time period. From Figure 2-2, it can be noted that the two daily incident distributions have similar trends. Therefore, probabilities of incidents (Column 4) were calculated directly using the section data (Column 3) divided by 365. For the time period with no incidents (3:00 am-4:00am and 4:00 am-5:00 am), a probability of 0.1% was assumed.

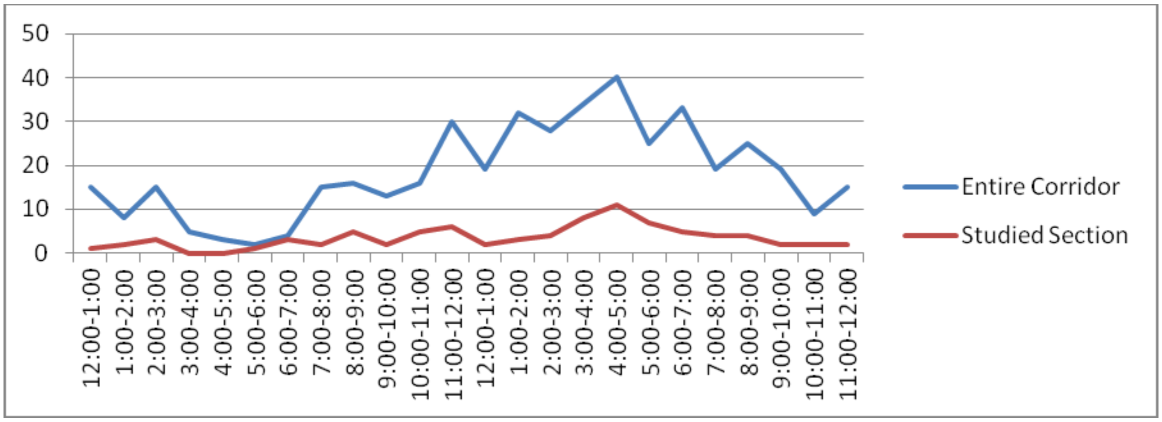

Figure 3-2 Daily Incident Distribution for the Entire Corridor and the Study Section (Beach Boulevard)

Since the frequency of two-lane blocked incidents is very low, it is not possible to calculate its probability directly using the hourly two-lane blocked incident data. Therefore, we first calculate the ratio of two-lane blocked incidents to total incidents. Then, the probability of the two-lane blocked incident (Column 6) was estimated by multiplying this ratio by the probability of total incidents. The probability of one-lane blocked incident (Column 5) was calculated using the probability of total incidents subtracting the probability of two-lane blocked incidents. The last two columns in Table 2-3 are the final calculation results inserted into the respective spreadsheet (Column Q of the Arterial Inputs tab).

<u>Example</u>

The calculation of the probability of incident for 5:00 pm to 6:00 pm is presented below as an example to illustrate the calculation method discussed above.

First, given the value of hourly number of incidents, the probability of total incidents is as follows:

$$\Pr ob.of\ Total\ Incidents = \frac{Number\ of\ Incidents}{365} = \frac{7}{365} = 1.918\% \tag{4}$$

Then, the two-lane blocked incidents to total incidents ratio is:

$$2\ Lane\ Blocked\ Incidents\ to\ Total\ Incidents\ Ratio$$
$$= \frac{Total\ Num.of\ 2\ Lane\ Blocked\ Incidents\,(Section)}{Total\ Num.of\ Incidents\,(Section)} = \frac{8}{84} = 0.0952 \tag{5}$$

The probabilities of incidents for the studied time period can be calculated as:

$$\begin{aligned}&\Pr ob.of\ 2\,Lane\,Blocked\ Incidents = \Pr ob.of\ Total\ Incidents \times 2\,Lane\,to\,Total\ Ratio\\ &\qquad = 1.918\% \times 0.0952 = 0.1826\%\end{aligned} \tag{6}$$

$$\begin{aligned}&\Pr ob.of\ 1\,Lane\,Blocked\ Incidents\\ &\qquad = \Pr ob.of\ Total\ Incidents - \Pr ob.of\ 2\,Lane\,Blocked\ Incidents\\ &\qquad = 1.918\% - 0.1826\% = 1.735\%\end{aligned} \tag{7}$$

3.3 Use of the Incident Data for Atlantic Boulevard Between University Boulevard and Southside Boulevard

This arterial corridor has two lanes in each direction. Therefore, all incidents occurring along this corridor were assumed to be 1-lane blocked incidents. Calculations of the probability of incident are presented in Table 3-4.

Table 3-4 Calculations of the Probability of Incident for Atlantic Boulevard between University Boulevard and Southside Boulevard

Time Period		Number of Incidents		Hourly Incident Percentage	Number of Incidents	Probability of Incidents
		Entire Corridor	Studied Section			
12:00-1:00	am	32	1	0.012	4.617	1.265%
1:00-2:00	am	4	1	0.012	0.577	0.158%
2:00-3:00	am	15	0	0.015	2.164	0.593%
3:00-4:00	am	8	0	0.015	1.154	0.316%
4:00-5:00	am	5	0	0.008	0.721	0.198%
5:00-6:00	am	3	0	0.004	0.433	0.119%
6:00-7:00	am	11	2	0.008	1.587	0.435%
7:00-8:00	am	16	3	0.058	2.308	0.632%
8:00-9:00	am	19	0	0.046	2.741	0.751%
9:00-10:00	am	11	4	0.019	1.587	0.435%
10:00-11:00	am	15	4	0.054	2.164	0.593%
11:00-12:00	am	19	0	0.054	2.741	0.751%
12:00-1:00	pm	31	6	0.069	4.472	1.225%
1:00-2:00	pm	24	3	0.081	3.462	0.949%
2:00-3:00	pm	44	8	0.073	6.348	1.739%
3:00-4:00	pm	35	8	0.069	5.049	1.383%
4:00-5:00	pm	36	10	0.088	5.194	1.423%
5:00-6:00	pm	32	3	0.085	4.617	1.265%
6:00-7:00	pm	32	5	0.058	4.617	1.265%
7:00-8:00	pm	34	3	0.042	4.905	1.344%
8:00-9:00	pm	24	3	0.054	3.462	0.949%
9:00-10:00	pm	18	2	0.019	2.597	0.711%
10:00-11:00	pm	23	5	0.027	3.318	0.909%
11:00-12:00	pm	15	2	0.031	2.164	0.593%
Total		506	73			

The hourly number of crashes was first identified for the studied arterial section (Column 3 in Table 3-4). Similar to San Jose Boulevard discussed in subsection 2.1.1, the probabilities of incidents are too low for this arterial section, thus using the section data only does not show a clear trend in the probability of incidents by hour. Figure 3-3 shows the daily distribution for both the entire corridor and the section based on the crash data.

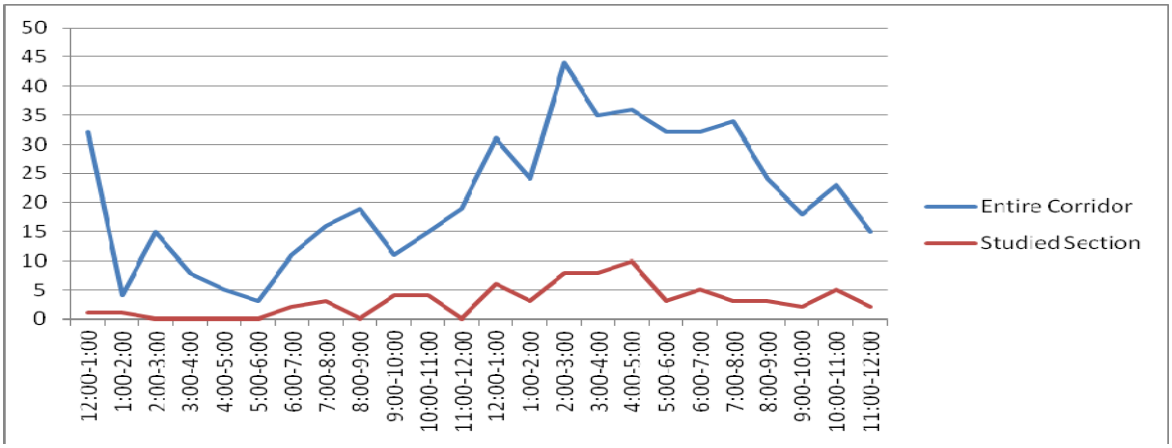

Figure 3-3 Daily Incident Distribution for the Entire Corridor and the Study Section (Atlantic Boulevard)

In order to better capture the hourly incident distribution, hourly numbers of crashes for the entire arterial corridor (San Jose Blvd) were identified (Column 2 in Table 2-1). Then, hourly incident percentages for the entire corridor (Column 4) were calculated using the corresponding hourly number of incidents (Column 2) divided by the total number of incidents for the entire corridor (506). After that, the number of incidents for the studied section (Column 5) was estimated by multiplying the hourly incident percent by the total number of section incidents (73), and the probability of incidents (Column 6) was calculated using the number of incidents divided by 365. The last column in table 2-4 provides the final calculation results which were inserted into the spreadsheet (Column Q of the Arterial Inputs tab). The entire calculation process for this arterial is the same as the example calculation discussed in subsection 3.1.

3.4 Use of the Incident Data for San Jose Boulevard between Baymeadows Road and I-295

This arterial corridor has three lanes in each direction. Therefore, both the one-lane blocked incident and the two-lane blocked incident were considered. As discussed previously, we assumed those incidents of category 0-3 cause one-lane blockages, and incidents of category 4, 5, and 6 cause two-lane blockages. Based on this assumption, calculations of the probability of each incident category are presented in Table 3-5.

Table 3-5 Calculations of the Probability of Incident for San Jose Boulevard between Baymeadows Road and I-295

Total # of incidents	ACCISEV >=4	2-Lane-Blocked to Total Incidents Ratio
260	16	0.061538462

Time Period		Number of Incidents		Probability of Incidents	Prob. of 1-Lane-Blocked Incidents	Prob. of 2-Lane-Blocked Incidents
		Entire Corridor	Studied Section			
12:00-1:00	am	3	2	0.548%	0.524%	0.0244%
1:00-2:00	am	3	1	0.274%	0.262%	0.0122%
2:00-3:00	am	4	0	0.100%	0.096%	0.0044%
3:00-4:00	am	4	3	0.100%	0.096%	0.0044%
4:00-5:00	am	2	1	0.100%	0.096%	0.0044%
5:00-6:00	am	1	1	0.274%	0.262%	0.0122%
6:00-7:00	am	2	2	0.548%	0.524%	0.0244%
7:00-8:00	am	15	5	1.370%	1.309%	0.0609%
8:00-9:00	am	12	6	1.644%	1.571%	0.0731%
9:00-10:00	am	5	1	0.274%	0.262%	0.0122%
10:00-11:00	am	14	8	2.192%	2.094%	0.0974%
11:00-12:00	am	14	2	0.548%	0.524%	0.0244%
12:00-1:00	pm	18	6	1.644%	1.571%	0.0731%
1:00-2:00	pm	21	7	1.918%	1.833%	0.0852%
2:00-3:00	pm	19	5	1.370%	1.309%	0.0609%
3:00-4:00	pm	18	6	1.644%	1.571%	0.0731%
4:00-5:00	pm	23	7	1.918%	1.833%	0.0852%
5:00-6:00	pm	22	9	2.466%	2.356%	0.1096%
6:00-7:00	pm	15	6	1.644%	1.571%	0.0731%
7:00-8:00	pm	11	5	1.370%	1.309%	0.0609%
8:00-9:00	pm	14	5	1.370%	1.309%	0.0609%
9:00-10:00	pm	5	0	0.100%	0.096%	0.0044%
10:00-11:00	pm	7	1	0.274%	0.262%	0.0122%
11:00-12:00	pm	8	1	0.274%	0.262%	0.0122%

Based on the field crash data, daily incident distributions for both the entire corridor and the studied arterial section are plotted in Figure 3-4. The figure shows that the two daily incident distributions have similar trends. Therefore, probabilities of incidents (Column 4) were calculated directly using the section data (Column 3) divided by 365. For the time period with no incidents (2:00 am-3:00 am and 9:00 pm-10:00 pm), a probability of 0.1% was assumed.

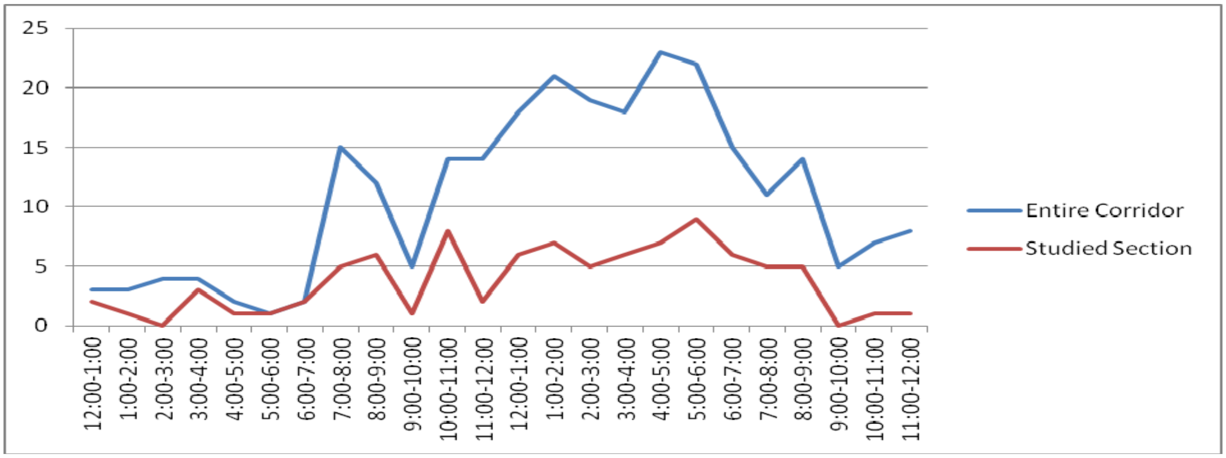

Figure 3-4 Daily Incident Distribution for the Entire Corridor and the Study Section (San Jose Boulevard)

The calculation process for this arterial is the same as the example calculation discussed in 3.2. The frequency of two-lane blocked incidents is very low and it is not possible to calculate its probability directly using the hourly two-lane blocked incident data. Therefore, we first calculate the ratio of two-lane blocked incidents to total incidents (0.0615). Then, the probability of the two-lane blocked incident (Column 6) was estimated by multiplying this ratio by the probability of total incidents. The probability of one-lane blocked incident (Column 5) was calculated using the probability of total incidents subtracting the probability of two-lane blocked incidents. The last two columns in Table 2-5 are the final calculation results inserted into the respective spreadsheet (Column Q of the Arterial Inputs tab).

4 MODEL VALIDATION AND FINAL RESULTS

4.1 Comparison of the Estimated Travel Time with Field Data

Travel times estimated using the travel time estimation spreadsheet were first compared to the field travel time data discussed in Chapter 2. Three travel time performance measures (hourly average travel time, daily average travel time, and 95% travel time), as well as the equivalent speed were compared. Table 4-1 through 4-4 present the values of these performance measures for the four arterial corridors identified in Table 2-1. Figure 4-1 through 4-4 plot the hourly average travel time for both the estimated values and the field data.

Table 4-1 Comparison for San Jose Blvd. between University Blvd and Baymeadows Rd.

		Field Data		Estimated Values	
		Travel Time (sec)	Speed (mph)	Travel Time (sec)	Speed (mph)
Hourly Average Travel Time	12:00 am-1:00 am	325.26	40.73	383.61	34.54
	1:00 am-2:00 am	321.53	41.20	275.23	48.13
	2:00 am-3:00 am	317.29	41.75	273.47	48.44
	3:00 am-4:00 am	315.90	41.94	275.97	48.01
	4:00 am-5:00 am	310.90	42.61	276.92	47.84
	5:00 am-6:00 am	304.04	43.57	409.38	32.36
	6:00 am-7:00 am	293.64	45.12	463.63	28.57
	7:00 am-8:00 am	306.36	43.24	515.20	25.71
	8:00 am-9:00 am	339.53	39.02	500.58	26.47
	9:00 am-10:00 am	338.09	39.19	490.41	27.01
	10:00 am-11:00 am	328.57	40.32	497.38	26.64
	11:00 am-12:00 pm	325.84	40.66	503.77	26.30
	12:00 pm-1:00 pm	329.11	40.25	508.87	26.03
	1:00 pm-2:00 pm	334.51	39.60	513.18	25.82
	2:00 pm-3:00 pm	336.25	39.40	521.04	25.43
	3:00 pm-4:00 pm	341.31	38.81	538.69	24.59
	4:00 pm-5:00 pm	346.37	38.25	557.90	23.75
	5:00 pm-6:00 pm	349.65	37.89	559.15	23.69
	6:00 pm-7:00 pm	360.52	36.75	503.70	26.30
	7:00 pm-8:00 pm	348.76	37.99	464.37	28.53
	8:00 pm-9:00 pm	339.90	38.98	440.58	30.07
	9:00 pm-10:00 pm	333.52	39.72	427.55	30.99
	10:00 pm-11:00 pm	330.45	40.09	411.41	32.20
	11:00 pm-12:00 am	326.94	40.52	397.36	33.34
Daily Average		329.34	40.23	446.22	29.69
95% Value		377.90	35.06	490.67	27.00

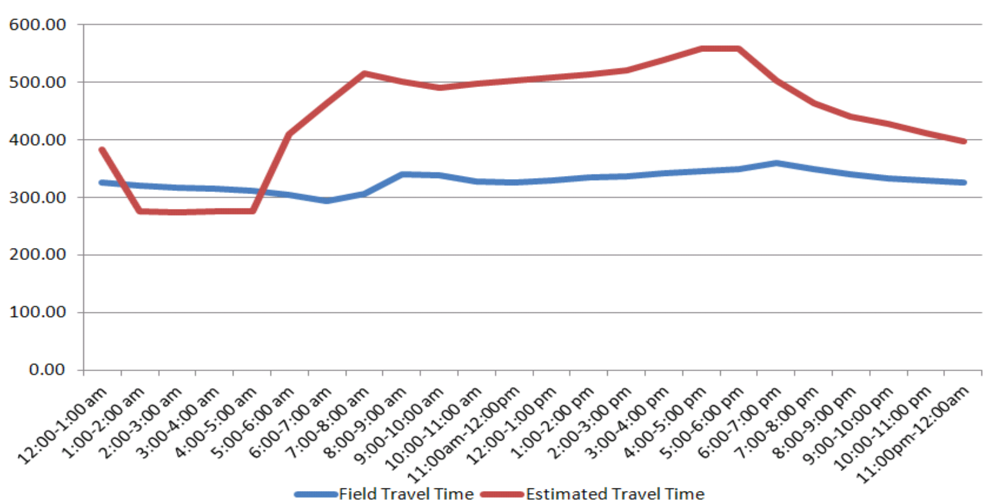

Figure 4-1 Comparison for San Jose Blvd between University Blvd. and Baymeadows Rd.

Table 4-2 Comparison for Beach Blvd. between University Blvd. and I-295

		Field Data		Estimated Values	
		Travel Time (sec)	Speed (mph)	Travel Time (sec)	Speed (mph)
Hourly Average Travel Time	12:00 am-1:00 am	569.99	30.95	614.05	28.73
	1:00 am-2:00 am	552.49	31.93	373.66	47.21
	2:00 am-3:00 am	527.19	33.46	375.51	46.98
	3:00 am-4:00 am	507.99	34.73	372.24	47.39
	4:00 am-5:00 am	497.69	35.44	374.25	47.13
	5:00 am-6:00 am	486.79	36.24	655.12	26.93
	6:00 am-7:00 am	486.72	36.24	745.28	23.67
	7:00 am-8:00 am	499.32	35.33	832.19	21.20
	8:00 am-9:00 am	570.77	30.91	816.19	21.61
	9:00 am-10:00 am	591.39	29.83	788.15	22.38
	10:00 am-11:00 am	591.30	29.83	800.32	22.04
	11:00 am-12:00 pm	593.85	29.70	819.79	21.52
	12:00 pm-1:00 pm	618.93	28.50	833.18	21.17
	1:00 pm-2:00 pm	647.23	27.25	843.34	20.92
	2:00 pm-3:00 pm	655.97	26.89	854.36	20.65
	3:00 pm-4:00 pm	681.78	25.87	911.93	19.34
	4:00 pm-5:00 pm	690.87	25.53	962.69	18.32
	5:00 pm-6:00 pm	693.84	25.42	950.44	18.56
	6:00 pm-7:00 pm	706.49	24.97	823.57	21.42
	7:00 pm-8:00 pm	686.46	25.70	746.24	23.64
	8:00 pm-9:00 pm	659.00	26.77	709.57	24.86
	9:00 pm-10:00 pm	633.00	27.87	691.30	25.52
	10:00 pm-11:00 pm	611.26	28.86	659.37	26.75
	11:00 pm-12:00 am	594.99	29.65	635.90	27.74
Daily Average		598.14	29.49	716.19	24.63
95% Value		789.90	22.33	801.82	22.00

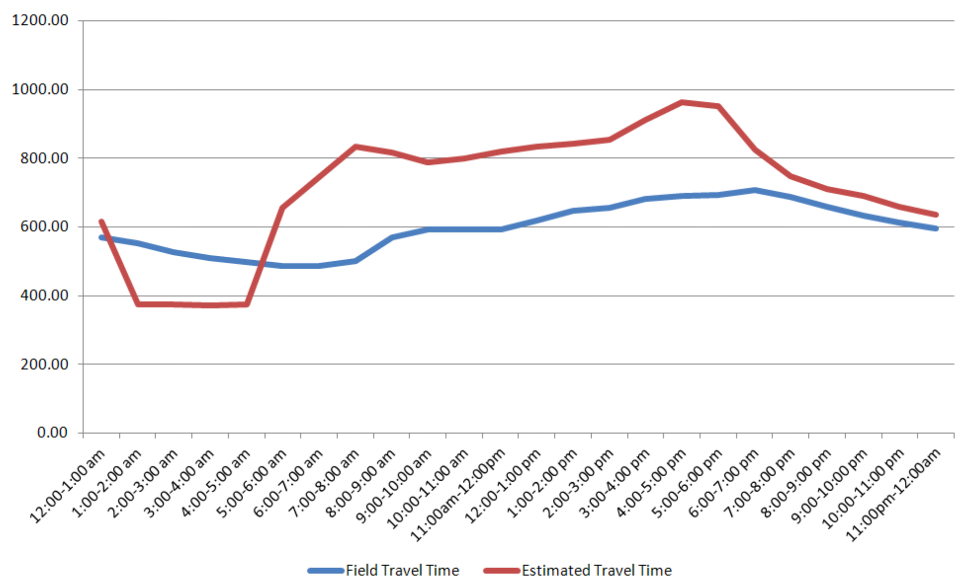

Figure 4-2 Comparison for Beach Blvd between University Blvd. and I-295

Table 4-3 Comparison for Atlantic Blvd between University Blvd. and Southside Blvd.

		Field Data		Estimated Values	
		Travel Time (sec)	Speed (mph)	Travel Time (sec)	Speed (mph)
Hourly Average Travel Time	12:00 am-1:00 am	297.07	30.30	330.43	27.24
	1:00 am-2:00 am	293.20	30.70	208.73	43.12
	2:00 am-3:00 am	292.35	30.78	207.98	43.27
	3:00 am-4:00 am	288.68	31.18	209.24	43.01
	4:00 am-5:00 am	288.54	31.19	210.07	42.84
	5:00 am-6:00 am	274.91	32.74	349.85	25.73
	6:00 am-7:00 am	260.41	34.56	392.79	22.91
	7:00 am-8:00 am	257.08	35.01	429.46	20.96
	8:00 am-9:00 am	273.30	32.93	421.94	21.33
	9:00 am-10:00 am	273.07	32.96	412.56	21.81
	10:00 am-11:00 am	281.33	31.99	416.18	21.63
	11:00 am-12:00 pm	285.50	31.52	424.39	21.21
	12:00 pm-1:00 pm	295.12	30.50	432.39	20.81
	1:00 pm-2:00 pm	301.55	29.85	431.15	20.87
	2:00 pm-3:00 pm	304.53	29.55	441.83	20.37
	3:00 pm-4:00 pm	311.87	28.86	454.39	19.81
	4:00 pm-5:00 pm	320.28	28.10	467.22	19.26
	5:00 pm-6:00 pm	323.22	27.84	469.06	19.19
	6:00 pm-7:00 pm	321.09	28.03	425.53	21.15
	7:00 pm-8:00 pm	313.41	28.72	394.83	22.79
	8:00 pm-9:00 pm	310.79	28.96	373.89	24.07
	9:00 pm-10:00 pm	311.25	28.92	363.91	24.73
	10:00 pm-11:00 pm	311.70	28.87	351.73	25.59
	11:00 pm-12:00 am	309.93	29.04	340.75	26.41
Daily Average		295.84	30.42	373.35	24.11
95% Value		354.00	25.42	409.09	22.00

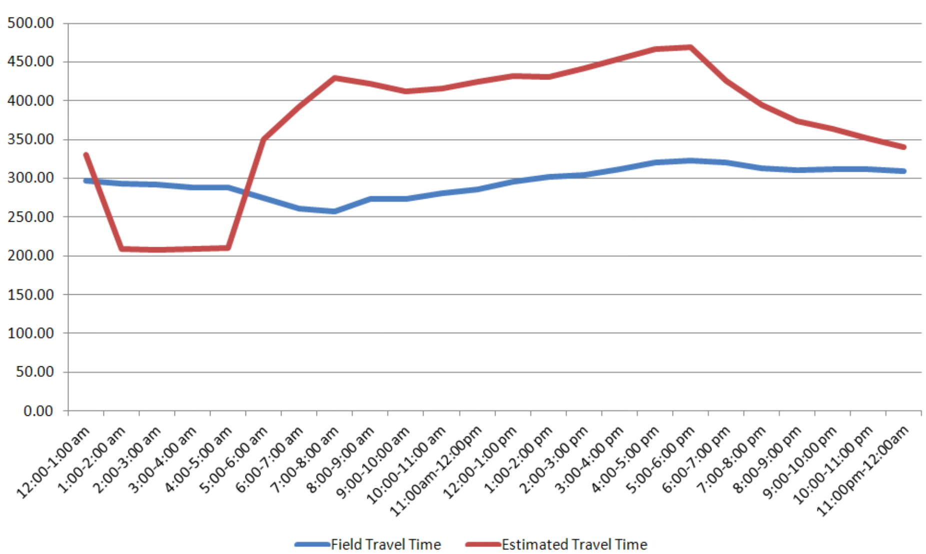

Figure 4-3 Comparison for Atlantic Blvd. between University Blvd. and Southside Blvd.

Table 4-4 Comparison for San Jose Blvd. between Baymeadows Rd. and I-295

		Field Data		Estimated Values	
		Travel Time (sec)	Speed (mph)	Travel Time (sec)	Speed (mph)
Hourly Average Travel Time	12:00 am-1:00 am	310.72	41.94	454.97	28.64
	1:00 am-2:00 am	306.52	42.52	275.03	47.38
	2:00 am-3:00 am	298.34	43.68	272.91	47.75
	3:00 am-4:00 am	287.11	45.39	275.05	47.38
	4:00 am-5:00 am	276.29	47.17	276.52	47.13
	5:00 am-6:00 am	265.33	49.12	484.55	26.90
	6:00 am-7:00 am	250.51	52.02	548.26	23.77
	7:00 am-8:00 am	273.35	47.68	604.84	21.55
	8:00 am-9:00 am	324.17	40.20	591.34	22.04
	9:00 am-10:00 am	334.67	38.94	576.05	22.62
	10:00 am-11:00 am	338.70	38.48	584.57	22.29
	11:00 am-12:00 pm	350.63	37.17	592.67	21.99
	12:00 pm-1:00 pm	365.81	35.63	605.34	21.53
	1:00 pm-2:00 pm	385.43	33.81	606.38	21.49
	2:00 pm-3:00 pm	397.56	32.78	614.37	21.21
	3:00 pm-4:00 pm	398.54	32.70	643.95	20.24
	4:00 pm-5:00 pm	389.02	33.50	665.75	19.57
	5:00 pm-6:00 pm	399.79	32.60	679.55	19.18
	6:00 pm-7:00 pm	407.35	31.99	592.65	21.99
	7:00 pm-8:00 pm	377.85	34.49	549.07	23.73
	8:00 pm-9:00 pm	349.61	37.28	522.06	24.96
	9:00 pm-10:00 pm	335.02	38.90	508.11	25.65
	10:00 pm-11:00 pm	326.51	39.91	487.09	26.75
	11:00 pm-12:00 am	319.36	40.81	470.72	27.69
Daily Average		336.17	38.77	520.07	25.06
95% Value		481.90	27.04	592.36	22.00

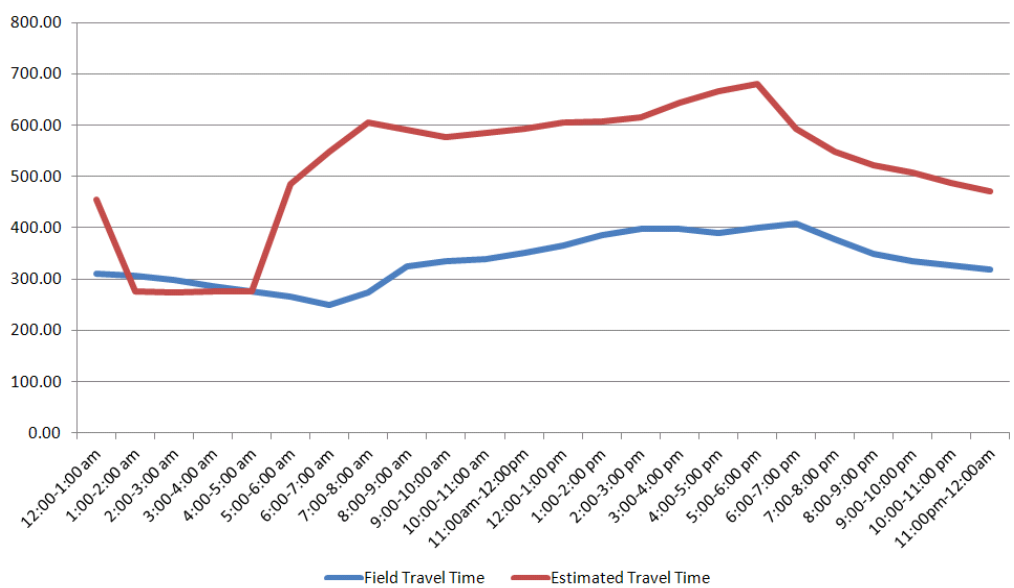

Figure 4-4 Comparison for San Jose Blvd. between Baymeadows Rd. and I-295

As shown in the figures and the tables above, despite the different travel time patterns that each arterial corridor has, the estimated travel time for these corridors are consistently higher than the field data during the day except for the early morning time period (1:00 am-5:00 am). The reason for the significant travel time drop during 1:00 am-5:00 am is the assumption that we made regarding conditions during this time. We assumed that for this time period, the occurrence probability for yellow flashing is 100 %, and the corresponding vehicle speed during this time period is free-flow speed for the "No Rain" scenario. For the "Flashing with Rain" scenario, free flow speed reduction and capacity reduction from rain were also considered. Therefore, only during this time period, the estimated travel times are lower than the field data. For the other time periods, estimated travel times are all higher than the field data, especially for the congested peak hour time.

In order to investigate which part of the calculation model caused this travel time overestimation, two additional comparisons were conducted between the field data and estimated travel time under different scenarios. Since the comparisons for the four arterial corridors have similar results, only the results for San Jose Boulevard (between University Blvd. and Baymeadows Rd.) are presented below as an example.

The first comparison is between the field travel time data and the estimated travel time without consideration of the "Yellow Flashing" scenario. The estimated hourly travel times used in this comparison were calculated based on the assumption that intersection signals are always active. Figure 4-5 shows the comparison results. As shown, estimated travel times are higher than field data for all time periods. We can conclude that the estimation model with consideration of the four factors (rain, incidents, work zones and congestion), overestimate arterial travel time.

A second comparison was conducted between field data and the estimated travel time for the "No Rain, No Incident, No Work zone, Undersaturated" scenario (Figure 4-6). As shown, the estimated travel times are still higher than the field data for all the time periods. Also, a comparison of Figure 4-5 and Figure 4-6 shows that the estimated travel time was not reduced much after the exclusion of the rain, incident, work zone or congestion impacted scenarios. Thus, we conclude that the difference is not due to the consideration for these scenarios, but that the model for the basic scenario causes the overestimation. Therefore, coefficients of the parameters used in the estimation model need to be adjusted based on the field data.

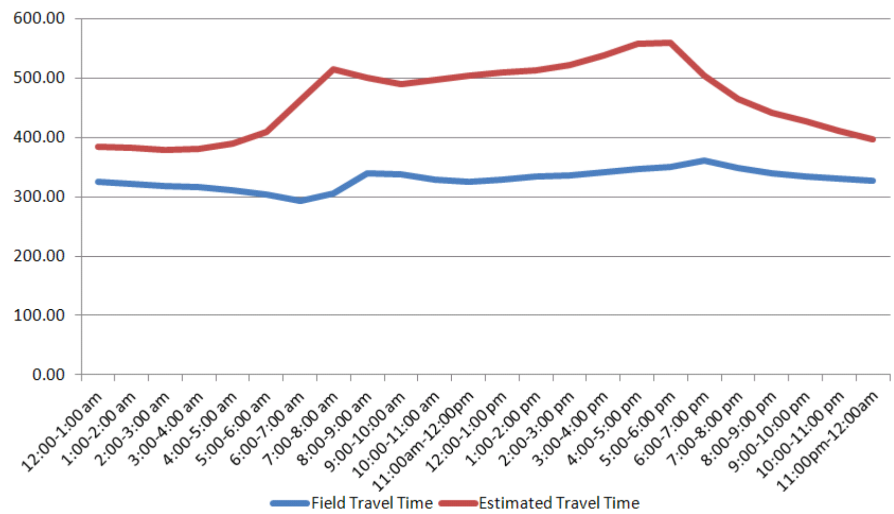

Figure 4-5 Comparison between Field Data and the Estimated Travel Time without Consideration of the "Yellow Flashing" Scenario

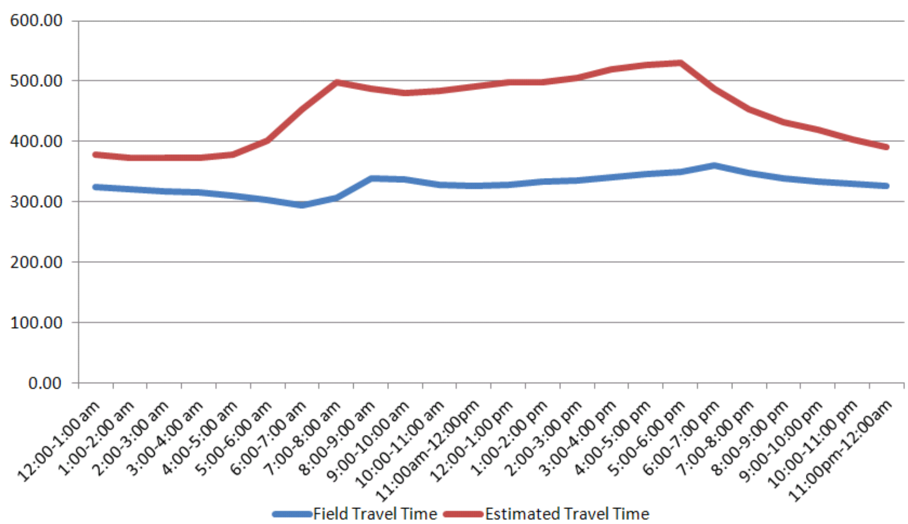

Figure 4-6 Comparison between Field Data and the Estimated Travel Time under "No Rain, No Incident, No Work zone, Undersaturated" Scenario

4.2 Revision of the Original Travel Time Estimation Models

As discussed in the previous subsection, the comparison between the model-estimated travel time and field data showed that the original model greatly overestimated the arterial travel time.

By examining the simulation models used to develop the original travel time estimation model, we found the simulated intersections along the arterials all implemented pre-timed signal control. However, the intersections in the four study sites all had actuated control, which resulted in lower delay. Therefore, the research team developed a new set of travel time estimation models based on actuated control, which was more suitable for intersections along the SIS.

This subsection describes the development of the new travel time estimation models based on actuated signalized network models. The of CORSIM™ traffic microsimulator was used to develop the models. The first part describes the development of the of CORSIM™ network and the factors considered for inclusion in the models. The second part summarizes the results of the simulated scenarios, while the third part presents the proposed travel time estimation models which were developed based on the simulation results.

4.2.1 Identification of Significant Factors and Development of the Simulated Scenarios

There are several factors that potentially affect travel time along arterials. When developing the previous travel time estimation model, nine factors were considered because of their potential effect on travel time, and also because of their availability to be used as input factors when using the model. These nine factors are: number of lanes, number of signals per mile, free-flow speed, demand, cycle length, *g/C* ratio, percent of lanes blocked by incidents, incident duration, and quality of progression. Since the of CORSIM™ network used for developing the new model implemented actuated signal control, cycle length and *g/C* ratio vary cycle by cycle. Therefore, these two factors were not considered as a potential variable in the new model.

An arterial section 1 mile long was simulated in CORSIM™, and a series of scenarios were developed and implemented on this section. The following paragraphs discuss the development of the simulated scenarios as they relate to each potential variable.

<u>1. Number of Signals Per Mile</u>

The number of signals per mile can have a significant effect on travel time. When developing the pre-timed model, three different scenarios were considered for this factor: 1, 4, and 7 signals per mile. In order to better capture the effect of this factor under different scenarios, four different scenarios were simulated and tested for developing the new model : arterials with 1 signal per mile, 3 signals per mile, 5 signals per mile, and 7 signals per mile. For the scenarios with more than one signal along the arterial, one of those signals was assumed to be a major intersection and the others minor intersections. 250-ft left-turn pockets were assumed to be provided at each intersection approach along the main street and 150-ft left-turn pockets were provided for approaches on side streets.

Signal timing plans for the major and minor intersections are presented in Figure 4-7, Table 4-5 and Table 4-6. Standard NEMA phasing was used for all the intersections. Minimum recall is used for the major street through movement (phase 2 and 6).

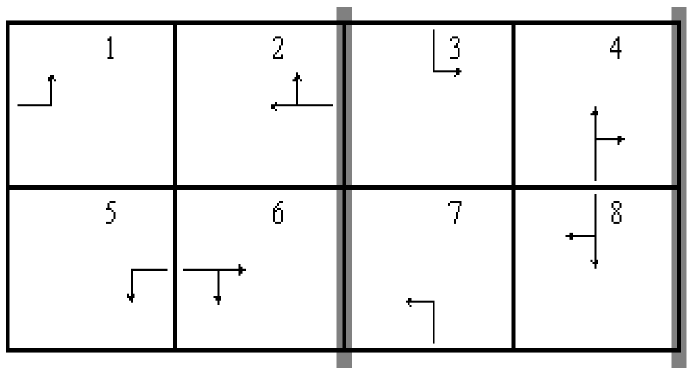

Figure 4-7 Phasing Diagram Used at All Simulated Intersections

Table 4-5 Timing Plan for Major Intersections

Phase	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Max Green	20	50	15	35	20	50	15	35
Min Green	4	15	4	8	4	15	4	8
Yellow	4	4	4	4	4	4	4	4
Red	1	1	1	1	1	1	1	1
Passage Time	3	3.5	2.5	3	3	3.5	2.5	3

Table 4-6 Timing Plan for Minor Intersections

Phase	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Max Green	20	50	20	25	20	50	20	25
Min Green	4	15	6	6	4	15	6	6
Yellow	4	4	4	4	4	4	4	4
Red	1	1	1	1	1	1	1	1

Passage Time	3	3.5	2.5	3	3	3.5	2.5	3

2. Number of Lanes

Both the two-lane and the three-lane scenarios were simulated for the main arterial. Regarding side streets, it was assumed that side streets at major intersections have two through lanes and side streets at minor intersections have only one through lane.

3. Free-flow Speed (mph)

Regarding Free-flow Speed (FFS), two scenarios were tested for the main arterial: 35 mph and 45 mph. For side streets, FFS was assumed to be 35 mph for side streets at major intersections and 30 mph for side streets at minor intersections.

4. Demand (vphpl)

The tested scenarios for the main arterial are: 100,300, 500, 800, 900, 1000, 1100, 1200 vphpl. Many more scenarios were tested compared to the scenarios simulated for developing the pre-timed model (100, 500, 800, 1200 vphpl for the main arterial). This is because travel time is very sensitive to the changes in demand especially for oversaturated conditions. Also, the nonlinear relationship between travel time and demand for oversaturated conditions is difficult to capture using a limited number of scenarios.

For side streets, it was assumed that when demand for the main arterial is 100, 300 or 500 vphpl, for side streets, the demand is 200 vphpl for minor intersections and 400 vphpl for major intersections. For scenarios when the main arterial is 800, 1000, or 1200 vphpl, side street demand is assumed to be 500 vphpl at minor intersections and 800 vphpl at major intersections.

For the main arterial, the percent of both the right- and left-turning movements were assumed to be 15% for major intersections and 5% for minor intersection. For side streets, the percent of the right- and left-turning movements are assumed to be 15% for major intersections and 25% for minor intersections. The percent of heavy vehicles for the entire network was assumed to be zero.

5. Incident Duration (min)

The following incident durations were tested: no incidents (base case), 15 min, and 30 min. All the incidents were assumed to occur on one link near the major intersection starting at time 100 sec (the total simulation time is 3600 sec).

6. Percent of Lanes Blocked by Incident

Since of CORSIM™ permits only one long term event on a link at any moment, only one lane blockage can be simulated on any particular link for the incident scenarios. Therefore, the research team tested the following lane-closure scenarios: 1) single lane closure along a 2-lane arterial, and 2) single lane closure along a 3-lane arterial.

To incorporate the number of lanes blocked into the travel time estimation models, the following index was employed:

$$Lane\ Blocked\ Index = \frac{Num.of\ \ Lanes\ Blocked\ by\ Incidents}{Total\ Num.of\ \ Lanes\ per\ Direction} \tag{8}$$

Accordingly, the tested scenarios are: 1/2 (incident blocks one lane on a 2-lane arterial) and 1/3 (incident blocks one lane on a 3-lane arterial).

7. Quality of Progression

Two categories of progression were tested: favorable progression and unfavorable progression. If all the intersections along the arterial are coordinated, the scenario is considered as favorable progression, otherwise, the scenario has unfavorable progression.

For the coordinated scenario, the main street through phase was designated as the coordinated phase. A 100-second cycle length were selected for the coordinated signal timing. Splits were calculated based on the demand of different movements, and values presented in Table 4-7 were implemented in the simulation model. Offsets were calculated considering the travel speed and the distances between intersections.

Table 4-7 Split Used for the Coordinated Signal Timing

Phase	1	2	3	4	5	6	7	8
Major Intersection	16	40	12	32	16	40	12	32
Minor Intersection	16	45	17	22	16	45	17	22

The scenarios tested and the assumptions associated with each factor are summarized in Table 4-8 for both the actuated model and the pre-timed model. The actuated-control based models were developed using the same method as the original pre-timed models. However, these revised models tested additional scenarios for factors with a significant effect on travel time, such as number of signals per mile and demand.

Table 4-8 Summary of the Tested Scenarios and Assumptions

	Actuated Models	Pre-timed Models
Number of Signals Per Mile	• Scenarios of 1, 3, 5, and 7 signals per mile were tested. • Actuated signal timing for all intersections. • 250-ft left-turn pockets on main street and 150-ft left-turn pockets on sidestreets.	• Scenarios of 1, 4, and 7 signals per mile were tested. • Pre-timed signal timing for all intersections. • 250-ft left-turn pockets for all intersection approaches.
Number of Lanes	• 2 lane and 3 lane scenario were tested for main arterial. • Side streets at major intersections has 2 through lanes and side streets at minor intersections has 1 through lane.	• 2 lane and 3 lane scenario were tested for main arterial. • All side streets were assumed to have 2 through lanes.
FFS	• 35 mph and 45 mph for the the main arterial. • 35 mph for side streets at major intersetions and 30 mph for side streets at minor intersections.	• 35 mph and 45 mph for the the main arterial. • All side streets have 35 mph FFS.
Demand	• 100,300, 500, 800, 900, 1000, 1100, and 1200 vphpl for the the main arterial. • When the main arterial has 100, 300 or 500 vphpl, for side streets, the demand is 200 vphpl at minor intersections and 400 vphpl at major intersections. For the other	• 100,500, 800, and 1200 vphpl for the the main arterial. • 500 vphpl for side streets at minor intersections and 800 vphpl for side streets at major intersections. • For all approaches, percent of both the

Table 4-8 Summary of the Tested Scenarios and Assumptions (Cont'd)

	Actuated Models	Pre-timed Models
	scenarios, 500 vphpl for side streets at minor intersections and 800 vphpl at major intersections. • For main arterial approaches, right- and left-turning movements are 15% at major intersections and 5% at minor intersection. For side street approaches, percent of the right- and left-turning movements are 15% at major intersections and 25% at minor intersections. • Percent of heavy vehicles for the entire network is zero	right- and left-turning movements are assumed to be 15% at major intersections and 5% at minor intersection. • Percent of heavy vehicles for the entire network is zero.
Incident Duration	• Scenarios of no incidents (base case), 15 min, and 30 min were tested. • The incidents were assumed to occur on one link near the major intersection at time 100 sec.	• Scenarios of no incidents (base case), 15 min, and 30 min were tested. • The incidents were assumed to occur on one link near the major intersection at time 100 sec.
Percent of Lanes Blocked by Incident	• Scenarios of 0 (base case), 1/2, and 1/3 were tested.	• Scenarios of 0 (base case), 1/2, and 1/3 were tested.
Quality of Progression	• If all the intersections along the arterial are coordinated, the scenario is considered as favorable progression, otherwise, the scenario is unfavorable.	• A preliminary analysis was conducted for 88 basic scenarios to determine which set of offsets would result in favorable and unfavorable progression.
Cycle length	N/A	• Two scenarios of 100 sec and 140 sec were tested.
Weighted *g/C* ratio	N/A	• Scenarios of 0.4, 0.45, and 0.5 were tested. • g/C ratios of 0.3 and 0.6 were also tested for undersaturated and non-incident conditions.

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Based on the seven factors discussed above, a total of 504 scenarios were tested for developing the new models, as shown in Table 4-9.

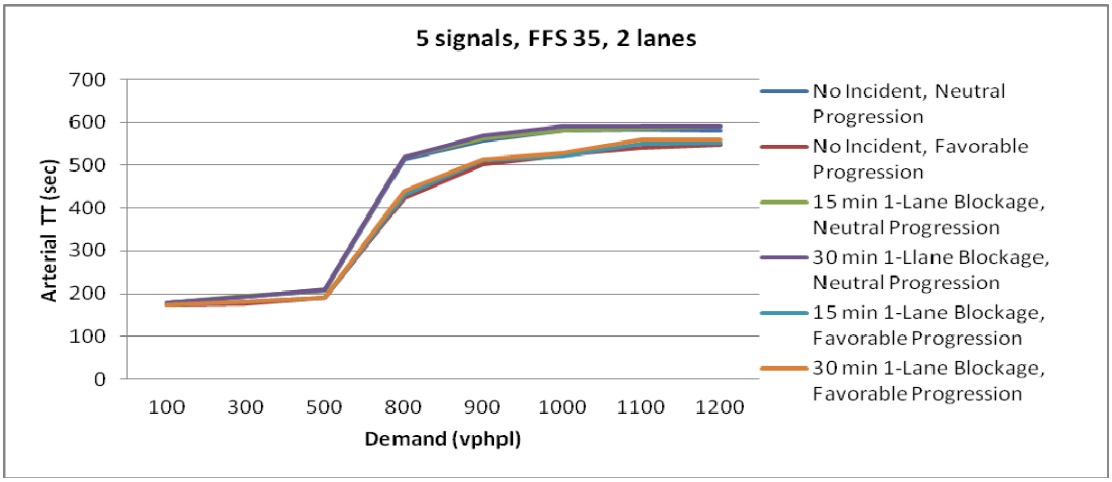
Table 4-9 List of Scenarios Used for Developing Travel Time Estimation Model

	# of signals/mile	FFS (mph)	Demand (vphpl)	Incident Duration (min)	# of Lanes Blocked by Incident	Quality of Progression	# of Scenarios
2-lane Arterial	1 3 5 7	35 45	100 300 500 800 900 1000 1100 1200	0 15 30	No Incident 1-lane Blocked Incident	1-Favorable 0-Neutral	336
3-lane Arterial	1 3 5 7	45	100 300 500 800 900 1000 1100 1200	0 15 30	No Incident 1-lane Blocked Incident	1-Favorable 0-Neutral 1	168
Total # of Scenarios							504

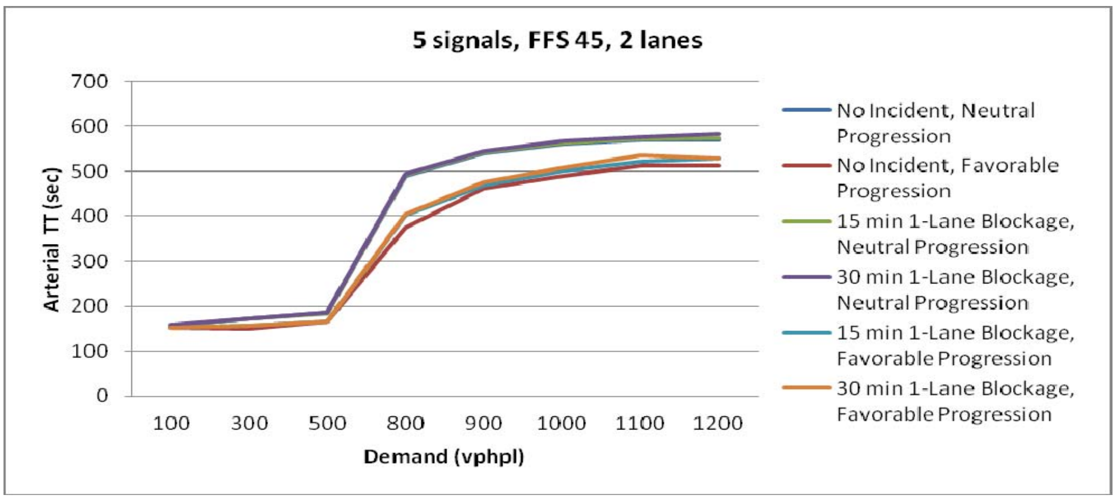
Due to the stochastic nature of CORSIM™, a relatively large number of runs are required in order to estimate the performance measures with reasonable accuracy. Therefore, the simulated travel times are all the average of 10 simulation runs for each scenario, to account for the stochastic variability.

4.2.2 Preliminary Analysis of the Travel Time Estimates

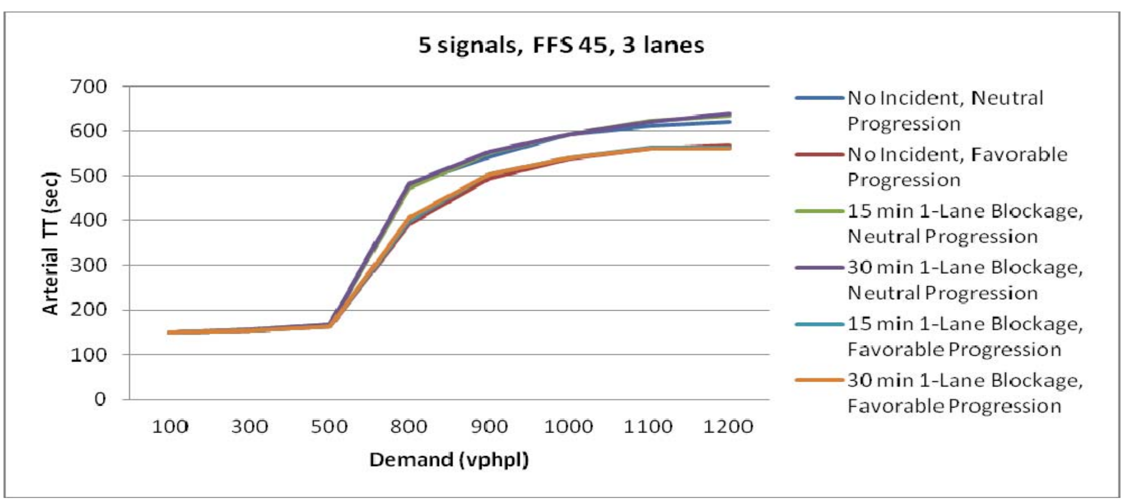
After all scenario runs were completed, a preliminary analysis was conducted to assess the relationships between various sets of parameters and travel times and identify trends and potential relationships. First, an analysis was conducted among the scenarios with the same number of signals per mile. Figure 4-8 shows the simulated travel times for scenarios with 5 signals per mile.



(a) Scenarios with 5 Signals per Mile, 35mph FFS and 2 Lanes



(b) Scenarios with 5 Signals per Mile, 45mph FFS and 2 Lanes



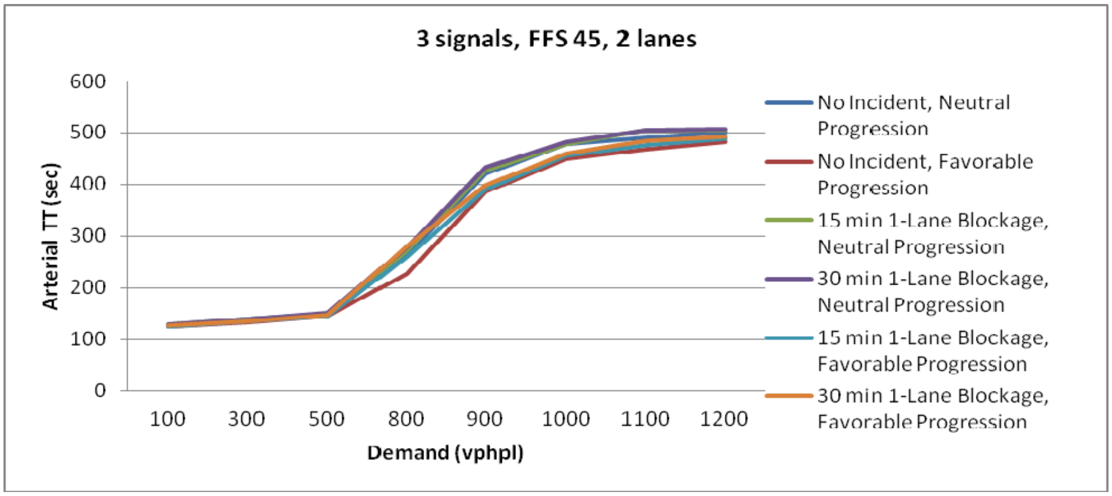
(c) Scenarios with 5 Signals per Mile, 45mph FFS and 3 Lanes

Figure 4-8 Simulated Travel Times for Scenarios with 5 Signals/Mile

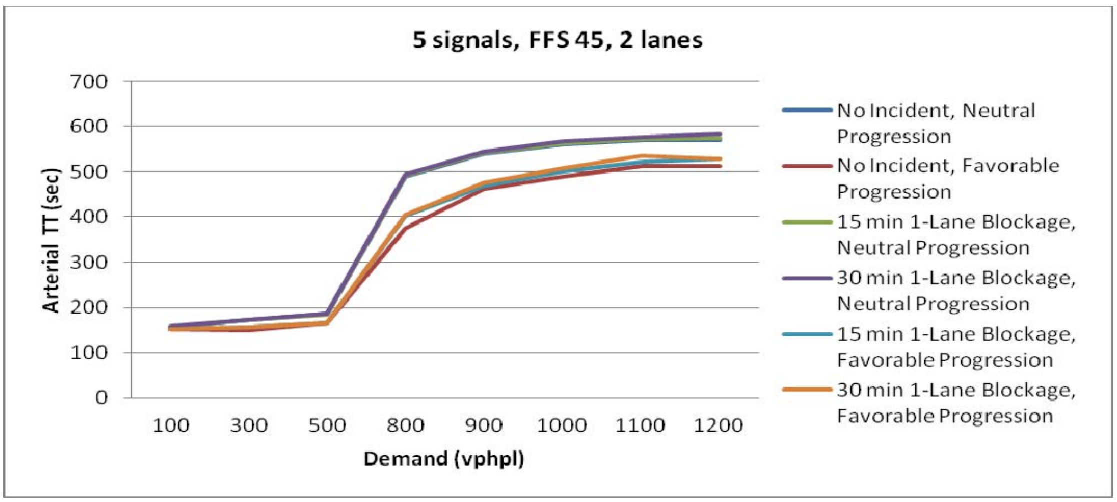
As shown in these graphs, the relationship between demand and travel time is not linear, and it is different for undersaturated vs. oversaturated conditions. Thus, separate models are required to estimate the arterial travel time for these two conditions. For all scenarios plotted in Figure 4-8, scenarios with favorable progression have lower travel time than the scenarios with neutral progression, indicating that the coordinated intersections significantly reduce the delay times. Incidents and increasing incident duration also result in higher travel times, although their impact is not as significant as the one caused by the quality of progression. Note that this is because progression becomes more important for increasing number of signals; when the corridor has fewer signals, incidents become more important to operations (additional discussion on the effect of the number of signals is provided later).

Comparing Figure 4-8-(a) and Figure 4-8-(b), it can be noted that the increase in FFS reduces travel time, especially for oversaturated scenarios with favorable progression. By comparing Figure 4-8-(b) and Figure 4-8-(c), it can be observed that an increase in the number of lanes slightly reduces the travel time for undersaturated conditions, but it increases the travel time for oversaturated conditions. This is because for undersaturated scenarios, more lanes provide more space for vehicles to make lane changes, reducing the probability that slower vehicles block faster ones. However, for oversaturated scenarios, traffic density is very high, and lane changes are difficult to make regardless of the number of lanes. Also, lane changes do not provide much of a speed advantage benefit since all vehicles are traveling slowly, and there is not much to be gained by changing lanes.

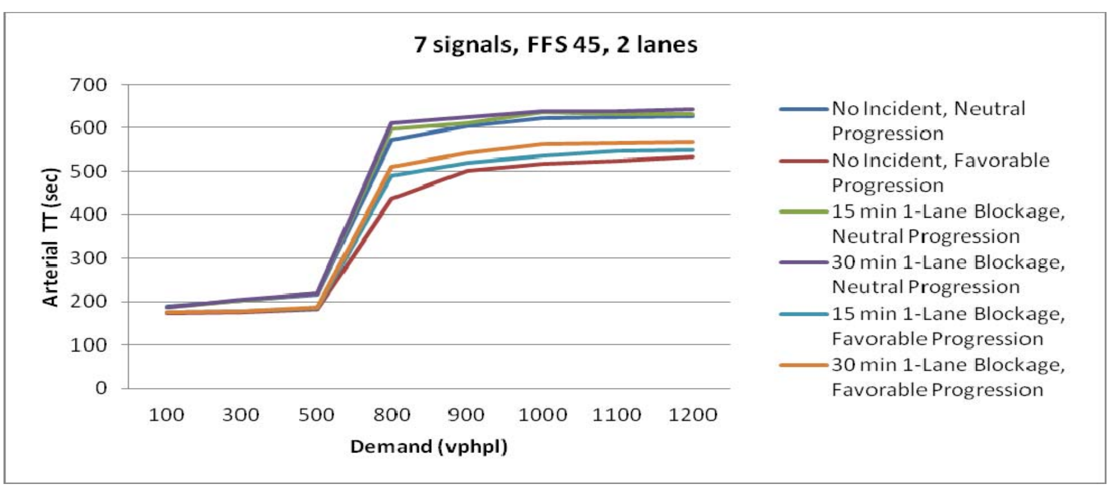
Figure 4-9 shows the comparison between simulated travel times for scenarios with different number of signals per mile. Figure 4-9 shows that as the number of signals per mile increases, travel time also increases. Also, by comparing the difference between scenarios with neutral progression and favorable progression in the three charts shown above, it can be noted that the impact of progression is more significant with increasing number of signals per mile. Therefore, an interaction variable may need to be included in the travel time estimation equation to capture the simultaneous impact of number of signals per mile and quality of progression on travel time.



(a) Scenarios with 3 Signals per Mile, 45mph FFS and 2 Lanes



(b) Scenarios with 5 Signals per Mile, 45mph FFS and 2 Lanes



(c) Scenarios with 7 Signals per Mile, 45mph FFS and 2 Lanes

Figure 4-9 Simulated Travel Times for Scenarios with Different Number of Signals/Mile

4.2.3 Revised Arterial Travel Time Estimation Models

This section presents the travel time estimation models developed based on the results of the simulation runs. As discussed in the previous subsection, the relationship between demand and travel time is different for undersaturated and oversaturated conditions. Therefore, travel time estimation models were developed separately for these two conditions. Identification for the undersaturated and oversaturated conditions was conducted based on the demand-travel time curves shown in Figure 4-8 and Figure 4-9. In addition to the seven factors discussed in section 4.2.1, an interaction variable was also considered when developing the models to capture the simultaneous influence of number of signals per mile and quality of progression on travel time. The regression models were developed using IBM SPSS Statistics. The development of the two models as well as their final form are provided below.

<u>1. Model for Undersaturated Scenarios</u>

A total of 189 scenarios belong to this condition. A linear regression model was developed that estimates travel time as a function of various arterial characteristics. All the original variables included in the model are continuous variables except for the quality of progression, which is categorized as favorable or neutral. The model also includes an interaction variable which is constructed from the number of signals and the quality of progression. The model developed is:

$$TT = \frac{3600}{FFS} + 0.041 \times t + 4.862 \times laneclose + 0.059 \times D + 14.406 \times N - 2.874 \times Inter \qquad (8)$$

where

TT:	estimated arterial travel time, in sec/mile
FFS:	free-flow speed, in mph
N:	number of signals per mile
D:	number of vehicles per hour per lane
t:	incident duration, in seconds
laneclose:	percent of lanes blocked by incident/total number of lanes
Inter:	variable that used to capture the interactive impact of the variable '*N*' and

‘*P*’, $Inter=N*P$

P: quality of progression, 1- favorable, 0-neutral

The resulting adjusted R-square value is 0.995, indicating a good fit of the model to the simulated data. According to the equation, when demand is approaching zero, there are no signals along the arterial and no incidents, the travel time would be (60/FFS) seconds per mile. Travel time increases linearly with incident duration, percent of lanes blocked by incident, demand, and the number of signals. The travel time decreases when the progression becomes favorable, and this travel time reduction becomes steeper as the number of signals per mile increases. The variable ‘*Lanes*’ (adjusted number of lanes per direction) was also tested when developing the travel time estimation model. The coefficient of this variable is negative, which is consistent with the discussion in the previous section, but the variable is statistically insignificant. Therefore, it has been removed from the model.

Note that the variables ‘*t*’ and ‘*laneclose*’ are included in the model to consider the effects of incident duration and closed lanes on travel time, although they are not statistically significant. One of the early versions of the models included two separate models, one for scenarios with incidents and another for scenarios without incidents. However, if the two models are developed separately, their results are not consistent. For example, the models sometimes resulted in lower travel times when an incident was present with all other variables being identical. Therefore the researchers combined all data in one model to avoid those discrepancies.

2. Model for Oversaturated Scenarios

A total of 315 scenarios belong to this condition. The final model is as follows:

$$\begin{aligned} TT = \frac{3600}{FFS} &+ 0.355 \times t + 5.462 \times laneclose + 0.223 \times D + 28.968 \times N \\ &- 11.133 \times Inter + 44.302 \times Lanes \end{aligned} \tag{9}$$

where

TT: estimated arterial travel time, in sec/mile

FFS: free-flow speed, in mph

N: number of signals per mile

D: number of vehicles per hour per lane

t: incident duration, in seconds

laneclose: percent of lanes blocked by incident/total number of lanes

Inter: variable that used to capture the interactive impact of the variable '*N*' and '*P*', *Inter =N*P*

P: quality of progression, 1- favorable, 0-neutral

Lanes: adjusted number of lanes per direction

The resulting adjusted R-square value is 0.996, which indicates very good agreement with the simulated data. Similar to the equation for undersaturated conditions, travel time increases linearly with incident duration, percent of lanes blocked by incident, demand, and the number of signals. However, in this case the increase is steeper for all variables compared to the undersaturated case. Travel time also increases as the number of lanes increases, and this is consistent with the discussion in section 4.2.2. The negative sign of the interaction variable indicates that the travel time decreases when the progression becomes favorable, and this travel time reduction becomes steeper as the number of signals per mile incrreases. Similarly to the model for undersaturated conditions, the variable 'laneclose' is included in this model to consider the effects of closed lanes on travel time, although it is not significant.

The spreadsheet developed in a previous project (FDOT Contract BDK77 977-10) was revised based on the new travel time estimation model described above. Changes in the spreadsheet are illustrated in Appendix A. The guide to the spreadsheet is provided in Appendix B.

4.3 Results of Arterial Travel Time Estimation after Revisions

4.3.1 Comparison of the Estimated Travel Time to Field Data

The new travel time estimation models were applied to obtain travel time and travel time reliability estimates for the four selected arterial corridors described in Chapter 2 using the revised spreadsheet. Figure 4-10 through Figure 4-13 plot the field travel time and the estimated hourly average travel time calculated using the original model and the revised model for the four arterials.

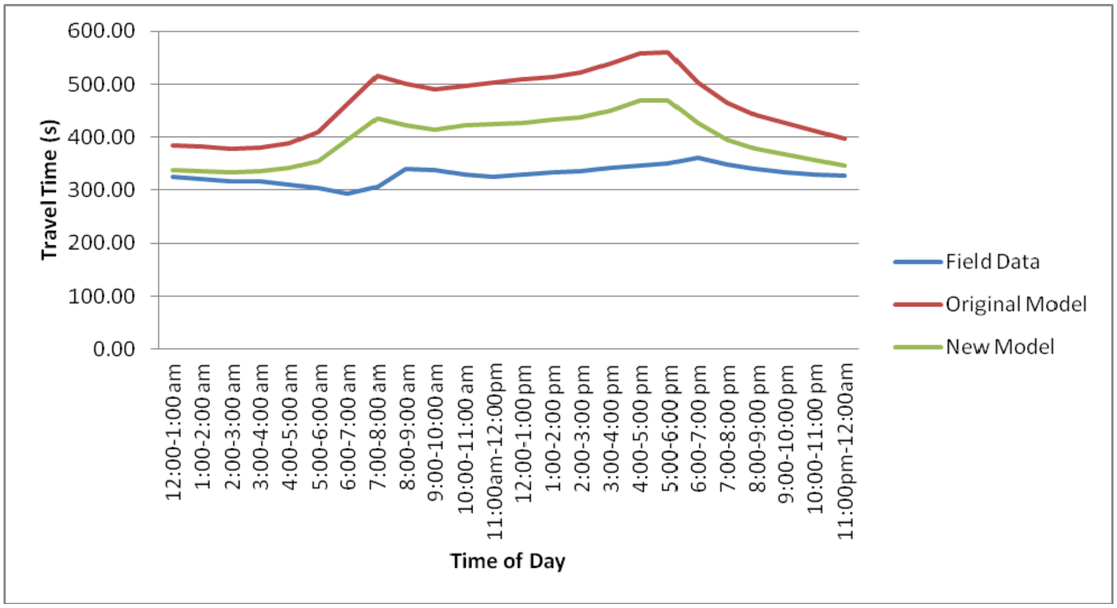


Figure 4-10 Comparison between the Estimated Travel Time and Field Data for San Jose Blvd. between University Boulevard and Baymeadows Road

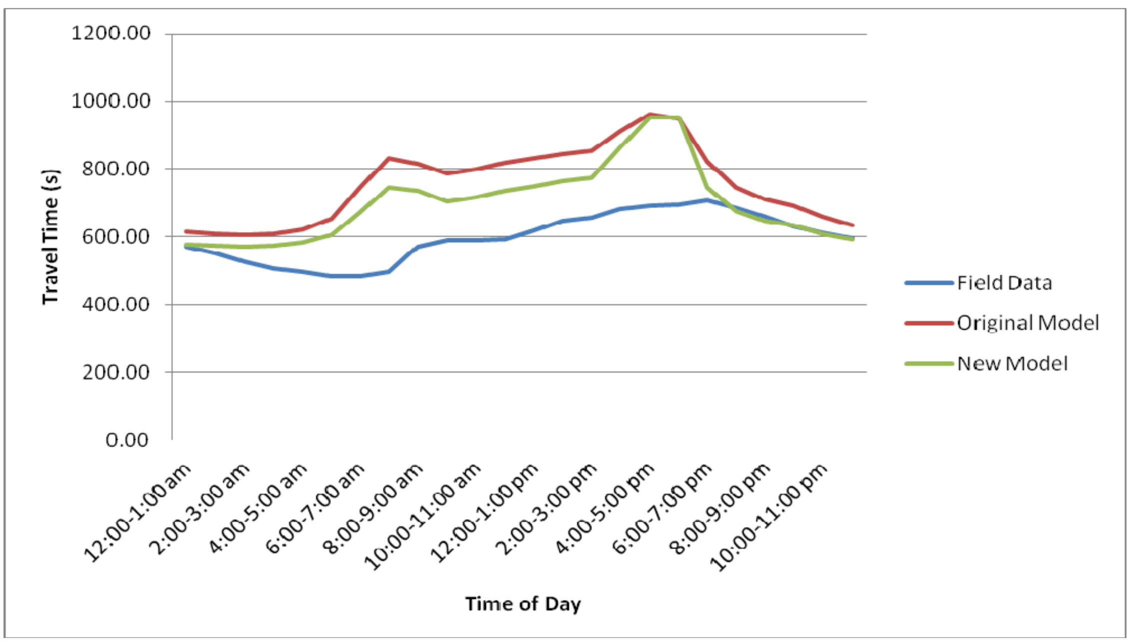


Figure 4-11 Comparison between the Estimated Travel Time and Field Data for Beach Boulevard between University Boulevard and I-295

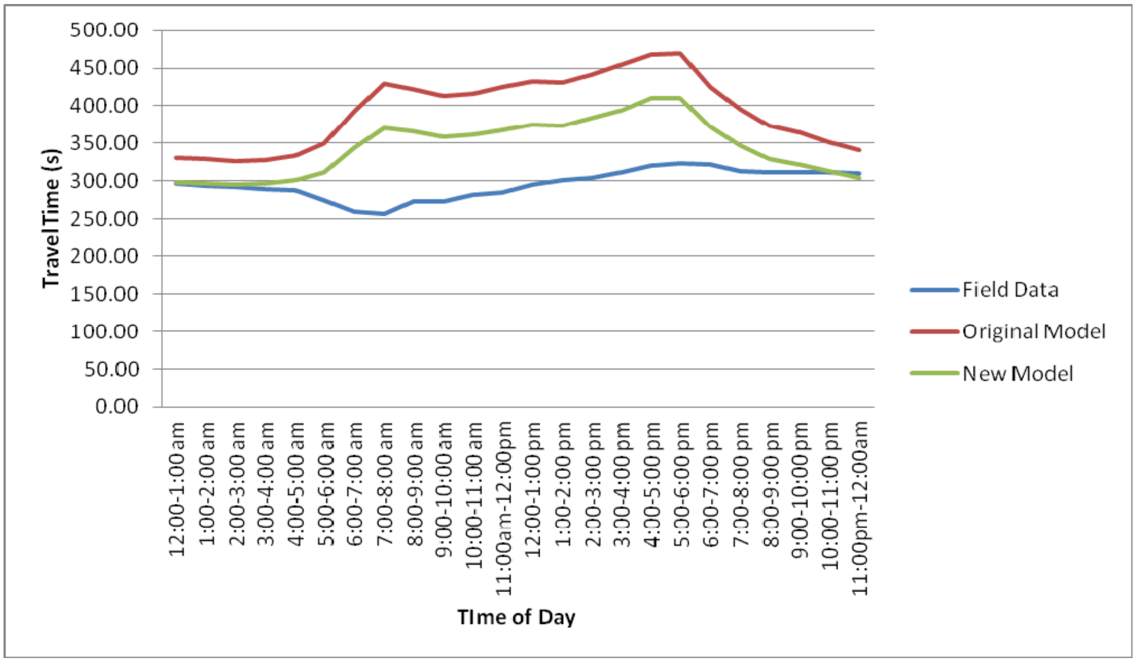


Figure 4-12 Comparison between the Estimated Travel Time and Field Data for Atlantic Boulevard between University Boulevard and Southside Boulevard

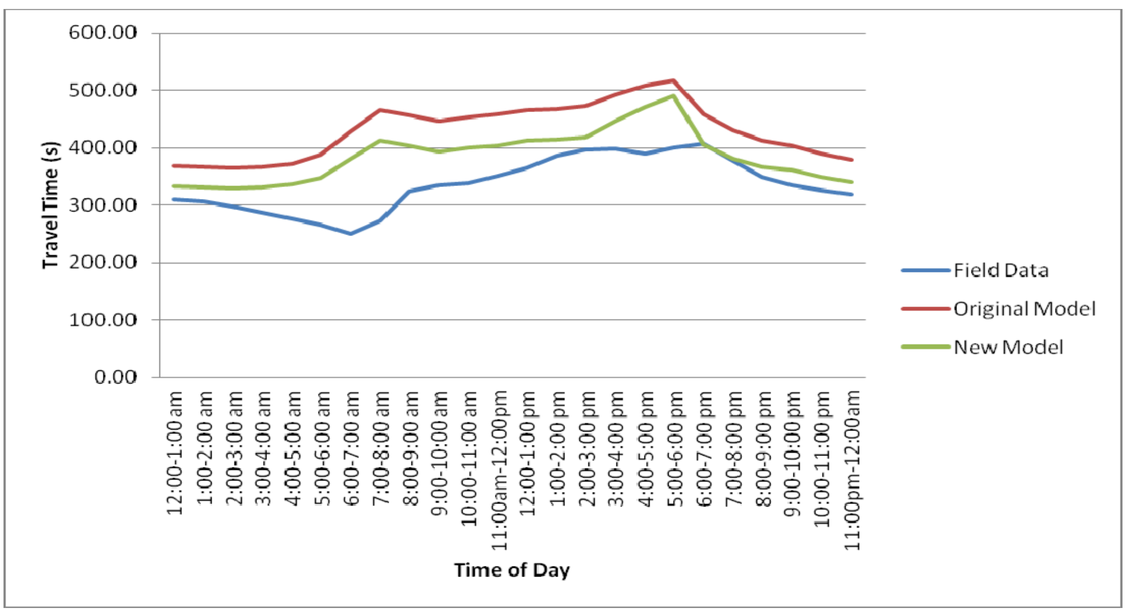


Figure 4-13 Comparison between the Estimated Travel Time and Field Data for San Jose Boulevard between Baymeadows Road and I-295

As shown in the figures above, travel times estimated using the newly developed model are consistently lower than the travel times estimated using the original model which was developed assuming pre-timed control. This is reasonable as actuated control greatly reduces delay times at the intersections.

Comparisons between the new model estimated travel time and the field data shows that for the time periods when traffic demand is very low (early morning and late night), the model-estimated travel time is very close to the field data. However, for the rest of the time periods, the new models still overestimate the travel time, especially for the morning and afternoon peak hours. One possible reason for this overestimation is the assumptions made for calculating average hourly volume, which was used as input in the travel time estimation process. Since the BlueTOAD database does not provide traffic volumes, the hourly volume for the selected arterial sites was calculated by using the respective AADT adjusted by hourly K factors. However, the hourly K factors used are based on undersaturated conditions. Also, they may not reflect the demand patterns at every arterial. Therefore, the overestimation of the travel time may be caused by demand-related assumptions rather than the model itself.

In this project, intersections along the four studied arterial corridors all have actuated control. Therefore, the revised model provides a better estimation of the travel time. For field sites where pre-timed signals are prevalent, the original models (FDOT Contract BDK77 977-10) may be more accurate.

4.3.2 Summary of the Reliability Calculation Results for Study Arterials

Estimated reliability performance measures for the four selected arterial corridors (San Jose Boulevard between University Boulevard and Baymeadows Road; Beach Boulevard between University Boulevard and I-295; Atlantic Boulevard between University Boulevard and Southside Boulevard; and San Jose Boulevard between Baymeadows Road and I-295) were calculated by using the travel time estimation spreadsheet.

The road lane count and signal locations were obtained from Google Maps, and the number of signals per mile was obtained for each corridor and used as input. The values of directional distribution factor, g/C ratio, FFS for reliability calculations are obtained from FDOT Quality/Level of Service Handbook (FDOT, 2009). Hourly demands were obtained from the FDOT's Level of Service (LOS) database. Based on the HCM 2010 (Transportation Research

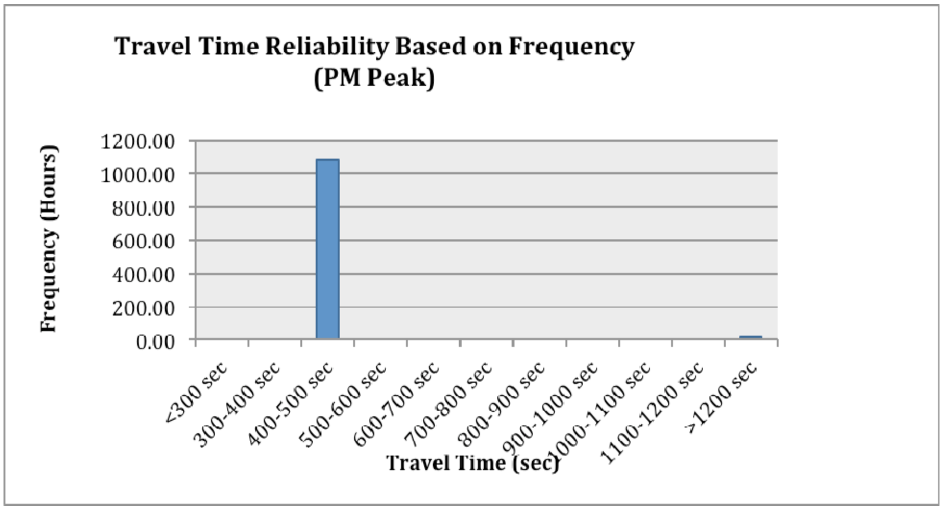
Board, 2010), the default value for adjusted saturation flow rate is 1800 pcphpl. Therefore, the expected capacity was calculated as “1800*number of lanes *g/C ratio”.

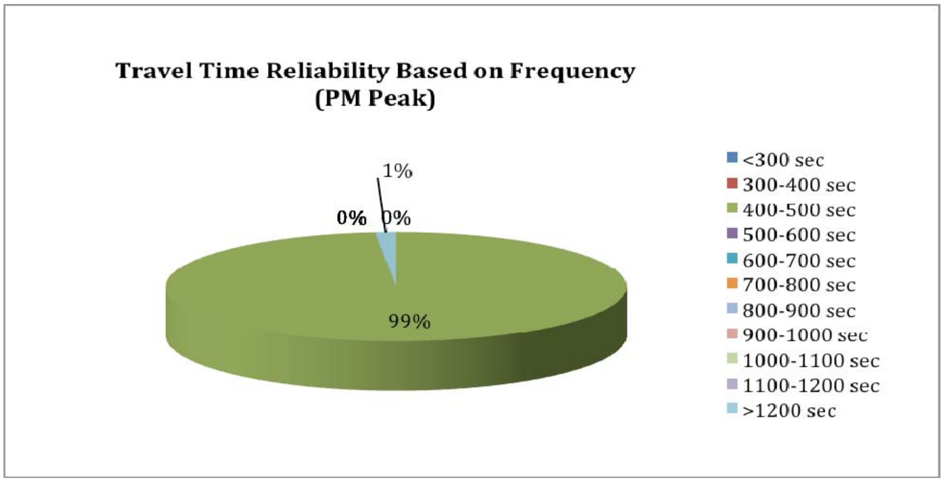
The 2011 statewide SHS crash database provides the time and date for the incidents. The locations of incidents are associated with each roadway segment. By knowing the incidents that occur in a specific hour during a day, the probability of incidents in each of the 24 hours along each segment were estimated as discussed in Chapter 3. The SHS crash database does not provide the duration of incidents and the number of lanes blocked by incidents. All incidents occurring along a 2-lane arterial corridor were assumed to be 1-lane blocked incidents. For 3-lane arterials, the probability of each incident category was estimated based on the injury severity categorization (incidents of injury category 0-3 cause one-lane blockage and incidents of category 4, 5 and 6 cause two-lane blockage). All the incident durations were assumed to be 1 hour. The reliability weather model uses different parameters for three regions in Florida. All facilities studied in this project are located within region 2.

In the last two tabs of the spreadsheet, reliability performance measures were calculated for both the entire day and the evening peak (4:00 pm-7:00 pm). Travel time distributions for the study corridors were obtained by plotting the travel times and their respective frequencies. A variety of travel time reliability-related measures were estimated based on this distribution, including the probability of on-time arrival, the planning time index and the travel time index. In this project, the probability of on-time arrival is defined as the percentage of trips with travel speed below a certain threshold (10 mph and 15 mph below the speed limit). The planning time index is defined as the ratio of the travel time of the worst day of the month (95th percentile travel time) to the free-flow travel time. The travel time index is the ratio of average travel time to the travel time at free-flow conditions. In addition to these measures, the expected travel time for the entire year, and the expected travel time for selected peak periods were also estimated. The remaining portion of this subsection presents the summary of these reliability calculations for the four arterial corridors during the evening peak hours.

<u>1. Summary of the Reliability Calculation Results for San Jose Boulevard Between University Boulevard and Baymeadows Road</u>

Figures 4-14 and 4-15 plot the travel time frequencies for the evening peak period based on frequency and volume, respectively.





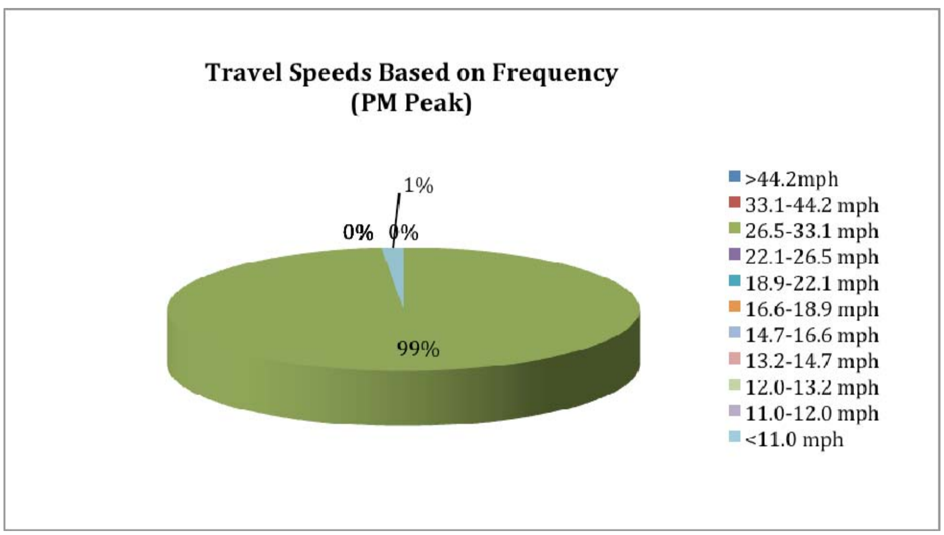
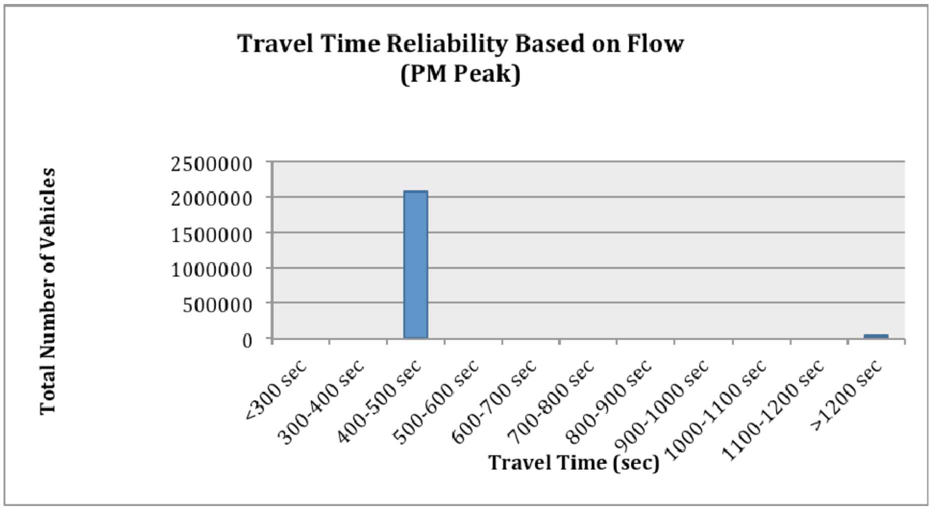
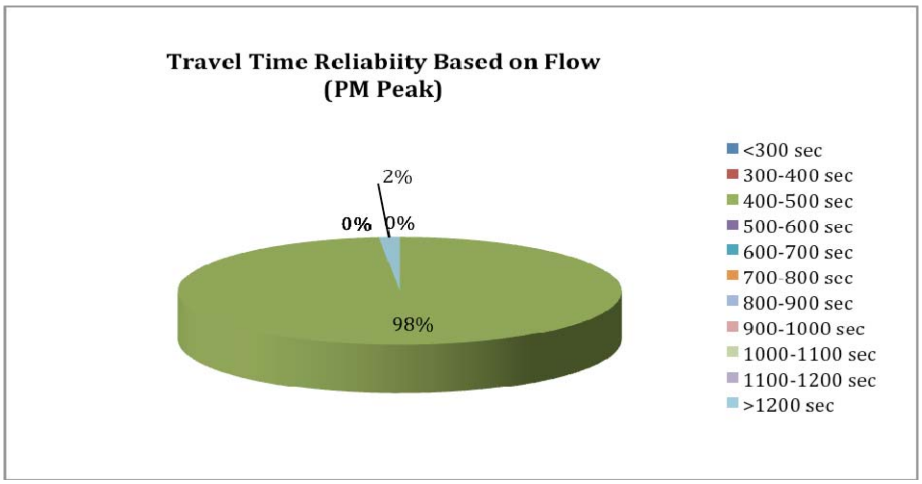


Figure 4-14 Estimated Travel Time Distribution based on Frequency (PM Peak, San Jose Boulevard)





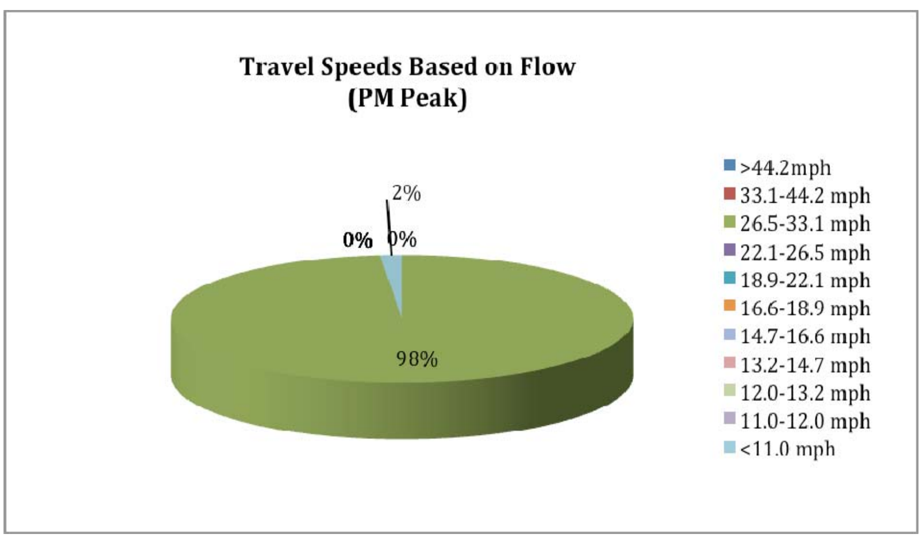


Figure 4-15 Estimated Travel Time Distribution based on Volume (PM Peak, San Jose Boulevard)

Figure 4-14 and Figure 4-15 show that the estimated travel times fall in only two groups, “400-500 sec (26.5-33.1 mph)” and “ >1200 sec (<11.0 mph)”. The travel time group “400-500 sec” has 99% of frequency and 98% of vehicles. The other travel time group only has 1% of frequency and 2% of vehicles. Note that the LOS C threshold speed is 27 mph. Therefore, for most of the time, traffic conditions during the evening peak period are close to the LOS C threshold. Extremely congested condition is still possible to occur, but with a very low probability.

Table 4-10 provides estimates of travel time reliability based on on-time arrival, planning time index, and travel time index. It also provides expected travel times for the evening peak period.

Table 4-10 Estimated Travel Time Reliability Measurements (PM Peak, San Jose Boulevard)

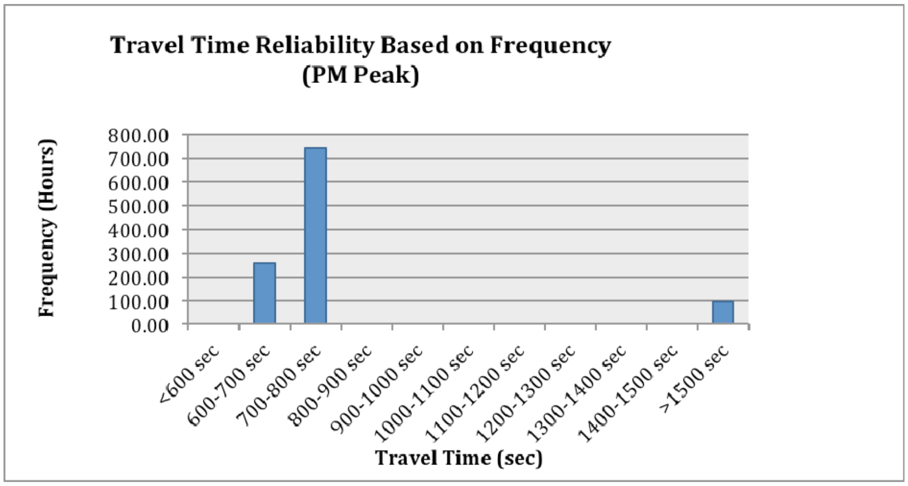
	Average Travel Time (sec)	Average Travel Speed (mph)	On-Time Arrival		Planning Time Index	Travel Time Index
			10 mph	15 mph		
Based on Frequency	455.06	29.17	98.53%	98.53%	1.7784	1.7175
Based on Volume	457.68	29.00	98.48%	98.48%	1.7784	1.7273

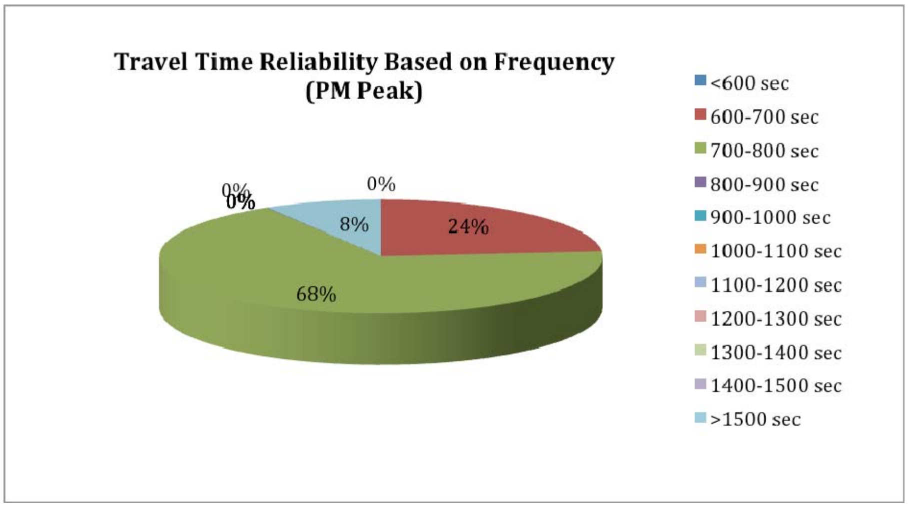
Average travel time for the evening peak periods is approximately 450 seconds (29 mph), which is higher than the LOS C threshold for both frequency-weighted and volume-weighted results.

Probability of on-time arrival is about 98.53% for both the 10 mph threshold and the 15 mph threshold. The planning time index is 1.7784 and is the same for the frequency-weighted and the volume-weighted results. It indicates that during the worst peak period, 1.7784 times the free flow travel time should be planed to ensure on time arrivals for 95 percent of the trips. The travel time index is around 1.7 for both calculation methods. It indicates that the average traffic condition during the evening peak period is about 1.7 times the free flow travel time.

2. Summary of the Reliability Calculation Results for Beach Boulevard (The section between University Boulevard and I-295)

Similar to the discussion in the previous subsection, travel time distributions were generated for Beach Boulevard in the spreadsheet. Figure 4-16 and Figure 4-17 plot the travel time frequencies for the evening peak period based on frequency and volume, respectively.





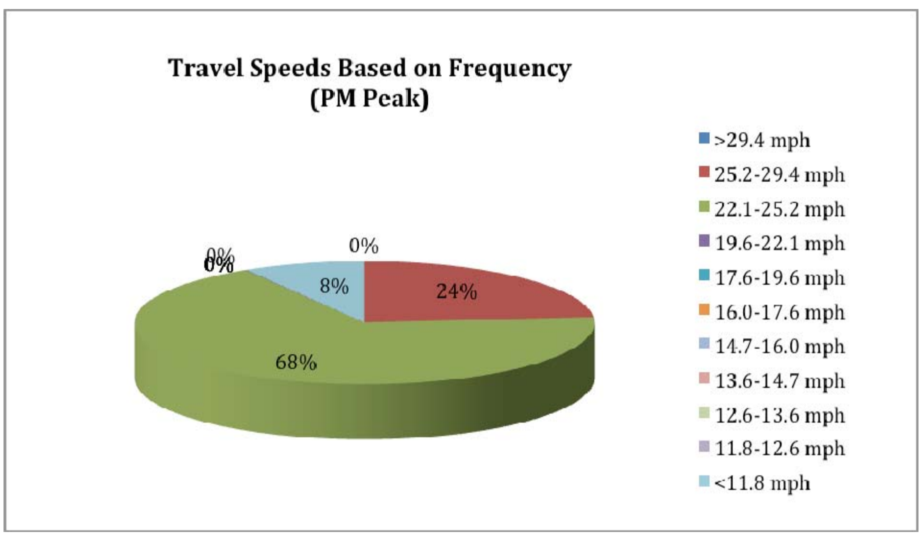
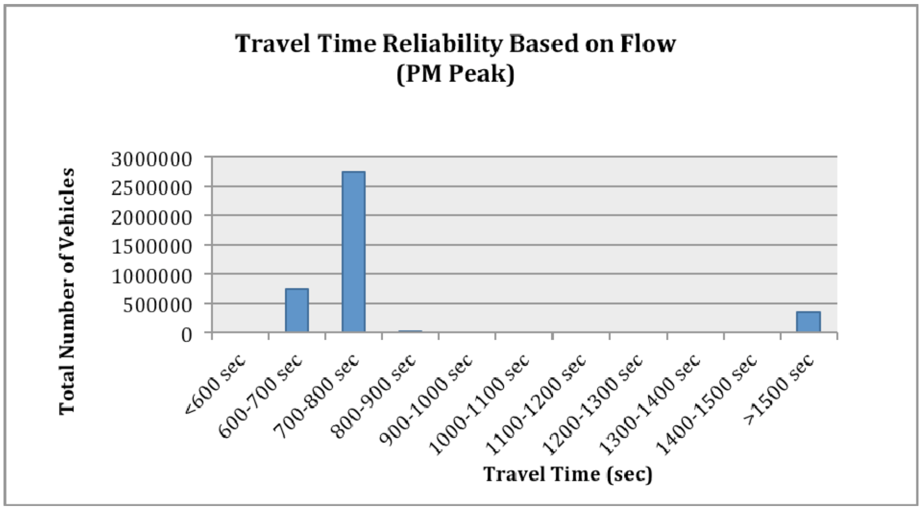
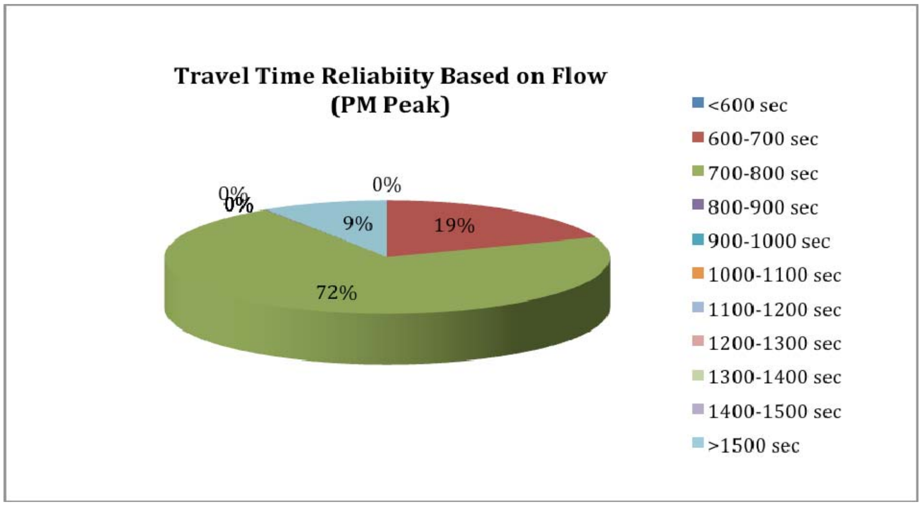


Figure 4-16 Estimated Travel Time Distribution based on Frequency (PM Peak, Beach Boulevard)





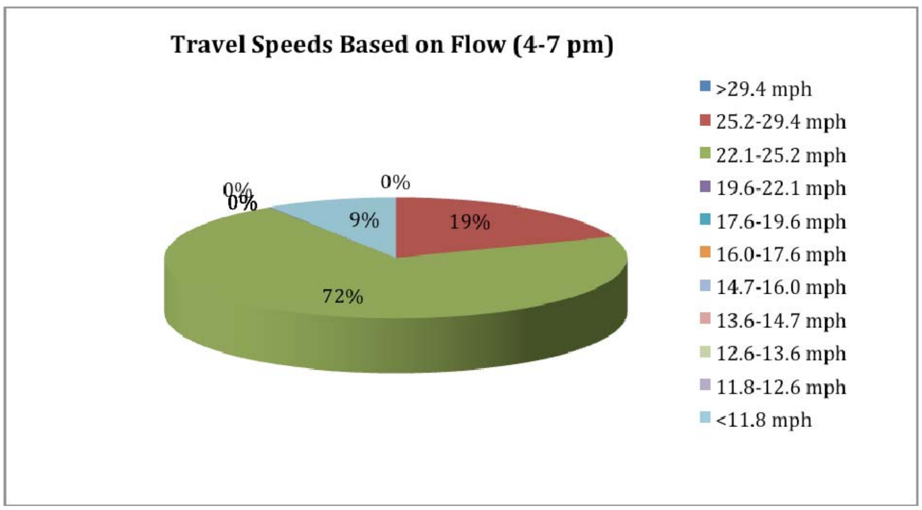


Figure 4-17 Estimated Travel Time Distribution based on Volume (PM Peak, Beach Boulevard)

For this arterial corridor, the travel time group “700-800 sec (22.1-25.2 mph)” has the highest frequency (68%) and the highest percentage of vehicles (72%). Also, the travel time group “(600-700 sec) 25.2-29.4 mph” has significant frequency (24%) and number of vehicles (19%). There is also a noticeable percentage in the very long travel time group (>1500 sec, <11.8 mph). This is because the traffic demand during the time period 16:00 to 18:00 is very high and there is a high probability for congested conditions. Therefore, travel times of congested conditions are a noticeable percentage in the distribution.

Table 4-11 provides an estimate of travel time reliability based on on-time arrival, planning time index and travel time index. It also provides expected travel time reliability measures for evening peak periods.

Table 4-11 Estimated Travel Time Reliability Measurements (PM Peak, Beach Boulevard)

	Average Travel Time (sec)	Average Travel Speed (mph)	On-Time Arrival		Planning Time Index	Travel Time Index
			10 mph	15 mph		
Based on Frequency	883.43	20.23	91.41%	91.41%	6.5766	2.5040
Based on Volume	895.75	19.92	90.83%	90.83%	6.5766	2.5390

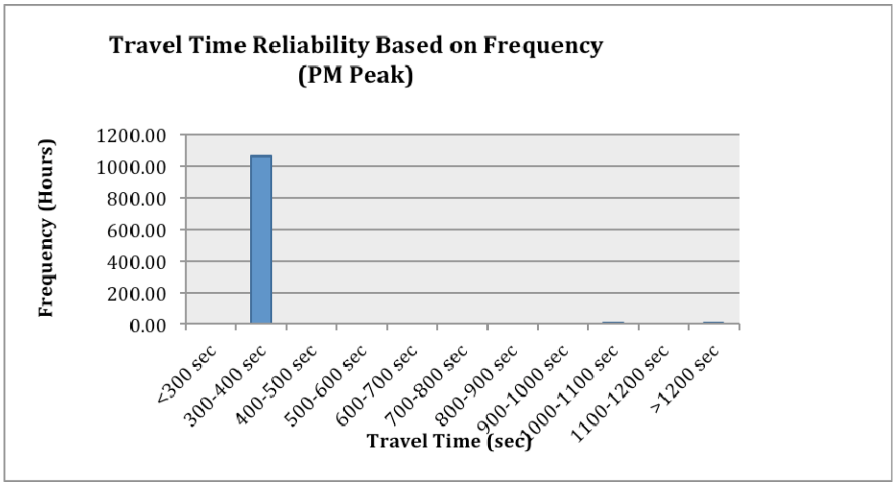
The frequency-weighted average travel time of the evening peak periods is 883.43 seconds (20.23 mph), and the volume-weighted average travel time is 895.75 seconds (19.92 mph). Both values are higher than the LOS C threshold (801.82 sec) travel time (lower than the respective speed 22 mph).

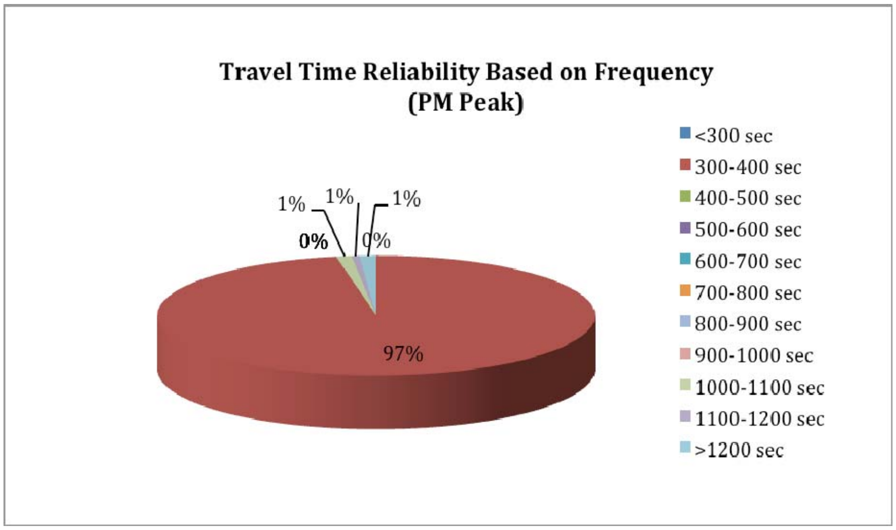
The probability of frequency based on-time arrival is 91.41% and the probability of volume based on-time arrival is 90.83% for both the 10mph and the 15 mph threshold. The planning time index is 6.5766 and is the same for the frequency weighted and the volume weighted results. It indicates that travelers should allow 6.5766 times the free-flow travel time to ensure on-time arrival during the worst peak period. This value also implies that this arterial can be very congested during the evening peak hours.

The travel time index based on frequency is 2.5040 and the travel time index based on volume is 2.5040. This value is much less than the planning time index. Since the planning time index is defined as the ratio of the travel time of the worst day of the month (95th percentile travel time) to the free-flow travel time while the travel time index is the ratio of average travel time to the travel time at free-flow conditions, travel time along this arterial varies significantly during the evening peak hours.

3. Summary of the Reliability Calculation Results for Atlantic Boulevard (The Section between University Boulevard and Southside Boulevard)

Figures 4-18 and 4-19 plot the travel time frequencies for the evening peak period based on frequency and volume, respectively.





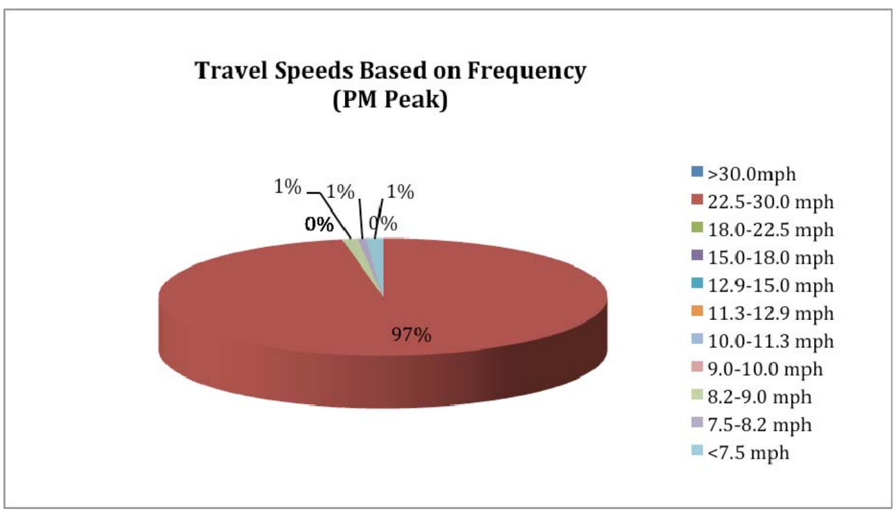
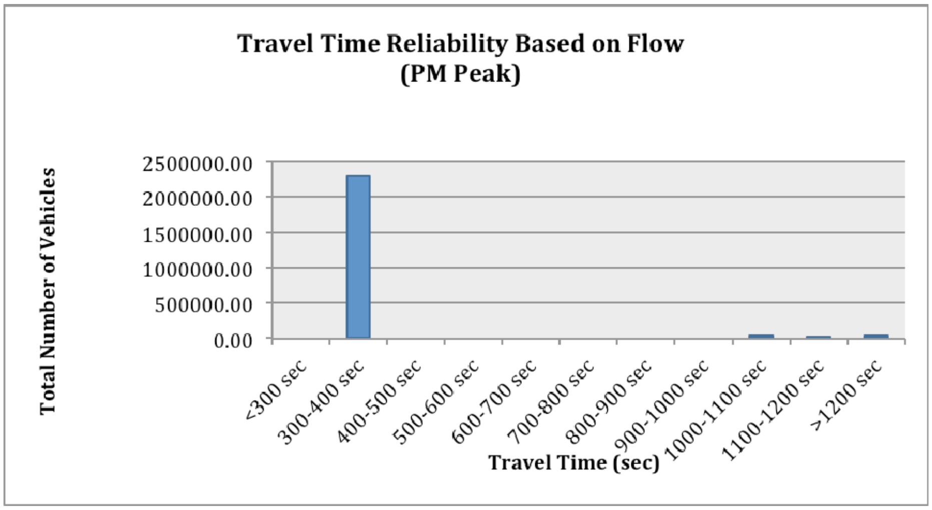
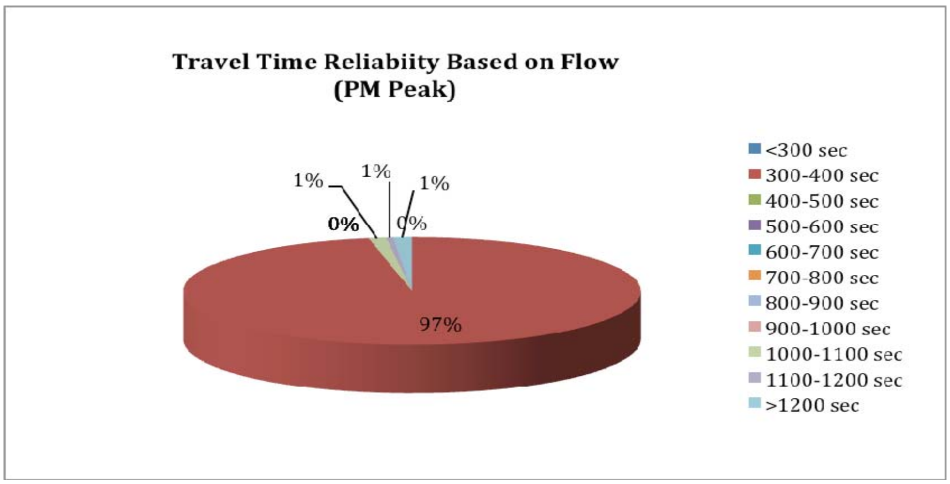


Figure 4-18 Estimated Travel Time Distribution based on Frequency (PM Peak, Atlantic Boulevard)





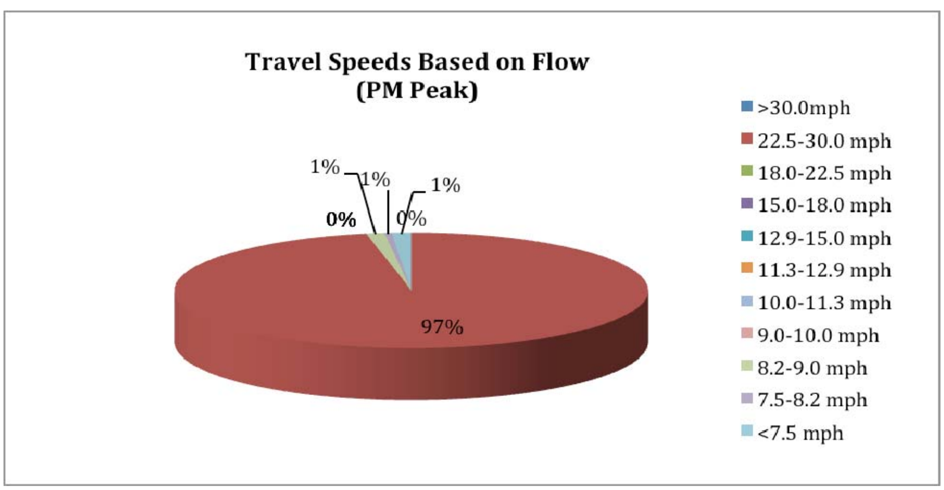


Figure 4-19 Estimated Travel Time Distribution based on Volume (PM Peak, Atlantic Boulevard)

Figure 4-19 and Figure 4-20 show that the travel time group “300-400 sec (22.5-30.0 mph)” has the highest frequency (97%) and the highest percentage of vehicles (97%). The other groups have very small percentages (3% of frequency and 3% of number of vehicles). Traffic conditions during the evening peak period are close to LOS C.

Table 4-12 provides an estimate of travel time reliability based on on-time arrival, planning time index and travel time index. It also provides expected travel time reliability values for the evening peak period.

Table 4-12 Estimated Travel Time Reliability Measurements (PM Peak, Atlantic Boulevard)

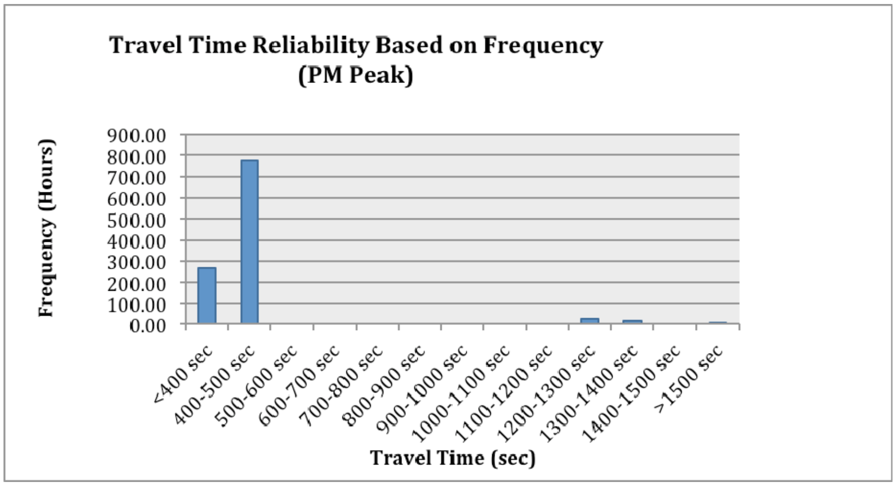
	Average Travel Time (sec)	Average Travel Speed (mph)	On-Time Arrival		Planning Time Index	Travel Time Index
			10 mph	15 mph		
Based on Frequency	397.44	22.70	97.05%	97.05%	1.9936	1.9872
Based on Volume	399.79	22.56	96.95%	96.95%	1.9936	1.9990

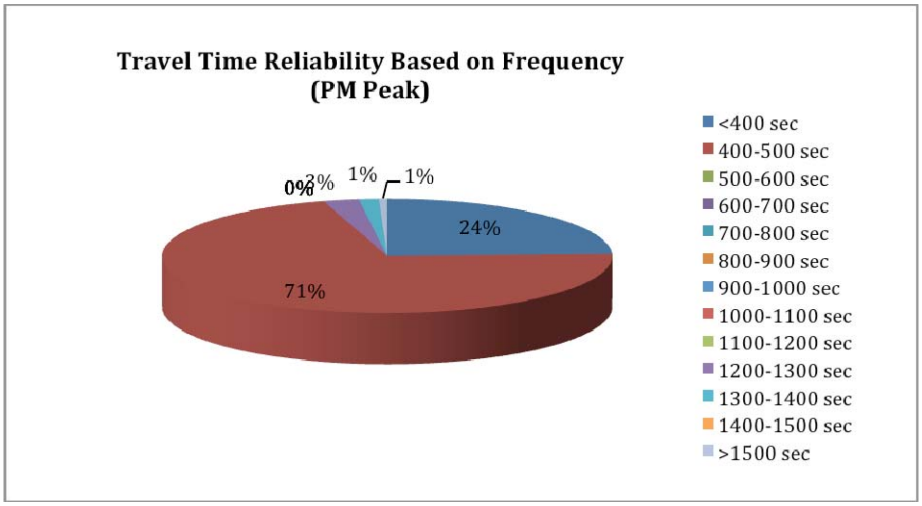
Average travel time for the evening peak periods is approximately 400 seconds (22.5 mph), which is lower than the LOS C threshold for both frequency-weighted and volume-weighted results.

The probability of on-time arrival is 97.05% based on frequency and 96.95% based on volume for both the 10mph and the 15 mph threshold. The planning time index is 1.9936 and is the same for the frequency-weighted and the volume-weighted results. The value indicates that travel time during the worst peak period are expected to be about 2 times the free-flow travel time to ensure on-time arrival. The frequency based travel time index is 1.9872 and the volume based travel time index is 1.9990. Note that, the values of travel time index is very close to the planning time index, and the volume weighted travel time index is even higher than the volume weighted planning time index. Since the travel time index approximates the average of travel conditions, whereas the planning time index represents the 95th percentile, it indicates that the top 5% travel times are extremely high. As a result, the average travel time is close to or even higher than the 95th percentile travel time.

4. Summary of the Reliability Calculation Results for San Jose Boulevard (The Section between Baymeadows Road and I-295)

Similar to the discussion in the previous section, the travel time distributions were generated for San Jose Boulevard in the spreadsheet. Figure 4-20 and Figure 4-21 plot the travel time frequencies for the evening peak period based on frequency and volume, respectively.





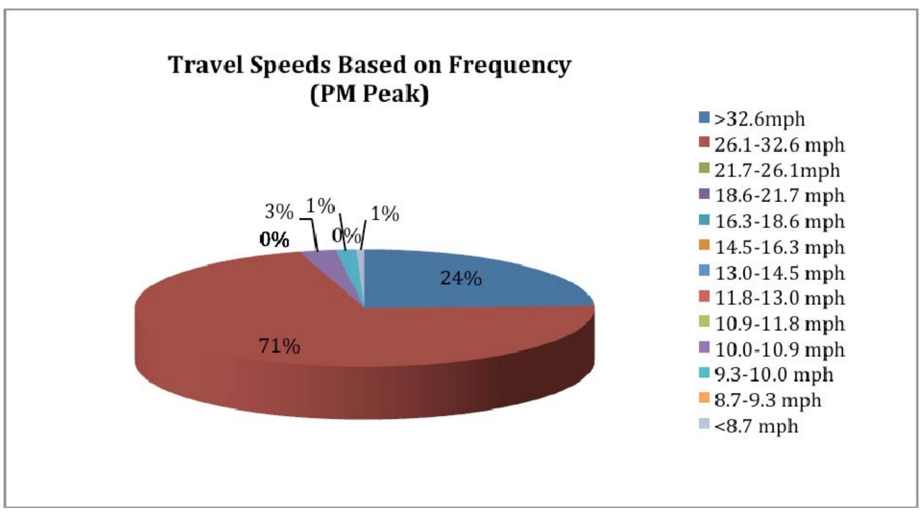
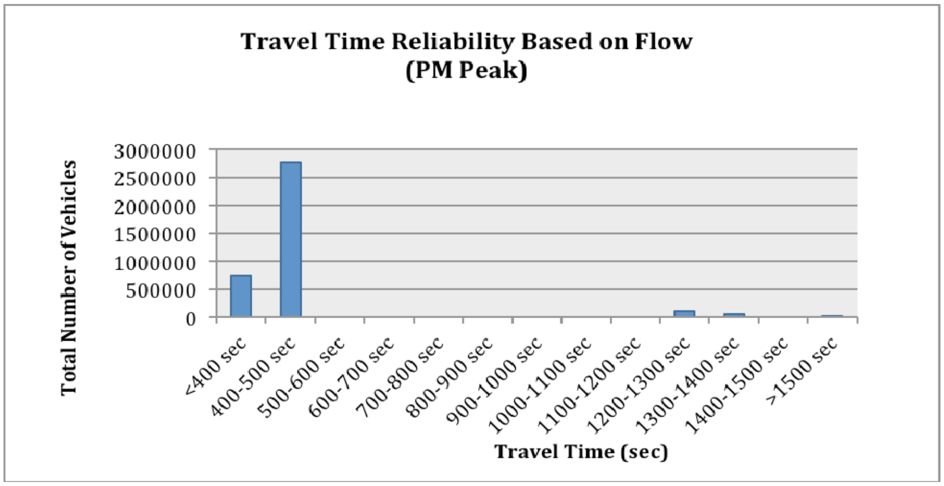
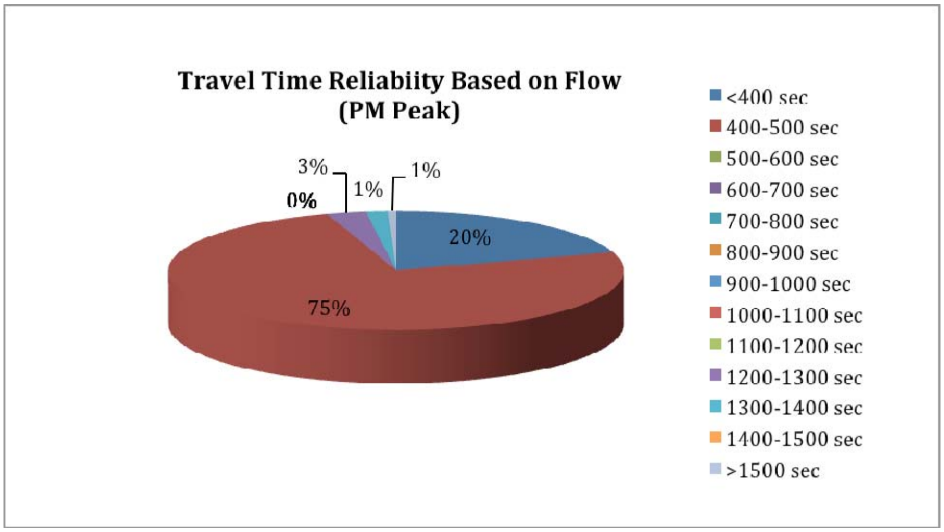


Figure 4-20 Estimated Travel Time Distribution based on Frequency (PM Peak, San Jose Boulevard)





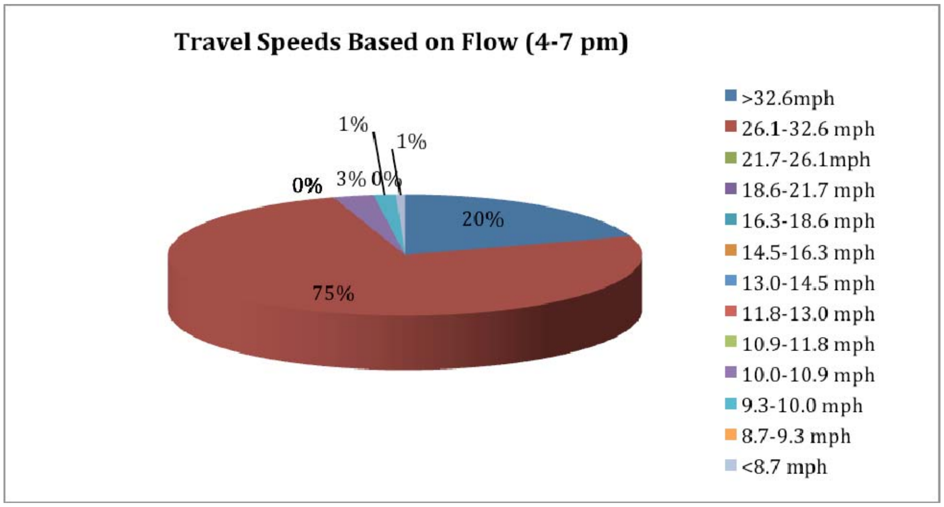


Figure 4-21 Estimated Travel Time Distribution based on Volume (PM Peak, San Jose Boulevard)

For this corridor, the travel time group “400-500 sec (26.1-32.6 mph)” has the highest frequency (71%) and the highest percentage of vehicles (75%). Also, the travel time group “ <400 sec (>32.6 mph)” has significant frequency (24%) and number of vehicles (20%). The other groups have very small percentages (5% of frequency and 5% of number of vehicles).

Table 4-13 provides an estimate of travel time reliability based on on-time arrival, planning time index and travel time index. It also provides expected travel time for evening peak periods.

Table 4-13 Estimated Travel Time Reliability Measurements (PM Peak, San Jose Boulevard)

	Average Travel Time (sec)	Average Travel Speed (mph)	On-Time Arrival		Planning Time Index	Travel Time Index
			10 mph	15 mph		
Based on Frequency	455.22	20.38	95.42.02%	95.42%	2.3663	2.4697
Based on Volume	459.79	20.16	95.07.90%	95.07%	2.4414	2.4945

The frequency-weighted average travel time of the evening peak periods is 455.22 seconds (20.38 mph), and the volume-weighted average travel time is 459.79 seconds (20.16 mph). Both values are higher than the LOS C threshold travel time. The probability of frequency based on-time arrival is 95.42% and the probability of volume based on-time arrival is 95.07% for both the 10mph and the 15 mph threshold. The frequency weighted planning time index is 2.3663 and the volume weighted result is 2.4414, indicating that travelers should allow about 2.4 times the free-flow travel time to ensure on-time arrival during the worst peak period.

The travel time index based on frequency is 2.4697 and the travel time index based on volume is 2.4945. Both values are higher than the planning time index, indicating that the top 5% travel times are extremely high, and as a result, the average travel time is higher than the 95th percentile travel time. This is similar to the situation of Atlantic Boulevard, but this arterial section is even more congested during the evening peak hours.

5 DEVELOPMENT OF THE 2011 STATEWIDE ARTERIAL RELIABILITY DATABASE

The 2011 statewide urbanized arterial reliability databases were built in the Microsoft Access database program. To build the databases, statewide crash data on the SHS from 2005 to September 2012 were requested and provided by the FDOT State Safety Office in ‘csv’ format. The SHS crash records data include freeway and arterial crashes on the Florida SHS roadways. The 2011 crashes on arterial portions were used in this study.

Queries in Access database program were created to split the data into tables in different years. The DOTCOUNTY, SECTION and SUBSECT fields provided by the FDOT State Safety Office are in number format. These fields were reformatted to be strings with fixed lengths. The three reformatted fields were concatenated to generate the roadway ID number which was a unique 8-character identification number for roadway locations of crash records. The statewide SHS crash data were associated with arterial roadway segments using information of roadway ID and local milepost for arterial reliability calculation.

The 2012 FDOT GIS Traffic Signal Locations feature class provides spatial information on locations of traffic signals in the Department's Roadway Characteristics Inventory (RCI). In the attribute table of this feature class, there is a Roadway ID field which is a unique 8-character identification number assigned to a roadway or section of a roadway either on or off the SHS for which information is maintained in the RCI. The milepost field for traffic signals of the roadway is also given in the attribute table. Using this information, we calculate the number of signals for each of the sections.

Geometric information for the arterial portion of the SIS as well as hourly demands were obtained from the 2011 FDOT’s Level of Service (LOS) databases from FDOT’s Systems Planning Office. Reliability measures for arterials in urbanized areas were calculated for this study. The total number of urbanized arterial segments is 3450 with average segment length of 1.15 miles.

The 2011 Statewide Arterial Reliability database was built by applying the arterial travel time reliability methods demonstrated in the reliability calculation spreadsheet to the statewide urbanized arterial segments. The database used multiple queries to calculate reliability measures using the equations in the reliability calculation spreadsheet. Due to the large numbers of urbanized arterial segments (3450) and 3GB file size limitation of Access database program file, the 2011 urbanized arterial segments were split into three pieces by segments 1- 1200, 1201-2400, and 2401-3450. Figure 5-1 provides a snapshot of the reliability database.

Three databases were created for calculating reliability for each set of segments. The final statewide urbanized arterial reliability results table combined the information from outputs of the three databases. The final results from the three databases were found to provide consistent results with the reliability calculation spreadsheet.

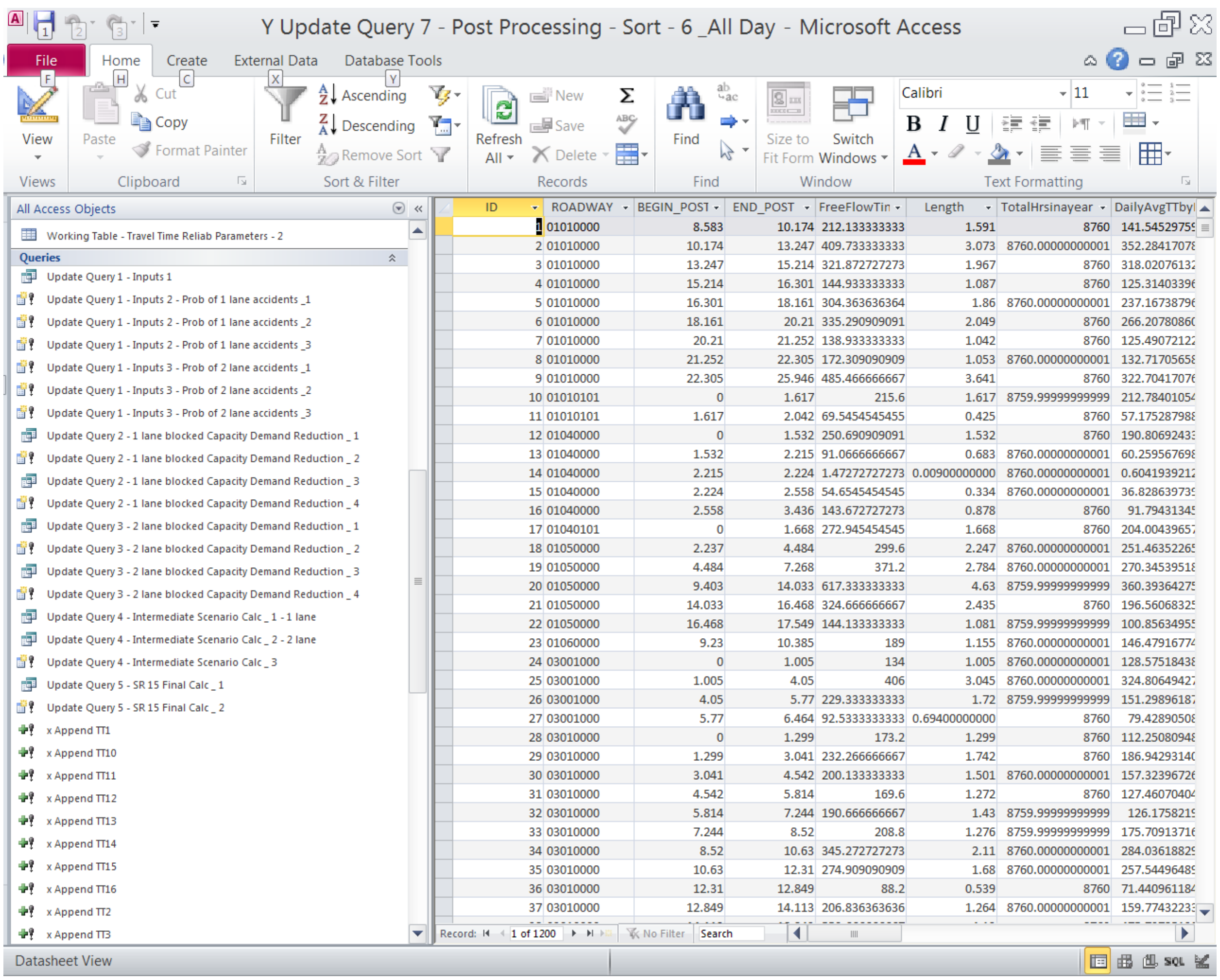


Figure 5-1 Statewide Urbanized Arterial Reliability Database

Tables 5-1 and 5-2 provide daily and peak period aggregated results for each county in Florida. The results are aggregated by VMT. In total, 3452 urbanized arterial segments in SHS were analyzed. The total average segment length is 1.15 miles. The results show that for short section lengths (there are 45 sections with length less than 0.01 mile) the speed calculated can be unreasonably low. This is an issue that should be further addressed. Appendix C provides reliability calculation results for arterials connecting major ports and airports in Florida.

Table 5-1 Daily Travel Time Reliability Estimates for Arterials by County

County	Sum Of Centerline Miles	Avg Daily Speed by Freq	Avg Daily Speed by Vol	Avg Daily TTI By Freq	Avg Daily TTI by Vol	Avg On time Arrival 10 mph by Freq	Avg On time Arrival 10 mph by Vol	Avg On time Arrival 15 mph by Freq	Avg Ontime Arrival 15 mph by Vol	Avg PTI based on Freq
Alachua	76.30	30.55	28.86	0.82	0.87	1.00	1.00	0.98	0.97	0.90
Bay	102.53	34.28	31.69	0.80	0.86	0.99	0.98	0.99	0.98	0.93
Brevard	180.51	34.62	32.24	0.78	0.83	1.00	0.99	1.00	0.99	0.88
Broward	296.29	27.56	25.75	0.82	0.88	0.99	0.98	0.98	0.98	0.96
Charlotte	38.84	34.70	32.23	0.76	0.82	0.99	0.99	0.99	0.99	0.98
Clay	35.50	31.43	29.03	0.84	0.90	0.99	0.99	0.99	0.99	1.03
Collier	31.56	32.96	30.89	0.80	0.84	1.00	1.00	1.00	1.00	0.90
Duval	260.47	30.16	28.33	0.83	0.88	1.00	0.99	0.99	0.98	0.93
Escambia	179.45	33.50	31.08	0.76	0.82	0.99	0.99	0.99	0.98	0.93
Flagler	9.79	39.26	37.34	0.75	0.78	1.00	1.00	1.00	1.00	0.82
Hernando	44.70	39.18	36.48	0.71	0.76	1.00	1.00	1.00	1.00	0.80
Hillsborough	253.49	31.98	29.07	0.83	0.92	0.98	0.96	0.97	0.96	1.16
Indian River	39.11	34.83	33.07	0.72	0.75	1.00	1.00	1.00	1.00	0.79
Lake	82.26	35.19	32.64	0.75	0.81	1.00	0.99	0.99	0.99	0.84
Lee	103.39	33.15	30.49	0.82	0.89	0.99	0.98	0.99	0.98	1.00
Leon	115.28	33.03	30.98	0.80	0.84	1.00	1.00	0.99	0.99	0.88
Manatee	75.76	31.02	28.67	0.82	0.89	0.99	0.98	0.98	0.97	1.03
Marion	92.22	34.91	32.60	0.77	0.82	1.00	1.00	1.00	1.00	0.86
Martin	36.11	31.94	29.64	0.75	0.81	0.99	0.98	0.99	0.98	1.00
Miami-Dade	387.08	25.27	23.20	0.98	1.08	0.97	0.94	0.95	0.92	1.41
Nassau	22.28	34.23	31.69	0.81	0.87	1.00	0.99	1.00	0.99	0.91
Okaloosa	66.95	31.51	28.18	0.89	1.00	0.97	0.95	0.97	0.95	1.32
Orange	192.53	29.57	26.93	0.87	0.95	0.98	0.96	0.98	0.96	1.17
Osceola	42.34	30.90	27.81	0.88	0.97	0.98	0.97	0.98	0.96	1.25

Table 5-1 Daily Travel Time Reliability Estimates for Arterials by County (Cont'd)

County	Sum Of Centerline Miles	Avg Daily Speed by Freq	Avg Daily Speed by Vol	Avg Daily TTI By Freq	Avg Daily TTI by Vol	Avg On time Arrival 10 mph by Freq	Avg On time Arrival 10 mph by Vol	Avg On time Arrival 15 mph by Freq	Avg Ontime Arrival 15 mph by Vol	Avg PTI based on Freq
Palm Beach	228.88	31.91	30.04	0.76	0.80	1.00	1.00	0.99	0.99	0.85
Pasco	95.09	35.93	32.29	0.80	0.90	0.98	0.96	0.97	0.95	1.22
Pinellas	175.58	30.82	27.93	0.86	0.95	0.98	0.96	0.97	0.96	1.24
Polk	183.80	35.73	33.21	0.73	0.78	1.00	1.00	1.00	1.00	0.83
Santa Rosa	68.55	35.51	32.39	0.78	0.85	0.99	0.98	0.99	0.98	0.90
Sarasota	86.32	32.27	29.98	0.78	0.83	1.00	0.99	1.00	0.99	0.88
Seminole	78.14	29.36	27.11	0.84	0.91	0.99	0.98	0.99	0.98	1.10
St.Johns	54.10	33.37	30.90	0.81	0.87	0.99	0.99	0.99	0.98	1.05
St.Lucie	60.55	33.75	31.81	0.75	0.79	1.00	1.00	1.00	1.00	0.83
Sumter	7.71	31.05	29.75	0.82	0.86	1.00	1.00	1.00	1.00	0.89
Volusia	145.69	33.05	31.07	0.78	0.82	1.00	1.00	1.00	0.99	0.87
Walton	7.58	33.34	29.76	0.85	0.95	0.98	0.97	0.98	0.97	0.94

Table 5-2 Afternoon Peak Travel Time Reliability Estimates for Arterials by County

County	Sum Of Centerline Miles	Avg Pk Speed by Freq	Avg Pk Speed by Vol	Avg Pk TTI By Freq	Avg Pk TTI by Vol	Avg Ontime Arrival 10 mph by Freq	Avg Ontime Arrival 10 mph by Vol	Avg Ontime Arrival 15 mph by Freq	Avg Ontime Arrival 15 mph by Vol	Avg PTI based on Freq
Alachua	76.30	26.95	26.94	0.92	0.93	0.99	0.99	0.94	0.94	0.97
Bay	102.53	28.44	28.43	0.98	0.98	0.96	0.96	0.95	0.95	1.15
Brevard	180.51	29.51	29.50	0.91	0.91	0.98	0.98	0.98	0.98	1.04
Broward	296.29	23.15	23.13	1.00	1.01	0.94	0.94	0.93	0.93	1.31
Charlotte	38.84	29.24	29.23	0.92	0.92	0.96	0.96	0.96	0.96	0.99
Clay	35.50	25.78	25.76	1.05	1.05	0.95	0.94	0.94	0.94	1.61
Collier	31.56	28.72	28.71	0.91	0.91	0.99	0.99	0.99	0.99	0.95
Duval	260.47	26.13	26.12	0.96	0.96	0.98	0.98	0.97	0.97	1.05
Escambia	179.45	27.94	27.93	0.93	0.93	0.96	0.96	0.95	0.95	1.09
Flagler	9.79	35.25	35.25	0.83	0.83	0.99	0.99	0.99	0.99	0.82
Hernando	44.70	33.66	33.65	0.82	0.82	0.99	0.99	0.99	0.99	0.83
Hillsborough	253.49	24.58	24.54	1.15	1.16	0.88	0.88	0.87	0.87	1.65
Indian River	39.11	31.14	31.14	0.80	0.80	1.00	1.00	1.00	1.00	0.79
Lake	82.26	29.55	29.53	0.90	0.91	0.97	0.97	0.97	0.97	1.10
Lee	103.39	27.07	27.05	1.04	1.04	0.94	0.94	0.94	0.94	1.34
Leon	115.28	28.65	28.64	0.91	0.91	0.99	0.99	0.98	0.98	1.00
Manatee	75.76	25.71	25.69	1.03	1.03	0.94	0.94	0.93	0.93	1.20
Marion	92.22	30.13	30.13	0.88	0.88	0.99	0.99	0.99	0.99	0.88
Martin	36.11	26.46	26.44	0.94	0.94	0.94	0.94	0.94	0.94	1.15
Miami-Dade	387.08	19.94	19.92	1.34	1.34	0.85	0.85	0.82	0.82	1.79
Nassau	22.28	28.69	28.67	0.96	0.96	0.98	0.98	0.98	0.98	0.94
Okaloosa	66.95	22.81	22.77	1.30	1.30	0.84	0.83	0.83	0.83	1.77
Orange	192.53	23.18	23.16	1.15	1.15	0.90	0.90	0.90	0.89	1.51

Table 5-2 Afternoon Peak Travel Time Reliability Estimates for Arterials by County (Cont'd)

County	Sum Of Centerline Miles	Avg Pk Speed by Freq	Avg Pk Speed by Vol	Avg Pk TTI By Freq	Avg Pk TTI by Vol	Avg Ontime Arrival 10 mph by Freq	Avg Ontime Arrival 10 mph by Vol	Avg Ontime Arrival 15 mph by Freq	Avg Ontime Arrival 15 mph by Vol	Avg PTI based on Freq
Osceola	42.34	22.93	22.89	1.24	1.24	0.89	0.89	0.86	0.86	1.85
Palm Beach	228.88	27.93	27.92	0.86	0.86	0.99	0.99	0.98	0.98	0.96
Pasco	95.09	27.57	27.54	1.11	1.11	0.90	0.90	0.88	0.88	1.44
Pinellas	175.58	23.69	23.66	1.19	1.19	0.88	0.88	0.87	0.87	1.68
Polk	183.80	30.41	30.40	0.86	0.86	0.99	0.99	0.99	0.99	0.95
Santa Rosa	68.55	28.64	28.62	0.97	0.97	0.96	0.96	0.96	0.96	1.47
Sarasota	86.32	27.35	27.34	0.92	0.92	0.98	0.98	0.98	0.98	1.12
Seminole	78.14	23.86	23.83	1.07	1.08	0.93	0.93	0.93	0.93	1.37
St.Johns	54.10	27.62	27.60	1.00	1.00	0.95	0.95	0.94	0.94	1.20
St.Lucie	60.55	29.53	29.51	0.85	0.86	0.99	0.99	0.98	0.98	0.99
Sumter	7.71	28.23	28.23	0.90	0.90	0.99	0.99	0.99	0.99	0.90
Volusia	145.69	28.92	28.91	0.88	0.88	0.99	0.99	0.99	0.99	0.87
Walton	7.58	23.95	23.90	1.22	1.22	0.88	0.87	0.88	0.87	1.89

6 CONCLUSIONS AND RECOMMENDATIONS

This research project first implemented and evaluated the travel time estimation models developed in a previous project (FDOT Contract BDK77 977-10) using data from four selected arterials in Jacksonville, Florida. Field travel time data for the four selected arterials were collected through BlueTOAD database. The comparison between the model-estimated travel time and field data showed that the original models greatly overestimated arterial travel times. One of the reasons for this discrepancy was the assumption initially used regarding the flashing yellow during the early morning hours along arterial streets. In the field, travel time was not reduced as significantly as originally assumed during those times. Another reason for the discrepancy was that the initial simulations implemented pre-timed signal control. However, all intersections at the study sites use actuated control. Therefore, the research team developed a new travel time estimation model based on actuated control.

The CORSIM^{TM} traffic microsimulator was used, and a total of 504 scenarios were simulated considering several factors (number of lanes, number of signals per mile, demand, FFS, incident duration, percent of lanes blocked by incident, and quality of progression) which affect travel time along arterials. Regression models were developed separately for undersaturated and oversaturated conditions using IBM SPSS Statistics. The resulting adjusted R-square values indicate a good fit for both models, and the format of the equations is consistent with the preliminary analysis of the simulation results.

Travel times were also estimated for the four selected arterials using the new model. Comparison between the field travel times and the estimated travel times using the two models showed that:

- Travel times estimated using the newly developed model were consistently lower than the travel times estimated using the original model, and were closer to the field data for the four arterials studied in this project.
- For the time periods when traffic demand was very low (early morning and late night), the model estimated travel time was very close to the field data. However, for the remaining time periods, the new model still overestimated the travel time, especially for the morning and afternoon peak hours.

One possible reason for the overestimation of the new model is the assumptions made in calculating average hourly volume, which was used as input in the travel time estimation process. Since demand field data are not available, hourly traffic volume was calculated using AADTs and the corresponding hourly K factor. However, these K-factors are based on undersaturated conditions and they may not necessarily be accurate for congested conditions.

Next, a 2011 statewide arterial reliability database was developed to implement the revised models and to obtain reliability performance measures for all arterials in the SHS. The results were aggregated by county and provided in this report. One of the issues that should be addressed in the future is that for short segment lengths the speed estimates are very low and thus the measures obtained may be unreasonable.

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Appendix A Changes in the Reliability Calculation Spreadsheet

1. Changes in the Travel Time Estimation Model

Original Model

The equation for estimating travel time for undersaturated scenarios is

$$TT = \frac{60}{FFS} + 0.001603 \times t + 0.084618 \times laneclose + 0.001413 \times D + 0.012962 \times C_{(act-60)} \\ + 0.020414 \times N - 4.70594 \times C_{(act-0.3)} - 0.52147 \times P \quad \text{(A-1)}$$

where

TT :	estimated arterial travel time, in min/mile
FFS:	free-flow speed, in mph
t:	incident duration, in min
$laneclose$:	percent of lanes blocked by incidents (= lanes blocked by incidents / total lanes)
D:	demand, in veh/h/ln
$C_{(act-60)}$:	cycle length – 60, in sec
N:	number of signals per mile
$gc_{(act-0.3)}$:	*g/C ratio* – 0.3
P:	quality of progression, 0 if favorable progression, 1 if unfavorable progression

The equation for estimating travel time for oversaturated scenarios is

$$TT = \frac{60}{FFS} + 0.030626 \times t + 0.727794 \times laneclose + 0.005191 \times D + 0.037972 \times C_{(act-60)} \\ + 0.136407 \times N - 24.1586 \times C_{(act-0.3)} - 0.82938 \times P \quad \text{(A-2)}$$

All the variables are as previously defined.

Since the two equations presented above were developed based on simulation models with intersections implementing pre-timed signal control, the variable "$C_{(act-60)}$" and "$gc_{(act-0.3)}$" were included in the equations to consider the impact of signal timing.

However, signal timing implemented in the field sites are all actuated. Delay time at the pre- timed intersections greatly increased travel time. Therefore, new travel time estimation model was developed based on actuated control, which is more suitable for the intersections along the SIS.

New Model

The equation for estimating travel time for undersaturated scenarios is:

$$TT = \frac{3600}{FFS} + 0.041 \times t + 4.862 \times laneclose + 0.059 \times D + 14.406 \times N - 2.874 \times Inter \qquad \text{(A-3)}$$

TT:	estimated arterial travel time, in sec/mile
FFS:	free-flow speed, in mph
N:	number of signals per mile
D:	number of vehicles per hour per lane
t:	incident duration, in seconds
laneclose:	percent of lanes blocked by incident/total number of lanes
Inter:	variable that used to capture the interactive impact of the variable '*N*' and '*P*', *Inter=N*P*
P:	quality of progression, 1- favorable, 0-neutral

The equation for estimating travel time for oversaturated scenarios is

$$TT = \frac{3600}{FFS} + 0.355 \times t + 5.462 \times laneclose + 0.223 \times D + 28.968 \times N - 11.133 \times Inter + 44.302 \times Lanes \qquad \text{(A-4)}$$

TT:	estimated arterial travel time, in sec/mile
FFS:	free-flow speed, in mph
N:	number of signals per mile
D:	number of vehicles per hour per lane
t:	incident duration, in seconds
laneclose:	percent of lanes blocked by incident/total number of lanes
Inter:	variable that used to capture the interactive impact of the variable '*N*' and

'*P*', *Inter=N*P*

P: quality of progression, 1- favorable, 0-neutral

Lanes: adjusted number of lanes per direction

Compared to the original model, the variable "$C_{(act\text{-}60)}$" and "$gc_{(act\text{-}0.3)}$" are removed from the new model, and are replaced by the other two variables "*Inter*" and "*Lanes*". The corresponding changes in the spreadsheet are made in tab "SIS 7 Final Calc" as illustrated by the following two figures.

Coefficients	C (sec)	# Signals/mile	g/c	Progression (0-favorable, -1-neutral)	constant	Incident Duration (min)	# lanes blocked by incidents/ total # lanes	Demand (vphpl)
Non-congested	0.012962	0.204141	-4.70594	-0.52147	0.634062	0.001603	0.084618	0.001413
Congested	0.037972	0.136407	-24.1586	-0.82938	4.96926	0.030626	0.727794	0.005191

Length	PD HourVol	OD HourVol	Cycle Length (sec)	# Signals/mile	Arterial g/C Ratio	Progression (0-favorable, -1-neutral)	constant	FFS	FFS adjusted for Light Rain	FFS adjuste Heavy
3.68	97	79	120	1.63	0.44	0	1	50	45.0	
3.68	63	51	120	1.63	0.44	0	1	50	45.0	
3.68	52	43	120	1.63	0.44	0	1	50	45.0	
3.68	57	46	120	1.63	0.44	0	1	50	45.0	
3.68	101	83	120	1.63	0.44	0	1	50	45.0	
3.68	259	212	120	1.63	0.44	0	1	50	45.0	
3.68	628	514	120	1.63	0.44	0	1	50	45.0	
3.68	942	771	120	1.63	0.44	0	1	50	45.0	
3.68	869	711	120	1.63	0.44	0	1	50	45.0	
3.68	809	662	120	1.63	0.44	0	1	50	45.0	
3.68	837	685	120	1.63	0.44	0	1	50	45.0	
3.68	897	734	120	1.63	0.44	0	1	50	45.0	
3.68	941	770	120	1.63	0.44	0	1	50	45.0	
3.68	936	766	120	1.63	0.44	0	1	50	45.0	
3.68	987	808	120	1.63	0.44	0	1	50	45.0	
3.68	1,088	891	120	1.63	0.44	0	1	50	45.0	
3.68	1,141	933	120	1.63	0.44	0	1	50	45.0	
3.68	1,163	951	120	1.63	0.44	0	1	50	45.0	
3.68	866	709	120	1.63	0.44	0	1	50	45.0	
3.68	621	508	120	1.63	0.44	0	1	50	45.0	
3.68	481	393	120	1.63	0.44	0	1	50	45.0	

Figure A - 1 Inputs for Travel Time Estimation Using the Original Model

Coefficients	# Signals/mile	# of lanes per direction	Progression (1- favorable, 0-neutral)	Interaction variable of progression and # signals/mile	constant	Incident Duration (min)	# lanes blocked by incidents/ total # lanes	Demand (vphpl)
Non-congested	14.406	0	0	-2.874	0	0.041	4.862	0.059
Congested	28.968	44.302	0	-11.133	0	0.355	5.462	0.223

th	PD HourVol	OD HourVol	# Signals/mile	# lanes/ direction	Progression (1- favorable, 0-neutrall)	Interaction variable of progression and # signals/mile	constant	FFS	FFS adjusted for Light Rain	FFS adjusted for Heavy Rain
3.68	97	79	1.09	2	0	0	1	50	45.0	41.5
3.68	63	51	1.09	2	0	0	1	50	45.0	41.5
3.68	52	43	1.09	2	0	0	1	50	45.0	41.5
3.68	57	46	1.09	2	0	0	1	50	45.0	41.5
3.68	101	83	1.09	2	0	0	1	50	45.0	41.5
3.68	259	212	1.09	2	0	0	1	50	45.0	41.5
3.68	628	514	1.09	2	0	0	1	50	45.0	41.5
3.68	942	771	1.09	2	0	0	1	50	45.0	41.5
3.68	869	711	1.09	2	0	0	1	50	45.0	41.5
3.68	809	662	1.09	2	0	0	1	50	45.0	41.5
3.68	837	685	1.09	2	0	0	1	50	45.0	41.5
3.68	897	734	1.09	2	0	0	1	50	45.0	41.5
3.68	941	770	1.09	2	0	0	1	50	45.0	41.5
3.68	936	766	1.09	2	0	0	1	50	45.0	41.5
3.68	987	808	1.09	2	0	0	1	50	45.0	41.5

Figure A - 2 Inputs for Travel Time Estimation Using the New Model

Accordingly, travel time estimation equations for the 16 scenarios (Column X, Z, AB, AD, AF, AH, AJ, AL, AN, AP, AR, AT, AV, AX, AZ, and BB in tab "SIS 7 Final Calc") were also changed according to the new model.

2. Changes in the Assumption for Yellow Flashing Scenarios

In the previous developed spreadsheet (tab "SIS 7 Final Calc"), we assumed that the occurrence probabilities of the two yellow flashing scenarios (scenario 0-1 and scenario 0-2) are 100% for 1:00 am-5:00 am, and 0% for the other time periods. However, by comparing the estimated value with field data, it was found that the field travel time during the yellow flashing time period is significantly longer than the estimated value. Therefore, in the new model no yellow flashing scenarios were for the studied area. The corresponding changes in the spreadsheet are illustrated by Figure A-3 and Figure A-4.

Flashing		Flashing with rain		Non-congested		Non-congested with rain		Non-congested with incident	
Scenario 0-1 TT (sec)	Scenario 0-1 Prob of Occurrence	Scenario 0-2 TT (sec)	Scenario 0-2 Prob of Occurrence	Scenario 1 TT (sec)	Scenario 1 Prob of Occurrence	Scenario 2 TT (sec)	Scenario 2 Prob of Occurrence	Scenario 3 TT (sec)	Sce P Occ
	0.00%		0.00%	378.42	84.38%	409.36	13.61%	408.57	
264.96	74.85%	295.86	23.14%		0.00%		0.00%	398.93	
264.96	80.30%	295.94	17.69%		0.00%		0.00%	395.95	
264.96	73.30%	295.87	24.43%		0.00%		0.00%	397.23	
264.96	72.13%	298.17	25.86%		0.00%		0.00%	409.82	
	0.00%		0.00%	401.40	76.21%	431.21	21.78%	454.52	
	0.00%		0.00%	453.72	71.85%	483.38	27.64%	546.13	
	0.00%		0.00%	498.33	80.86%	530.21	17.82%	574.19	
	0.00%		0.00%	487.91	78.56%	518.17	20.67%	567.37	
	0.00%		0.00%	479.37	81.31%	508.96	17.92%	560.84	
	0.00%		0.00%	483.39	83.61%	514.08	15.08%	563.62	
	0.00%		0.00%	491.84	82.69%	523.41	16.54%	569.68	
	0.00%		0.00%	498.17	81.53%	528.53	17.96%	573.96	
	0.00%		0.00%	497.50	78.34%	529.20	20.62%	572.97	
	0.00%		0.00%	504.73	78.34%	536.76	20.62%		
	0.00%		0.00%	519.06	70.09%	550.07	28.86%		
	0.00%		0.00%	526.44	57.25%	557.41	40.89%		
	0.00%		0.00%	529.60	60.14%	563.47	38.27%		
	0.00%		0.00%	487.51	74.22%	519.89	24.74%	566.76	
	0.00%		0.00%	452.82	68.91%	483.34	30.32%	544.83	
	0.00%		0.00%	432.85	76.75%	462.31	21.93%	515.65	
	0.00%		0.00%	419.49	77.37%	449.04	20.36%	490.71	
	0.00%		0.00%	404.28	80.30%	435.96	17.69%	460.28	
	0.00%		0.00%	391.22	84.16%	426.36	13.57%	434.16	

Figure A - 3 Assumptions for Yellow Flashing Scenarios in the Original Model

Flashing		Flashing with rain		Non-congested		Non-congested with rain		Non-congested with incident	
Scenario 0-1 TT (sec)	Scenario 0-1 Prob of Occurrence	Scenario 0-2 TT (sec)	Scenario 0-2 Prob of Occurrence	Scenario 1 TT (sec)	Scenario 1 Prob of Occurrence	Scenario 2 TT (sec)	Scenario 2 Prob of Occurrence	Scenario 3 TT (sec)	Sce Pr Occ
	0.00%		0.00%	327.23	84.38%	358.17	13.61%	343.99	
	0.00%		0.00%	323.88	74.85%	354.77	23.14%	337.29	
	0.00%		0.00%	322.84	80.30%	353.82	17.69%	335.21	
	0.00%		0.00%	323.28	73.30%	354.19	24.43%	336.10	
	0.00%		0.00%	327.67	72.13%	360.88	25.86%	344.86	
	0.00%		0.00%	343.22	76.21%	373.03	21.78%	375.97	
	0.00%		0.00%	379.63	71.85%	409.29	27.64%	440.62	
	0.00%		0.00%	410.68	80.86%	442.55	17.82%	460.15	
	0.00%		0.00%	403.42	78.56%	433.68	20.67%	455.40	
	0.00%		0.00%	397.48	81.31%	427.07	17.92%	450.86	
	0.00%		0.00%	400.28	83.61%	430.97	15.08%	452.80	
	0.00%		0.00%	406.16	82.69%	437.73	16.54%	457.01	
	0.00%		0.00%	410.57	81.53%	440.92	17.96%	459.99	
	0.00%		0.00%	410.10	78.34%	441.80	20.62%	459.30	
	0.00%		0.00%	415.13	78.34%	447.16	20.62%		
	0.00%		0.00%	425.10	70.09%	456.11	28.86%		
	0.00%		0.00%	430.24	57.25%	461.21	40.89%		
	0.00%		0.00%	432.44	60.14%	466.30	38.27%		
	0.00%		0.00%	403.14	74.22%	435.52	24.74%	454.98	
	0.00%		0.00%	379.00	68.91%	409.52	30.32%	439.72	
	0.00%		0.00%	365.10	76.75%	394.56	21.93%	419.41	

Figure A - 4 Assumptions for Yellow Flashing Scenarios in the New Model

Appendix B Example Worksheet Guide

Tab 1 – Facility Description

This tab is for information purposes only and it defines the various types of facilities and their corresponding abbreviations that will be used in the rest of the worksheet.

The example arterial section "Beach Boulevard (The section between University Boulevard and I-295, BlueTOAD section 4295/4296)" belongs to the facility types "1art2c", which are highlighted with olive green in the tab.

Tab 2 – LOS Criteria

This tab presents the level of service (LOS) volume thresholds (columns C to G) according to facility type (column A), number of lanes (column B) and time period – peak, off-peak and midday (column I). The LOS thresholds used in this tab are FDOT System Planning values.

The corresponding LOS data of "1art2c" are highlighted with olive green in the tab.

Tab 3 – HrlyK with Peak Hours Speed Table

This tab presents the average hourly K factors (column C) according to facility type (column A), hour of the day (column B) and time period (column D). Note that, the time period from 4:00 pm to 7:00 pm is defined as afternoon peak hours according to this tab.

The data for arterial road are highlighted with grey in the tab.

Tab 4 – SR15 Inputs

This tab has the basic information related to the example section. The orange-highlighted cells indicate user input. The grey column headers indicate information related to the characteristics of the example section. The blue-highlighted column headings indicate output that will be used as input in the intermediate calculations in other tabs.

Input

From the BlueTOAD data, the characteristics of the example section are inputted (cells B7:G7), as well as the speed limit (cell T7). From 2009 FDOT Quality/Level of Service Handbook, the directional distribution factor (cell H7), and g/C ratio (cell Q7) can be got from the Generalized Service Volume Table 1. The speed threshold for different road type and different LOS can also be acquired from the same table, and the LOS C threshold (cell U7) was used as the free flow speed for Reliability Calculation in Tab "Reliability All Day" and "Reliability 4-7".

The number of signals (cell O7) was counted from Google Earth. The progression type (cell Q7), was assumed to be 0. Based on HCM 2010, the default value for adjusted saturation flow rate is 1800 pcphpl. Therefore, the expected capacity was calculated as "1800*number of lanes *g/C ratio".

The probability of one/tow lane blocked incident (column Q) was obtained from the 2011 SHS accident data for Duval County. The probability of work zone (column S), and the duration of one/two lane blocked incident (column R) and work zone (column T), were not available. Those numbers were assumed and given for illustrative purposes.

Calculations

Columns B,C,D,E,F,G,H:

They obtain their respective values from row 7.

Column I:

PD HourVol = AADT * Directional Distribution Factor * Avg of HrlyK (from the HrlyK with Peak Hours tab, according to Facility type and hour of the day).

Column J:

OD HourVol = AADT * (1-Directional Distribution Factor)* Avg of HrlyK (from the HrlyK with Peak Hours tab, according to Facility type and hour of the day).

Cells I37, J37:

Sums of their respective columns.

Columns K,L,M,N,O:

LOSA, LOSB, LOSC, LOSD, LOSE are calculated from the lookup table "LOS Criteria" based on the LOSTABLE field for "1art1c", "1art2c", and "1art3d" type.

Cell P7:

Number of signals per mile = Number of signals / Length.

Cell S7:

FFS for Travel Time Calculation = Speed Limit + 5.

Cells U12:U35:

Probability of 1 Lane Blocked Incident and Work Zone = Probability of 1 Lane Blocked Incident * Probability of 1 Lane Blocked Work Zone.

Cells V12:V35:

1 Lane Blocked Incident and Work Zone Duration = Maximum (1 Lane Blocked Incident Duration, 1 Lane Blocked Work Zone Duration).

Cells U39:U62:

Probability of 2 Lane Blocked Incident and Work Zone

= Probability of 1 Lane Blocked Incident * Probability of 2 Lane Blocked Work Zone

+ Probability of 2 Lane Blocked Incident * Probability of 1 Lane Blocked Work Zone

+ Probability of 2 Lane Blocked Incident * Probability of 2 Lane Blocked Work Zone

Cells V39:V62:

2 Lane Blocked Incident and Work Zone Duration = Maximum (2 Lane Blocked Incident Duration, 2 Lane Blocked Work Zone Duration).

Tab 5 – Rain

This tab deals with all weather-related calculations. The orange-highlighted cells indicate user input fields, while the blue-highlighted column and row headings indicate output that will be used as input in other tabs.

Input

From the literature review, we assume the speed reduction for “None or Trace”, “Light Rain” and “Heavy Rain” is 0, 10% (cell F2) and 17% (cell F3) respectively. The capacity reduction for both light and heavy rain is 6% (cell F4).

The entire Florida is divided into three parts to reflect the differences in precipitation patterns. Table B-1 presents the division of the three rainfall distribution regions.

Table B - 1 Division of Rainfall Distribution Regions

	Representative Location	Counties	Description
Region 1	Tallahassee	Escambia, Santa Rosa, Okaloosa, Walton, Holmes, Washington, Bay, Jackson, Calhoun, Gulf, Franklin, Liberty, Gadsden, Leon, Wakulla, Jefferson, Madison, Taylor, Hamilton, Suwannee, Lafayette, Dixie, Columbia, Baker, Union, levy, Gilchrist	northwest extreme high precipitation area
Region 2	Orlando	Nassau, Duval, Clay, St. Johns, Putnam, Bradford, Alachua, Marion, Flagler, Volusia, Seminole, Lake, Citrus, Sumter, Hernando, Pasco, Pinellas, Hillsborough, Polk, Orange, Osceola, Brevard, Indian River, Okeechobee, Highlands, Hardee, Desoto, Manatee, Sarasota, Charlotte, Glades, Hendry, Lee, Collier	central low precipitation area
Region 3	Miami	St. Lucie, Martin, Palm Beach, Broward, Miami-Dade, Monroe	southeast high precipitation area

If the subject arterial section is located in Region 1, the value of Segment Location (cell F6) is 1; if it is located in Region 2, Segment Location is 2; and if it is located in Region 3, Segment Location is 3. The shape parameter k of the Gamma Distribution was estimated to be 0.2782, 0.3258, and 0.2872 for Region 1 (cell J5), Region 2 (cell J6), and Region 3 (cell J7), respectively.

From the weather underground website (http://www.wundergroud.com), the whole year rainfall data of 2011 was collected for the subject area. The number of rainy days is determined based on these data (column C). Average precipitation of the rainy days is also calculated as the input of “Average Rainfall” (column B).

Calculations

Column D:

Shape Parameter k of the Gamma Distribution = 0.2782 if Segment Location = 1; or Shape parameter k of Gamma Distribution = 0.3258, if Segment Location = 2; or Shape parameter k of Gamma Distribution = 0.2872, if Segment Location = 3.

Column E:

Scale Parameter θ of the Gamma Distribution = Average Rainfall/Shape Parameter k, if Average Rainfall is not 0; or Scale Parameter θ of the Gamma Distribution = 0.001/Shape Parameter k, if Average Rainfall equals to 0.

Column F:

Probability of Trace= GAMMADIST (0.01, k, θ, TRUE) (Returns the cumulative gamma distribution at 0.01 given values of k and θ). 0.01 is the upper bound of the rainfall intensity range for “Trace”.

Column G:

Probability of Light Rain= GAMMADIST (0.5, k, θ, TRUE) - GAMMADIST (0.01, k, θ, TRUE). 0.01 and 0.5 are the lower and upper bounds of the rainfall intensity range for “Light Rain” respectively.

Column H:

Probability of Heavy Rain= 1- Probability of Light Rain - Probability of Trace

Column I:

Probability of Rain = Number of Rainy Days/72, (72 is the sample size of the rainfall data.) if Number of Rainy Days is not 0; or Probability of Rain = 0.001, if Number of Rainy Days equals to 0.

Column J:

Ratio of Light Rain to Light + Heavy Rain = Probability of Light Rain/(Probability of Light Rain + Probability of Heavy Rain).

Column K:

Ratio of Heavy Rain to Light + Heavy Rain = 1 - Ratio of Light Rain to Light + Heavy Rain.

Tab 6 and 7– Capacity-Demand 1 lane blocked / Capacity-Demand 2 lane blocked

These tabs deal with 1 or 2 lane blocked calculations for different scenarios. The procedure followed is essentially the same in the two tabs, except the Number of Closed Lanes (Cells C12:C35) is respectively 1 and 2 as indicated in the tab title, thus only Tab 6 (Capacity-Demand 1 lane blocked) will be presented in this section.

The orange-highlighted cells indicate user input. The grey column headers indicate information related to the characteristics of the example section, which can be obtained from the previous tabs. The blue-highlighted column headings indicate output that will be used as input in the intermediate calculations in other tabs.

Input

The capacity maintained for each lane under different number of lane blocked conditions for incident (cells C5:D7) and work zone (cells I5:J7) were not available. Some numbers were given for illustrative purposes. In this calculation algorithm, it was assumed that the lane blockage caused by incident and the lane blockage cased by work zones have the same impact on capacity reduction. Therefore, in the "Capacity-Demand 2 lane blocked" tab, when calculating the probabilities of the demand over capacity scenario under both incident and work zone conditions, there's only one reduced capacity value. Therefore, we don't need to calculate the probabilities separately by different combinations of the two (such as two lane blockage all cased by work zones or incidents, or one lane is blocked because of work zones and the other lane is blocked by incidents).

Seasonal Factors for arterial road for the 52 weeks of a year (cells AW38:CV38) were not available. FDOT Seasonal Factors for freeway were used here for illustrative purposes.

Calculations

Cells B12:B35:

The number of lanes per direction is obtained from the SR15 Inputs Tab (column J).

Cells C12:C35:

The Number of Closed Lanes is 1 as indicated in the tab title.

Cells D12:D35:

The LOSE, i.e. capacity without incident or work zone or rain, is obtained from the Arterial Inputs Tab (Cell V7).

Columns E and F:

The peak and off-peak direction volume (vehicle per hour per direction) is obtained from the Arterial Inputs Tab (column I and J).

Cells H12:H35:

Capacity under no incident/no work zone (vphpd) = LOSE (Capacity without incident or work zone or rain).

Cells I12:I35:

Capacity under rain (vphpd) = LOSE (Capacity without incident or work zone or rain) * (1 - The capacity reduction from rain (Tab Rain Cell F4)).

Cells J12:J35:

If the Number of Lanes per direction (column B) is equal or less than the Number of Closed Lanes (column C), this means all lanes are blocked, so this scenario is considered as not happening and the capacity under incident is shown as blank.

If the Number of Lanes per direction is greater than the Number of Closed Lanes, capacity remains per lane for blocking incident is selected from the Incident Capacity Table (cells C5:D7) using the Number of Lanes per direction for the rows and the Number of Closed Lanes for the columns. Then Capacity under incident (vphpd) = LOSE * Capacity Remains per lane for blocking incident * (Number of Lanes per direction - Number of Closed Lanes).

Cells K12:K35:

If the Number of Lanes per direction (column B) is equal or less than the Number of Closed Lanes (column C), this means all lanes are blocked, so this scenario is considered as not happening and the capacity under work zone is shown as blank.

If the Number of Lanes per direction is greater than the Number of Closed Lanes, capacity remains per lane for blocking work zone is selected from the work zone Capacity Table (cells I5:J7) using the Number of Lanes per direction for the rows and the Number of Closed Lanes for the columns. Then Capacity under work zone (vphpd) = LOSE * Capacity Remains per lane for blocking work zone * (Number of Lanes per direction - Number of Closed Lanes).

Cells L12:L35:

Capacity under rain and incident (vphpd) = Capacity under incident * (1 - The capacity reduction from rain).

Cells M12:M35:

Capacity under rain and work zone (vphpd) = Capacity under work zone * (1 - The capacity reduction from rain).

Cells N12:N35:

Capacity under incident and work zone (vphpd) = Minimum (Capacity under incident, Capacity under work zone).

Cells O12:O35:

Capacity under rain, incident, and work zone (vphpd) = Capacity under incident and work zone * (1 - The capacity reduction from rain).

Columns AW to EV apply the FDOT seasonal factors (for the 52 weeks of the year, Cells AW 38 to EV38) on both the peak and the off-peak direction volumes in order to obtain the average demand as well as the probability of demand over capacity for different scenarios. In particular:

Cells AW12:CV35:

Peak Direction Volume for each week$_i$ (vphpd) = Peak Direction Volume (vphpd)* FDOT Seasonal Factors$_i$, where i = the week #.

Cells CW12:EV35:

Off-peak Direction Volume for each week$_i$ (vphpd) = Off-peak Direction Volume (vphpd)* FDOT Seasonal Factors$_i$, where i = the week #.

Cells AW43:EV66:

Demand-Capacity $_{\text{no incident/no work zone}}$ = 0, if Direction Volume for each week < Capacity under no incident/no work zone (column H).

Demand-Capacity $_{\text{no incident/no work zone}}$ = 1, if Direction Volume for each week > Capacity under no incident/no work zone (column H).

Cells AW71:EV94:

Demand-Capacity $_{\text{rain}}$ = 0, if Direction Volume for each week < Capacity under rain (column I).

Demand-Capacity $_{\text{rain}}$ = 1, if Direction Volume for each week > Capacity under rain (column I).

Cells AW99:EV122:

Demand-Capacity $_{\text{incident}}$ = 0, if Direction Volume for each week < Capacity under incident (column J).

Demand-Capacity $_{\text{incident}}$ = 1, if Direction Volume for each week > Capacity under incident (column J).

Cells AW127:EV150:

Demand-Capacity $_{\text{work zone}}$ = 0, if Direction Volume for each week < Capacity under work zone (column K).

Demand-Capacity $_{\text{work zone}}$ = 1, if Direction Volume for each week > Capacity under work zone (column K).

Cells AW155:EV178:

Demand-Capacity $_{\text{rain and incident}}$ = 0, if Direction Volume for each week < Capacity under rain and incident (column L).

Demand-Capacity $_{\text{rain and incident}}$ = 1, if Direction Volume for each week > Capacity under rain and incident (column L).

Cells AW183:EV206:

Demand-Capacity $_{\text{rain and work zone}}$ = 0, if Direction Volume for each week < Capacity under rain and work zone (column M).

Demand-Capacity $_{\text{rain and work zone}}$ = 1, if Direction Volume for each week > Capacity under rain and work zone (column M).

Cells AW211:EV234:

Demand-Capacity $_{\text{incident and work zone}}$ = 0, if Direction Volume for each week < Capacity under incident and work zone (column N).

Demand-Capacity $_{\text{incident and work zone}}$ = 1, if Direction Volume for each week > Capacity under incident and work zone (column N).

Cells AW239:EV262:

Demand-Capacity $_{\text{rain, incident, and work zone}}$= 0, if Direction Volume for each week < Capacity under rain, incident, and work zone (column O).

Demand-Capacity $_{\text{rain, incident, and work zone}}$ = 1, if Direction Volume for each week > Capacity under rain, incident, and work zone (column O).

Column AS:

weeks Demand > Capacity = SUM of the Demand-Capacity cells.

Column AT:

% of weeks Demand > Capacity = (# weeks Demand > Capacity)/(2*52).

Column AU:

Demand Undersaturated = Average of Direction Volumes of the weeks where Demand-Capacity = 0 / (Number of Lanes per direction - Number of Closed Lanes), if (# weeks Demand > Capacity) ≠ 104.

Demand Undersaturated = blank, if (# weeks Demand > Capacity) = 104.

Column AV:

Demand Oversaturated = Average of Direction Volumes of the weeks where Demand-Capacity = 1 / (Number of Lanes per direction - Number of Closed Lanes), if (# weeks Demand > Capacity) ≠ 0.

Demand Oversaturated = blank, if (# weeks Demand > Capacity) = 0.

Columns Q,R,S,T,U,V,W,X:

Probability of demand over capacity = % of weeks Demand > Capacity (column AT), depending on the scenario.

Columns Z,AA,AB,AC,AD,AE,AF,AG:

Demand for undersaturated conditions = Demand undersaturated (column AU), depending on the scenario.

Columns AI,AJ,AK,AL,AM,AN,AO,AP:

Demand for oversaturated conditions = Demand oversaturated (column AV), depending on the scenario.

Tab 8 – Intermediate Scenario Calc

This tab calculates the average incident duration, average # lanes blocked by incidents/ total # lanes, average Demand (vphpl), and Probability of Occurrence for different scenarios, which are highlighted as blue header columns and will be used as input in the SR 15 Final Calc Tab. During the calculation, we assume the occurrence of rain, work zone and incidents are independent.

Input from other Tabs

Column B:

Number of Lanes per direction is obtained from the “Arterial Inputs” Tab (column F).

Cells C8:C31:

Probability of Rain is obtained from the Rain Tab (column I).

For One Lane Blocked Situation:

Cells C68:C91:

Number of Closed Lanes is obtained from the “Capacity-Demand 1 lane blocked” Tab (column C).

Cells E68:J91:

PROBABILITY & DURATION OF INCIDENT is obtained from the “Arterial Inputs” Tab (cells Q12:V35).

Cells L68:S91:

PROBABILITY OF DEMAND OVER CAPACITY is obtained from the “Capacity-Demand 1 lane blocked” Tab (cells Q12:X35).

Cells U68:AB91:

DEMAND FOR UNDERSATURATED CONDITIONS is obtained from the Capacity-Demand 1 lane blocked Tab (cells Z12:AG35).

Cells AD65:AK88:

DEMAND FOR OVERSATURATED CONDITIONS is obtained from the Capacity-Demand 1 lane blocked Tab (cells AI12:AP35).

For Two Lane Blocked Situation:

Cells C98:C121:

Number of Closed Lanes is obtained from the Capacity-Demand 2 lane blocked Tab (column C).

Cells E98:J121:

PROBABILITY & DURATION OF INCIDENT is obtained from the “Arterial Inputs” Tab (cells Q39:V62).

Cells L98:S121:

PROBABILITY OF DEMAND OVER CAPACITY is obtained from the “Capacity-Demand 2 lane blocked” Tab (cells Q12:X35).

Cells U98:AB121:

DEMAND FOR UNDERSATURATED CONDITIONS is obtained from the "Capacity-Demand 2 lane blocked" Tab (cells Z12:AG35).

Cells AD98:AK121:

DEMAND FOR UNDERSATURATED CONDITIONS is obtained from the "Capacity-Demand 2 lane blocked" Tab (cells AI12:AP35).

Calculations

*If the probability of occurrence is equal to zero, this means the scenario will not happen at this specific time for this section. So the corresponding duration, # lanes blocked, and demand are shown as blank.

For Undersaturated Scenario:

Cells E8:E31:

Incident Duration = 0.

Cells F8:F31:

lanes blocked by incidents/ total # lanes = 0.

Cells G8:G31:

Demand (vphpl) = Undersaturated Demand under no incident/no work zone (vphpl) (U68:U91).

Cells H8:H31:

Prob of Occurrence = (1- Probability of Rain)*(1- Probability of Demand over Capacity under no incident/no work zone/no rain), if Number of Lanes per direction = 1;

Prob of Occurrence = (1- Probability of 1 Lane Blocked Incident)*(1- Probability of 1 Lane Blocked Work Zone)*(1- Probability of Rain)*(1- Probability of Demand over Capacity under no incident/no work zone/no rain), if Number of Lanes per direction = 2;

Prob of Occurrence = (1- Probability of 1 Lane Blocked Incident- Probability of 2 Lane Blocked Incident)*(1- Probability of 1 Lane Blocked Work Zone- Probability of 2 Lane Blocked Work Zone)*(1- Probability of Rain)*(1- Probability of Demand over Capacity under no incident/no work zone/no rain), if Number of Lanes per direction = 3.

For Undersaturated with rain Scenario:

Cells J8:J31:

Incident Duration = 0.

Cells K8:31:

lanes blocked by incidents/ total # lanes = 0.

Cells L8:L31:

Demand (vphpl) = Undersaturated Demand under rain (vphpl) (V68:V91).

Cells M8:M31:

Prob of Occurrence = Probability of Rain*(1- Probability of Demand over Capacity under no incident/no work zone), if Number of Lanes per direction = 1;

Prob of Occurrence = (1- Probability of 1 Lane Blocked Incident)*(1- Probability of 1 Lane Blocked Work Zone)*Probability of Rain*(1- Probability of Demand over Capacity under no incident/no work zone/with rain), if Number of Lanes per direction = 2;

Prob of Occurrence = (1- Probability of 1 Lane Blocked Incident- Probability of 2 Lane Blocked Incident)*(1- Probability of 1 Lane Blocked Work Zone- Probability of 2 Lane Blocked Work Zone)*Probability of Rain*(1- Probability of Demand over Capacity under no incident/no work zone/with rain), if Number of Lanes per direction = 3.

For Undersaturated with incident Scenario:

Cells O8:O31:

Incident Duration = blank, if Number of Lanes per direction = 1;

Incident Duration = 1 Lane Blocked Incident Duration, if Number of Lanes per direction = 2;

Incident Duration = (1 Lane Blocked Incident Duration*Probability of 1 Lane Blocked Incident*(1- Probability of Demand over Capacity under incident for 1 lane blocked) + 2 Lane Blocked Incident Duration*Probability of 2 Lane Blocked Incident*(1- Probability of Demand over Capacity under incident for 2 lane blocked)) / (Probability of 1 Lane Blocked Incident*(1- Probability of Demand over Capacity under incident for 1 lane blocked) + Probability of 2 Lane Blocked Incident*(1- Probability of Demand over Capacity under incident for 2 lane blocked)), if Number of Lanes per direction = 3.

Cells P8:P31:

lanes blocked by incidents/ total # lanes = blank, if Number of Lanes per direction = 1;

lanes blocked by incidents/ total # lanes = 1/2, if Number of Lanes per direction = 2;

lanes blocked by incidents/ total # lanes = (1*Probability of 1 Lane Blocked Incident*(1- Probability of Demand over Capacity under incident for 1 lane blocked) + 2*Probability of 2 Lane Blocked Incident*(1- Probability of Demand over Capacity under incident for 2 lane blocked)) / (Probability of 1 Lane Blocked Incident*(1- Probability of Demand over Capacity under incident for 1 lane blocked) + Probability of 2 Lane Blocked Incident*(1- Probability of Demand over Capacity under incident for 2 lane blocked)), if Number of Lanes per direction = 3.

Cells Q8:Q31:

Demand = blank, if Number of Lanes per direction = 1;

Demand = Undersaturated Demand under incident for 1 lane blocked, if Number of Lanes per direction = 2;

Demand = (Undersaturated Demand under incident for 1 lane blocked*Probability of 1 Lane Blocked Incident*(1- Probability of Demand over Capacity under incident for 1 lane blocked) + Undersaturated Demand under incident for 2 lane blocked*Probability of 2 Lane Blocked Incident*(1- Probability of Demand over Capacity under incident for 2 lane blocked)) / (Probability of 1 Lane Blocked Incident*(1- Probability of Demand over Capacity under incident for 1 lane blocked) + Probability of 2 Lane Blocked Incident*(1- Probability of Demand over Capacity under incident for 2 lane blocked)), if Number of Lanes per direction = 3.

Cells R8:R31:

Prob of Occurrence = 0, if Number of Lanes per direction = 1;

Prob of Occurrence = Probability of 1 Lane Blocked Incident*(1- Probability of 1 Lane Blocked Work Zone)*(1-Probability of Rain)*(1- Probability of Demand over Capacity under incident for 1 lane blocked), if Number of Lanes per direction = 2;

Prob of Occurrence = Probability of 1 Lane Blocked Incident*(1- Probability of 1 Lane Blocked Work Zone- Probability of 2 Lane Blocked Work Zone)*(1-Probability of Rain)*(1- Probability of Demand over Capacity under incident for 1 lane blocked) + Probability of 2 Lane Blocked Incident*(1- Probability of 1 Lane Blocked Work Zone- Probability of 2 Lane Blocked Work Zone)*(1-Probability of Rain)*(1- Probability of Demand over Capacity under incident for 2 lane blocked), if Number of Lanes per direction = 3.

For Undersaturated with work zone, Undersaturated with rain and incident, Undersaturated with rain and work zone, Undersaturated with incident and work zone, Undersaturated with rain, incident, work zone, Oversaturated, Oversaturated with rain, Oversaturated with incident, Oversaturated with work zone, Oversaturated with rain and incident, Oversaturated with rain and work zone, Oversaturated with incident and work zone, Oversaturated with rain, incident, work zone Scenarios, the calculations are similar.

Tab 9 – SIS 7 Final Calc

This tab calculates the final results of travel time under different scenarios and statistical average travel time for the example section. The orange-highlighted cells indicate user input. The grey column headers indicate information related to the characteristics of the example section. The blue column headers are reserved for the travel times and probabilities of each scenario and the purple column headers and highlighted cells are the results (yearly averages).

Input

Cells F3:M4:

The coefficients of the travel time estimation models from the SIS 6 project report.

Calculations

Column B:

Length is obtained from the “Arterial Inputs” Tab (column E).

Columns C and D:

The peak and off-peak direction volume is obtained from the “Arterial Inputs” Tab (column I and J).

Column F,G,H:

They obtain their respective values from the “Arterial Inputs” Tab (cells P7, F7, and R7, respectively).

Column I:

Interaction variable that is used to capture the simultaneous influence of the variable “number of signals per mile” and “quality of progression on travel time”.

Interaction Variable = # of signals/mile * Progression.

Column J:

Constant is used in the travel time estimation model calculation and given as 1.

Column L:

Free Flow Speed is obtained from the "Arterial Inputs" Tab (cell S7).

Column M:

FFS adjusted for Light Rain = FFS*(1- Free-flow speed reduction for Light Rain).

Column N:

FFS adjusted for Heavy Rain = FFS*(1- Free-flow speed reduction for Heavy Rain).

Columns O,P:

Light and Heavy rain ratios are obtained from their corresponding columns on the "Rain" tab.

Column Q:

Equivalent Free-flow Travel Time for Rain = ((Ratio of Light Rain to Total Rain*(3600/FFS adjusted for Light Rain)) + (Ratio of Heavy Rain to Total Rain*(3600/FFS adjusted for Heavy Rain)))*Length.

Column R:

FFS adjusted for Rain = Length*3600 / Equivalent Free-flow Travel Time for Rain.

Columns U,W,Y,AA,AC,AE,AG,AI,AK,AM,AO,AQ,AS,AU,AW,AY, BA, BC:

Probability of occurrence for each scenario is obtained from the "Intermediate Scenario Calc" Tab.

Columns T,V,X,Z,AB,AD,AF,AH, AJ, AL:

*If the probability of occurrence is equal to zero, this means the scenario will not happen at this specific time for this section. So the corresponding scenario travel time is shown as blank.

Undersaturated scenarios travel time (sec) = (3600/FFS (or FFS adjusted for Rain for scenarios with rain) + 0.041*incident duration + 4.862* # lanes blocked by incidents/ total # lanes + 0.059*demand + 14.406* # Signals/mile –2.874*Interaction Variable)*Length.

Columns AJ,AL,AN,AP,AR,AT,AV,AX, BA, BC:

*If the probability of occurrence is equal to zero, this means the scenario will not happen at this specific time for this section. So the corresponding scenario travel time is shown as blank.

Oversaturated scenarios travel time (sec) = (3600/FFS (or FFS adjusted for Rain for scenarios with rain) + 0.355*incident duration + 44.302* # lanes per direction +5.462* # lanes blocked by incidents/ total # lanes + 0.223*demand + 28.968* # Signals/mile – 11.133*Interaction Variable)*Length.

Column BE:

Total Probability Check = the sum of all scenario probabilities (must be 100%).

Column BF:

Annual Expected TT = the sum of all scenario probability*scenario travel time.

Column BH:

Annual Average Speed = Length / (Annual Expected TT/3600).

Column BJ:

Calculations for TT Weighted By Demand = Annual Expected TT*(PD HourVol + OD HourVol).

Cell BF33:

Avg. Annual TT = Average of the hourly Annual Expected.

Cell BH33:

Avg. Annual Speed = Length / (Avg. Annual TT/3600).

Cell BJ33:

Avg. Annual TT/mile = Avg. Annual TT / Length.

Cell BF34:

Avg. Weighted by Hourly Demand TT = (the sum of Calculations for TT Weighted By Demand) / (Total of PD HourVol + Total of OD HourVol).

Cell BH34:

Avg. Weighted by Hourly Demand Speed = Length / (Avg. Weighted by Hourly Demand TT/3600).

Cell BJ34:

Avg. Weighted by Hourly Demand TT/mile = Avg. Weighted by Hourly Demand TT / Length.

Tabs 10 and 11 – Reliability All Day / Reliability 4-7

In these tabs the results of the "SIS 7 Final Calc" Tab are used to estimate reliability performance measures. The procedure followed is essentially the same in the two tabs, thus only Tab 10 (Reliability All Day) will be presented in this section.

Input

There is no manual input in this tab, as everything will be obtained from some other tab. In cells AI11 and AI12 the total days in a year and the total hours in a year are found.

Calculations

Column C:

Travel Time is obtained from all the Travel Time columns of the "SIS 7 Final Calc" Tab.

Column D:

Frequency (%) is obtained from all the Probability of Occurrence columns of the "SIS 7 Final Calc" Tab.

Column E:

Average Speed = Length/(Travel Time/3600)

Column F:

Frequency (hours) = Frequency (%) * Total days in a year.

Column G:

Flow - Both Directions = PD HourVol + OD Hour Vol (from the "SIS 7 Final Calc" Tab).

Column H:

Annual Hourly Volume = Frequency (hours) * Flow_Both Directions

Column I:

TT*Freq (%) = Travel Time * Frequency (%).

Cells F441, H441:

The sums of Frequency (hours), Annual Hourly Volume

Column K:

Free-flow Travel Time = Section Length / (Free-flow Speed (“Arterial Inputs” Cell S7) / 3600)

Column L:

Section Hourly Volume = Flow - Both Directions

Column M:

Hourly Avg. TT (Weighted by Freq) = Sum of TT*Freq(%) of each scenario

Column N:

Hourly Avg. Speed (Weighted by Freq) = Section Length/(Hourly Avg. TT/3600)

Column O:

Hourly Travel Time Index = Hourly Avg. TT/Free-flow Travel Time

Cell M36:

Daily Average TT (Weighted by Freq) = Average of Hourly Avg. TT (Column M)

Cell M37:

Daily Average TT (Weighted by volume) = Section Hourly Volume (Column L) Weighted Average of Hourly Avg. TT (Column M)

Cell M39:

Daily Average Speed (Weighted by Freq) = Average of Hourly Avg. Speed (Column N)

Cell M40:

Daily Average Speed (Weighted by volume) = Section Hourly Volume (Column L) Weighted Average of Hourly Avg. Speed (Column N)

Cell M42:

Daily TTI (Weighted by Freq) = Average of Hourly Travel Time Index (Column O)

Cell M43:

Daily TTI (Weighted by volume) = Section Hourly Volume (Column L) Weighted Average of Hourly Travel Time Index (Column O)

Columns P, Q, R:

These are columns C, E, F sorted by Travel Time.

Column S:

Cumulative Hours = the cumulative of the sorted Frequency (hours).

Column V:

Frequency (Hours) by brackets in order to be used in a Chart. Refers to column R.

Columns W, X, Y:

These are columns C, E, H sorted by Travel Time.

Column Z:

Cumulative Volume = the cumulative of the sorted Volume.

Column AC:

Total Vehicles by brackets in order to be used in a Chart. Refers to column Y.

Travel Time Reliability Calculations

Cell AI11, AI12:

Total days in a year and the total hours in a year.

Cell AI13:

Total Annual Volume = Sum of Column H.

Cell AJ17:

Travel time corresponding to 10 mph = Length*3600/10.

We seek the last travel time value on column Q and X less than 10 mph and we highlight that line in yellow.

Cell AI18:

Percent of time travel speed is above 10 mph = Highlighted cell (see above) in the Cumulative Hours column / Total hours in a year.

Cell AI19:

Percent of trips travel speed is above 10 mph = Highlighted cell (see above) in the Cumulative Volume column / Total Annual volume.

Cell AJ21:

Travel time corresponding to 15 mph = Length*3600/15.

We seek the last travel time value on column Q and X less than 15 mph and we highlight that line in yellow.

Cell AI22:

Percent of time travel speed is above 15 mph = Highlighted cell (see above) in the Cumulative Hours column / Total hours in a year.

Cell AI23:

Percent of trips travel speed is above 15 mph = Highlighted cell (see above) in the Cumulative Volume column / Total Annual volume.

Cell AI27:

95% of the Total Annual Volume = Total Annual Volume*95%

We seek the last cumulative volume value on column Z that is less than the 95% of total annual volume and we highlight that line in yellow.

Cell AK27:

Travel Time corresponding to 95% of time = The value of the highlighted cell (see above) on the sorted Travel Time column (Column W).

Cell AM27:

Travel Speed corresponding to 95% of time = The value of the highlighted cell (see above) on the sorted Average Speed column (Column X).

Cell AJ28:

Free-Flow (LOS C Threshold Speed) Travel Time = The value in Cell K8.

Cell AJ29:

Planning Time Index based on number of trips = Travel Time corresponding to 95% of trips / Free-flow Travel Time.

Cell AI31:

95% of the Total Hours in a Year = Total hours in a year*95%

We seek the last cumulative hours value on column S that is less than the 95% of total hours in a year and we highlight that line in yellow.

Cell AK31:

Travel Time corresponding to 95% of time = The value of the highlighted cell (see above) on the sorted Travel Time column (Column P).

Cell AM31:

Travel Speed corresponding to 95% of time = The value of the highlighted cell (see above) on the sorted Average Speed column (Column Q).

Cell AJ32:

Free-Flow (LOS C Threshold Speed) Travel Time = The value in Cell K8.

Cell AJ33:

Planning Time Index based on number of trips = Travel Time corresponding to 95% of hours / Free-flow Travel Time.

Cell AJ37:

Volume Weighted Daily Average TT = The value in Cell M37

Cell AJ41:

Daily Average TT Weighted by Frequency = The value in Cell M36

Cell AJ38, AJ42:

Free-Flow (LOS C Threshold Speed) Travel Time = The value in Cell K8.

Cell AJ39:

Travel Time Index based on number of trips = Volume Weighted Daily Average TT/ Free-flow Travel Time

Cell AJ43:

Travel Time Index based on frequency = Daily Average TT Weighted by Frequency/ Free-flow Travel Time.

Appendix C Reliability Calculation Results for Arterials Connecting Major Ports and Airports in Florida

This appendix presents the reliability calculation results for arterials connecting the major ports (Port of Tampa, Port of Jacksonville, Port Everglades, and Port Miami) and airports (Southwest Florida International Airport, Tallahassee Regional Airport, Jacksonville International Airport, Orlando International Airport, and Miami International Airport) in Florida. The reliability calculations were carried out using the 2011 Statewide Arterial Reliability Database discussed in Section 5.

Figure C-1 through Figure C-9 provide maps of the studied ports and airports and indicate the arterials with access to these facilities. The two numbers next to each arterial ID is the daily average speed and travel time index (TTI) for this arterial. The color of the numbers represents the travel time index level of the arterial.

Table C-1 through Table C-9 present both the daily and peak period calculation results for each of the arterials shown in Figure C-1 through Figure C-9. Performance measures presented include average travel time, average speed, on-time arrival percentage based on 10 mph, on-time arrival percentage based on 15 mph, and Travel Time Index.

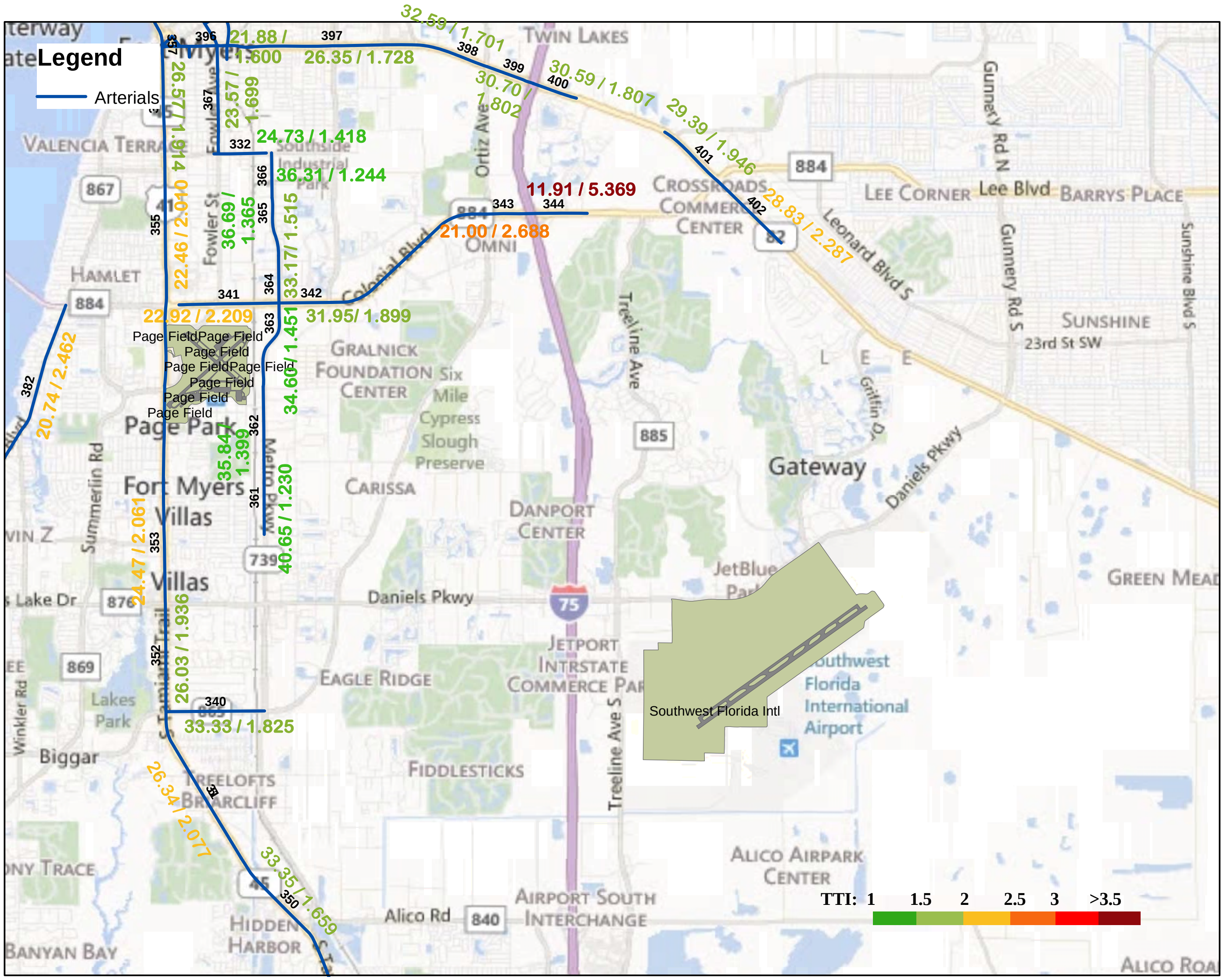

Figure C - 1 Arterials Connecting Southwest Florida International Airport (RSW)

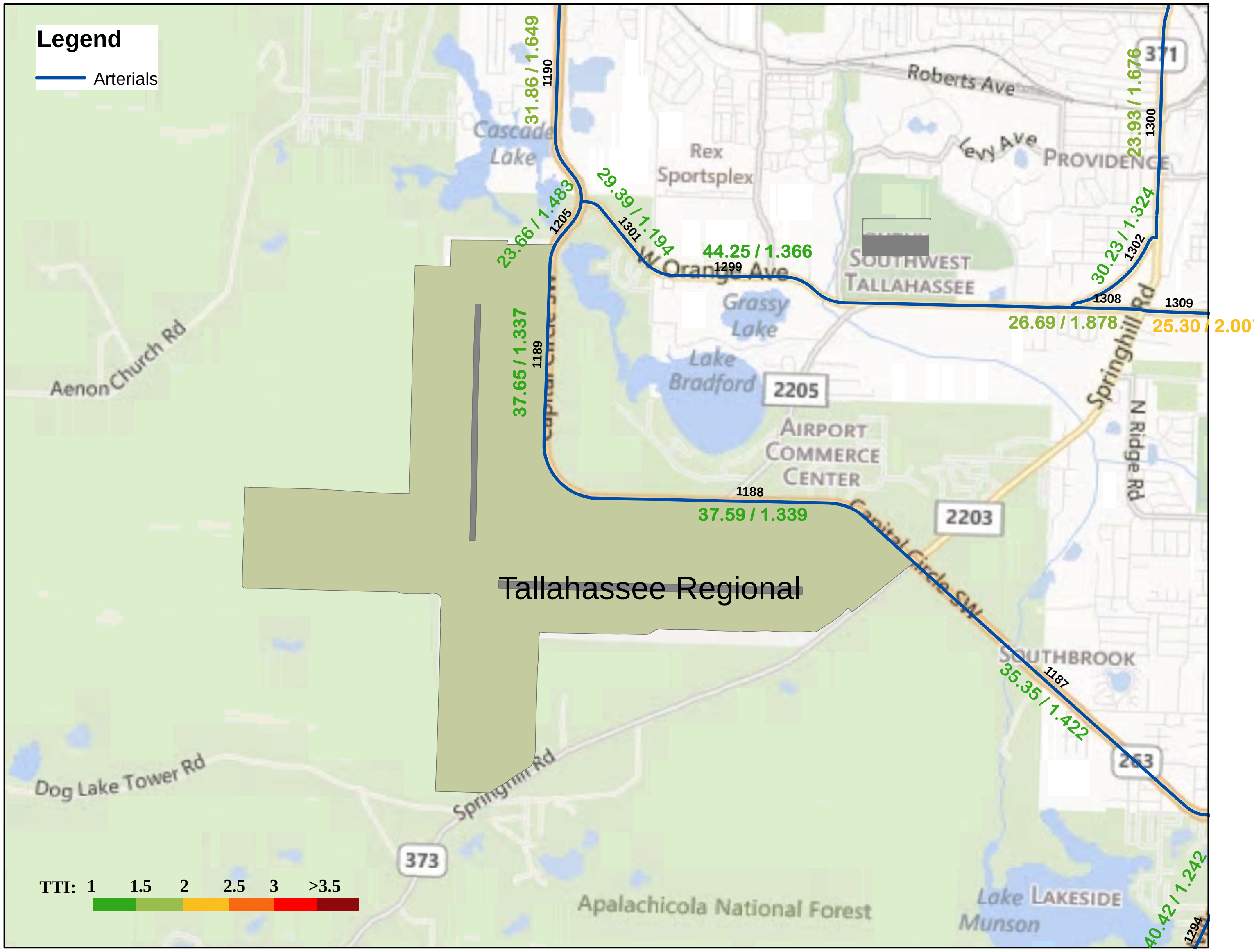

Figure C - 2 Arterials Connecting Tallahassee Regional Airport (TLH)

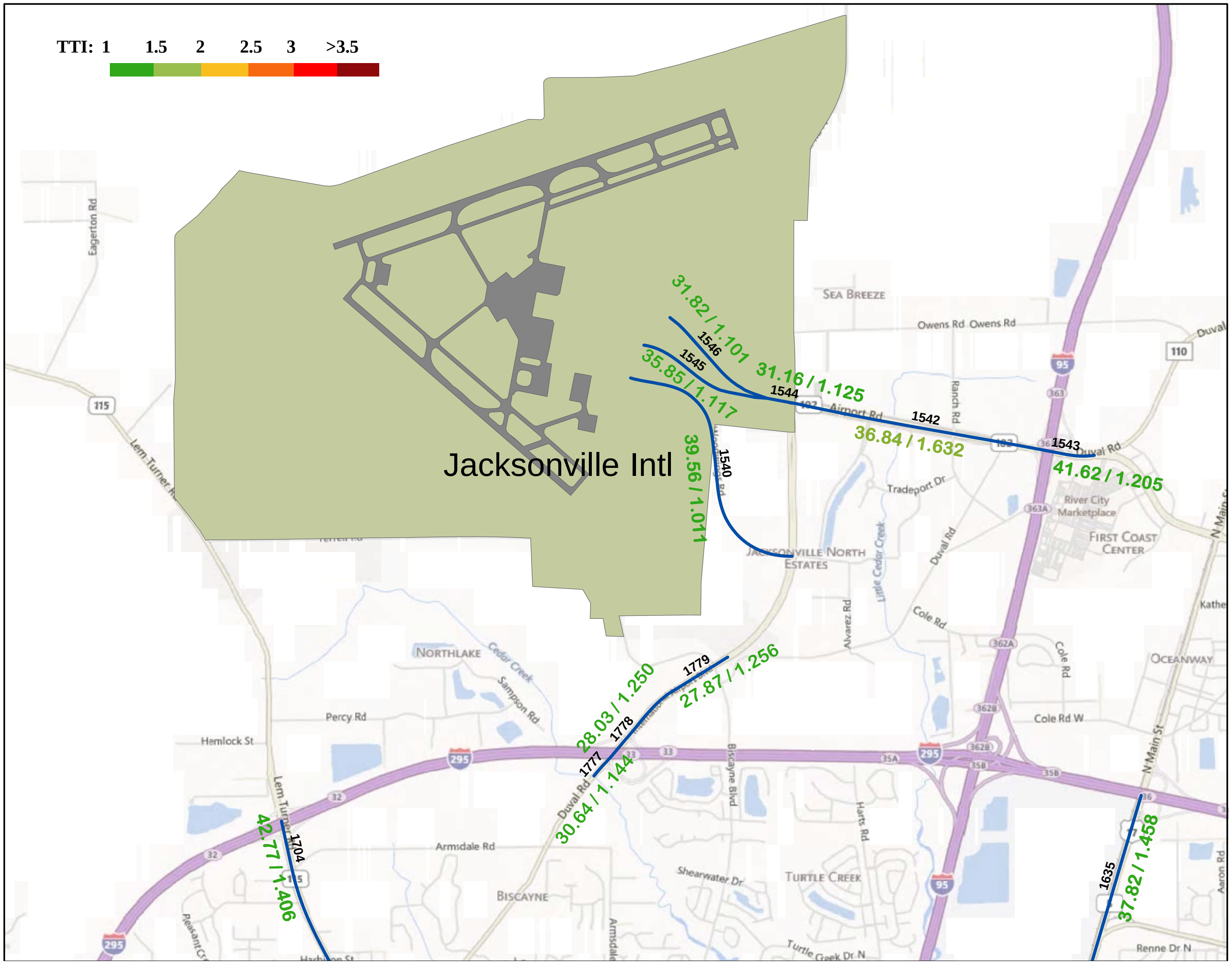

Figure C - 3 Arterials Connecting Jacksonville International Airport (JAX)

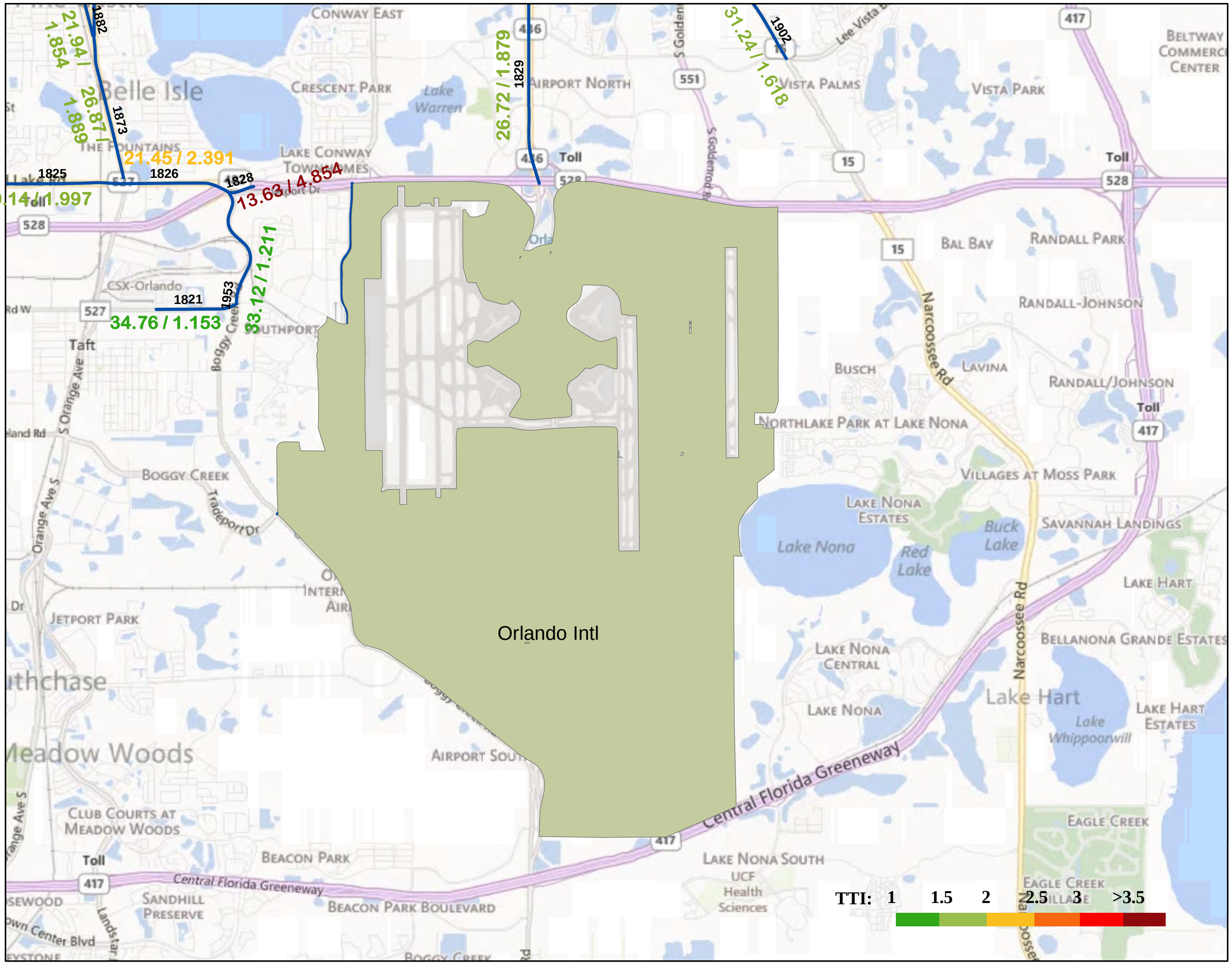

Figure C - 4 Arterials Connecting Orlando International Airport (MCO)

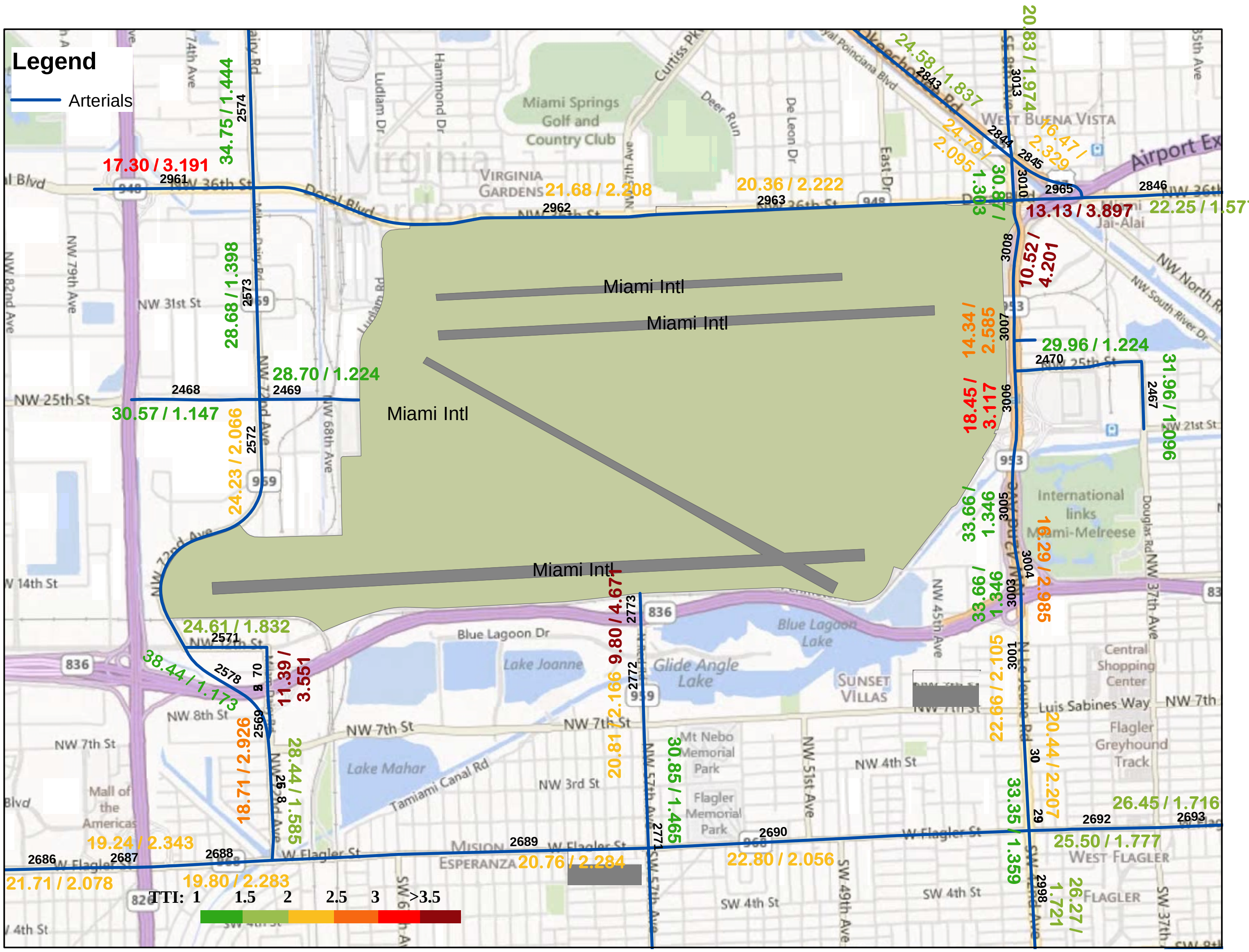

Figure C - 5 Arterials Connecting Miami International Airport (MIA)

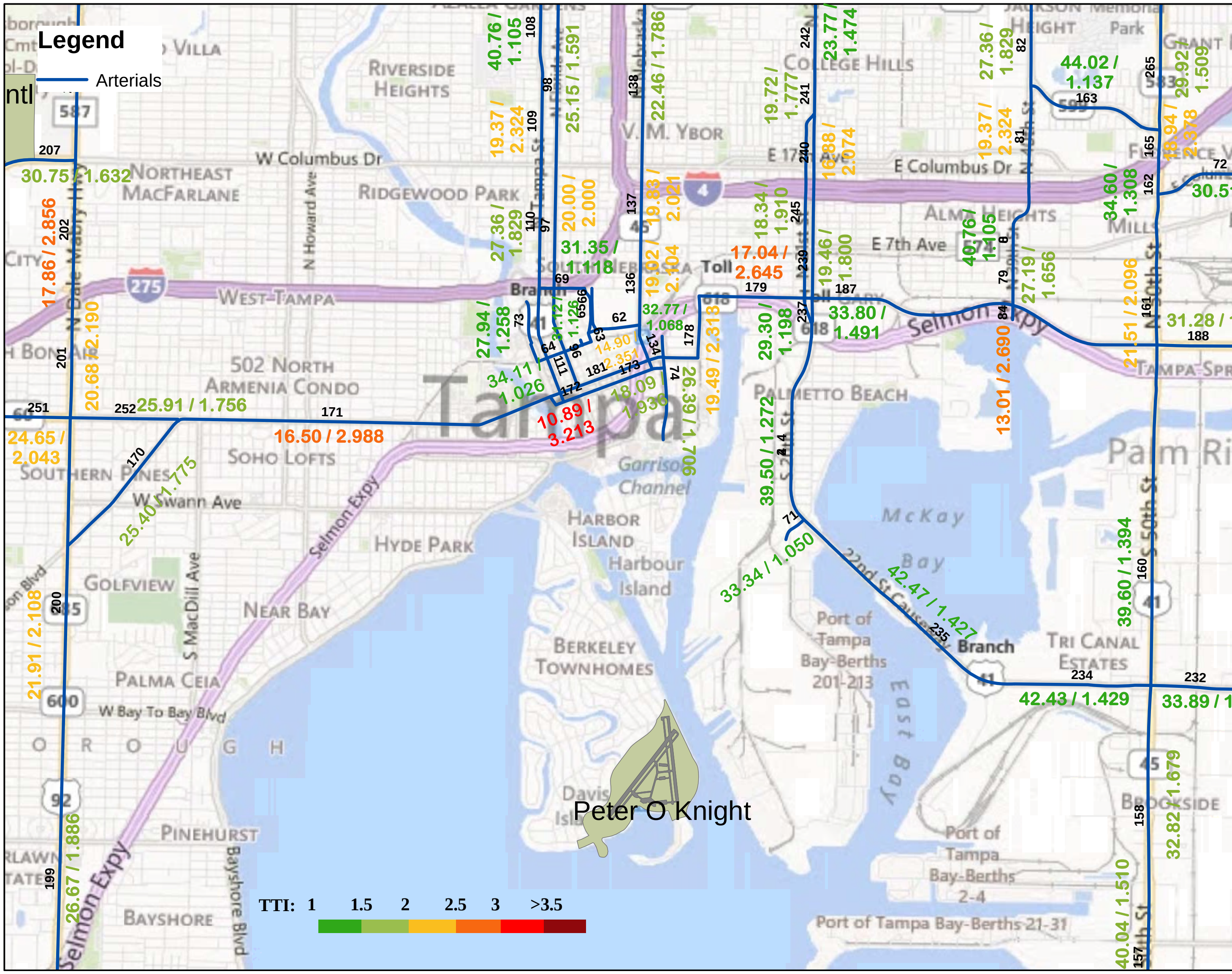

Figure C - 6 Arterials Connecting the Port of Tampa

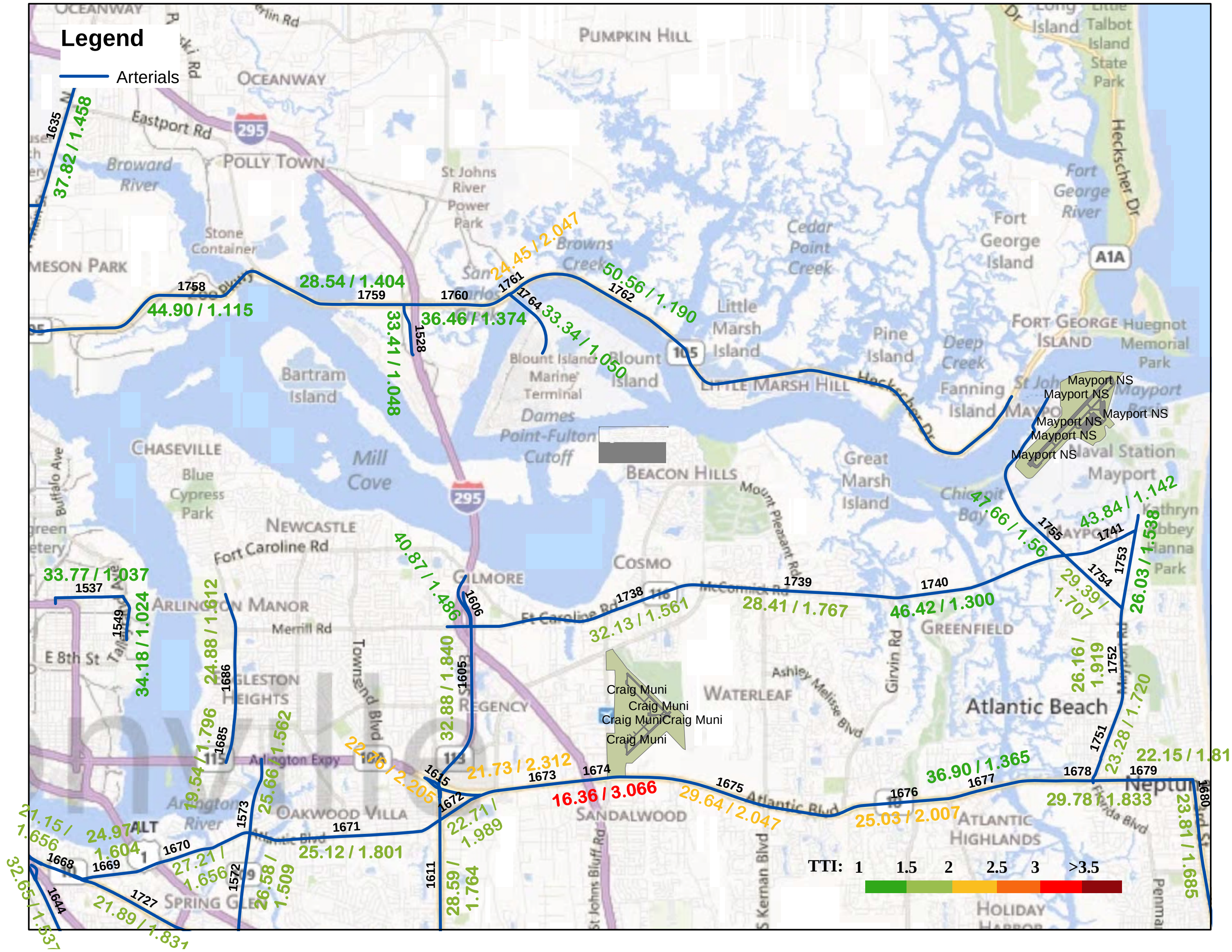

Figure C - 7 Arterials Connecting the Port of Jacksonville

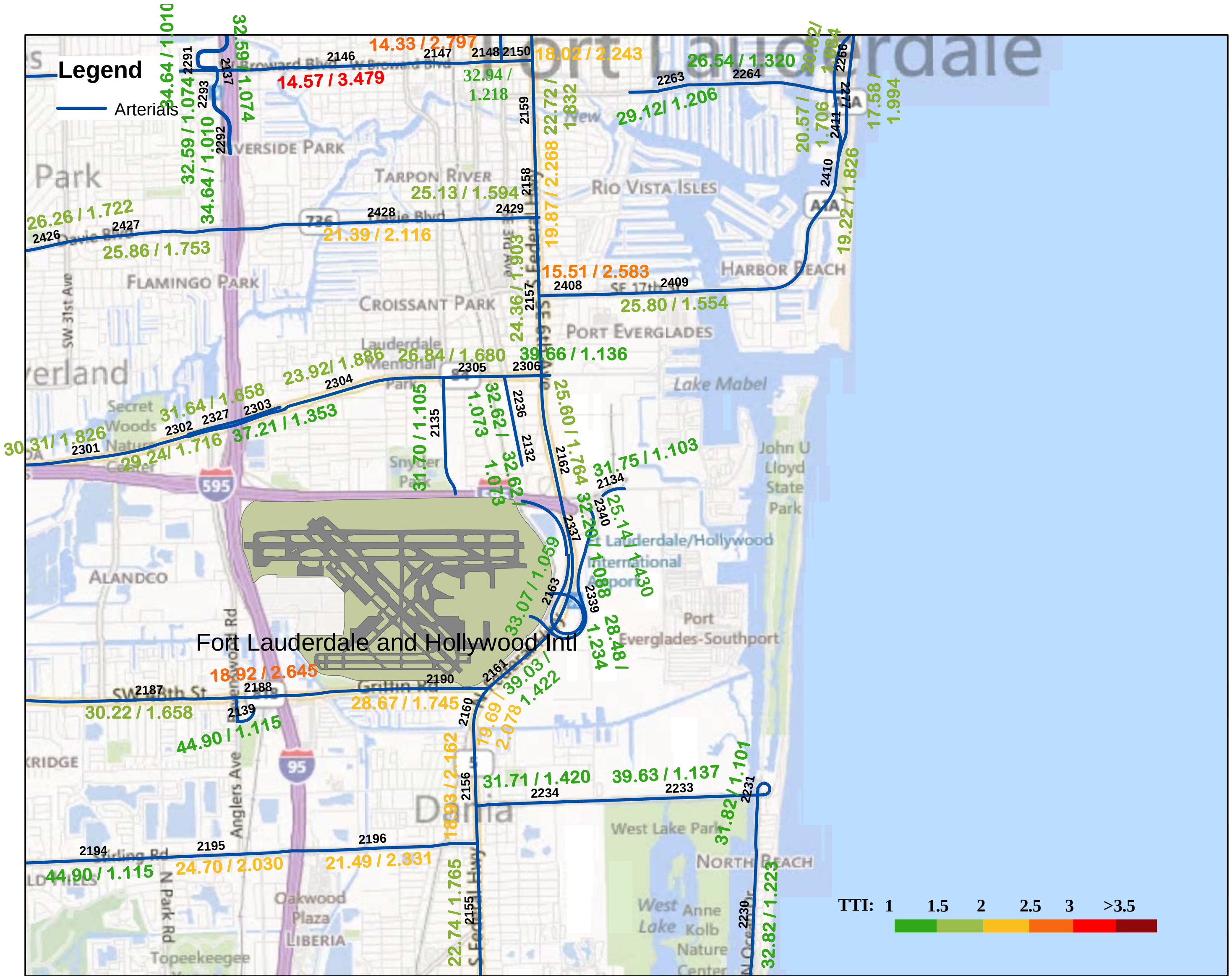

Figure C - 8 Arterials Connecting Port Everglades

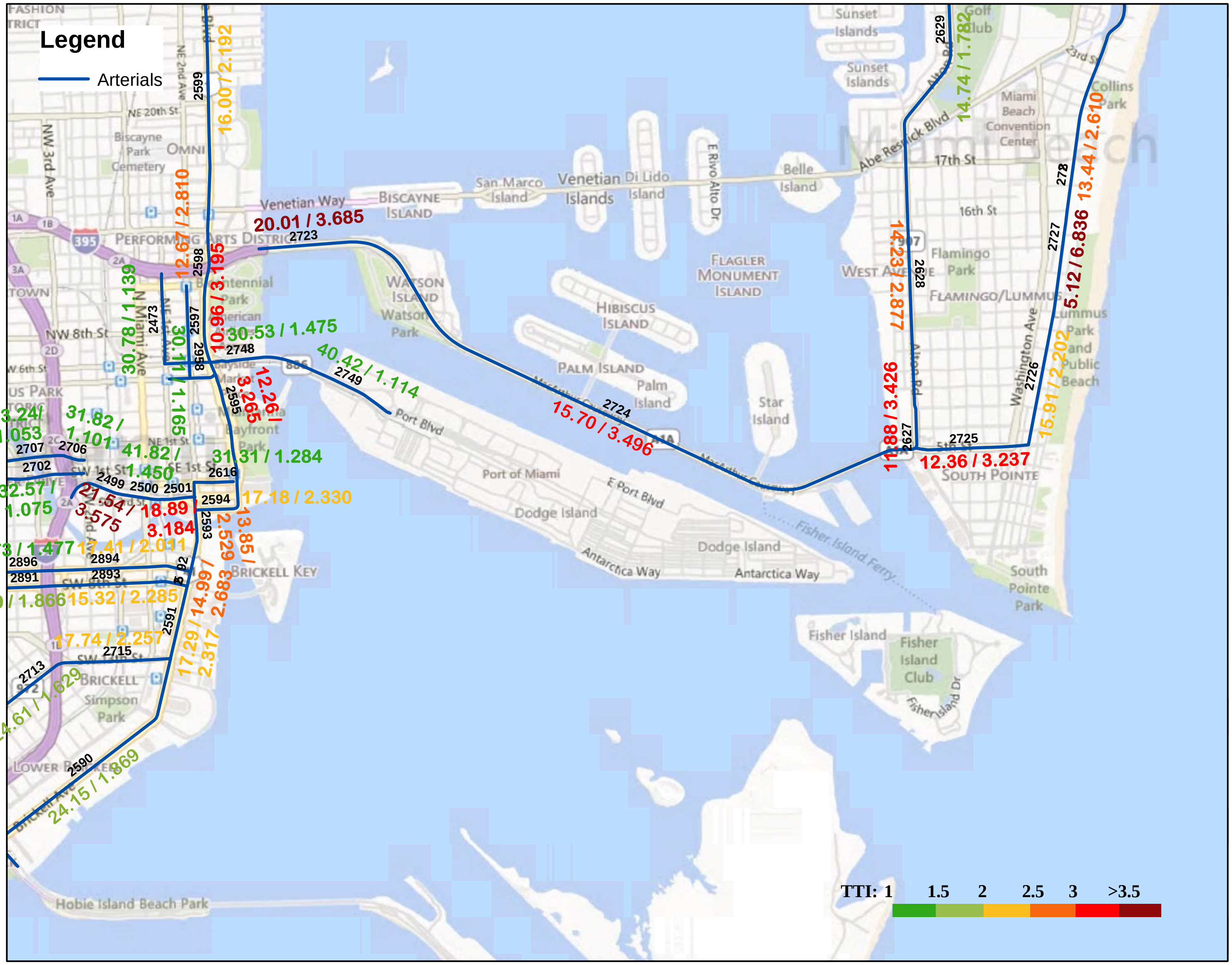

Figure C - 9 Arterials Connecting Port Miami

Table C - 1 Reliability Results for Arterials Connecting Southwest Florida International Airport (RSW)

Arterial ID	All Day					Peak Hour				
	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index
332	90.56	24.73	100.0%	100.0%	1.418	94.67	23.62	100.0%	100.0%	1.482
340	138.12	30.33	99.6%	99.6%	1.825	149.21	27.89	99.5%	99.5%	1.972
341	184.95	22.92	98.5%	98.5%	2.209	215.79	19.56	93.4%	93.4%	2.577
342	318.29	31.95	99.5%	99.5%	1.899	360.80	27.92	97.9%	97.9%	2.153
343	75.67	21.00	87.1%	87.1%	2.688	127.30	11.54	52.3%	52.3%	4.522
344	303.83	11.91	35.4%	35.4%	5.369	428.67	6.60	0.9%	0.9%	7.575
350	371.07	33.35	100.0%	100.0%	1.659	399.75	30.77	100.0%	100.0%	1.787
351	295.03	26.34	92.4%	92.4%	2.077	465.83	15.89	69.1%	69.1%	3.279
352	175.60	26.03	99.5%	99.5%	1.936	195.18	23.28	97.7%	97.7%	2.151
353	306.43	24.47	99.2%	99.2%	2.061	344.93	21.62	96.6%	96.6%	2.320
355	438.89	22.46	100.0%	100.0%	2.010	103.11	15.90	86.1%	86.1%	3.218
357	312.45	26.57	98.0%	98.0%	1.914	373.02	22.02	92.5%	92.5%	2.285
361	111.34	40.65	100.0%	100.0%	1.230	113.51	39.87	100.0%	100.0%	1.254
362	126.15	35.84	99.9%	99.9%	1.399	133.78	33.69	99.8%	99.8%	1.484
363	131.04	34.60	99.8%	99.8%	1.451	140.44	32.15	99.6%	99.6%	1.555
364	114.74	33.17	99.8%	99.8%	1.515	123.38	30.70	99.5%	99.5%	1.629
365	98.06	36.69	100.0%	100.0%	1.365	101.99	35.23	100.0%	100.0%	1.419
366	75.75	36.31	100.0%	100.0%	1.244	80.70	33.95	100.0%	100.0%	1.326
367	192.85	23.57	99.9%	99.9%	1.699	201.25	22.56	99.5%	99.5%	1.773
382	310.58	20.74	76.7%	76.7%	2.462	505.21	11.43	31.3%	31.3%	4.004
395	21.41	9.59	3.7%	-	3.651	21.79	9.42	-	-	3.716
396	46.09	21.88	100.0%	100.0%	1.600	47.06	21.42	100.0%	100.0%	1.634
397	320.92	26.15	99.4%	99.4%	1.728	344.34	24.27	98.9%	98.9%	1.855
398	95.73	32.59	99.6%	99.6%	1.701	104.51	29.63	99.3%	99.3%	1.857
399	67.48	30.70	99.5%	99.5%	1.802	73.04	28.19	99.1%	99.1%	1.951
400	62.46	30.59	99.6%	99.6%	1.807	67.39	28.21	99.2%	99.2%	1.950
401	107.51	29.39	99.8%	95.6%	1.946	143.64	21.64	98.9%	81.4%	2.600
402	141.36	28.83	98.4%	89.4%	2.287	223.62	16.98	93.3%	59.7%	3.619

Table C - 2 Reliability Results for Arterials Connecting Tallahassee Regional Airport (TLH)

Arterial ID	All Day					Peak Hour				
	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index
1187	201.38	35.35	100.0%	100.0%	1.422	216.47	32.71	100.0%	100.0%	1.528
1188	127.67	37.59	100.0%	100.0%	1.339	138.42	34.44	100.0%	100.0%	1.452
1189	175.37	37.65	100.0%	100.0%	1.337	190.06	34.51	100.0%	100.0%	1.449
1190	82.07	31.86	100.0%	94.8%	1.649	113.81	22.41	100.0%	78.1%	2.288
1205	86.81	23.66	100.0%	100.0%	1.483	91.44	22.40	100.0%	100.0%	1.562
1294	139.21	40.42	99.9%	99.9%	1.242	148.89	37.65	99.8%	99.7%	1.328
1299	169.45	44.25	100.0%	100.0%	1.366	184.54	40.33	100.0%	100.0%	1.488
1300	167.24	23.93	99.6%	99.6%	1.676	177.10	22.55	98.9%	98.9%	1.774
1301	61.53	29.39	100.0%	100.0%	1.194	64.87	27.80	100.0%	100.0%	1.259
1302	77.20	30.23	100.0%	100.0%	1.324	78.73	29.63	100.0%	100.0%	1.350
1308	46.92	26.69	100.0%	100.0%	1.878	49.42	25.28	100.0%	100.0%	1.978
1309	117.65	25.30	97.7%	97.7%	2.007	140.38	21.06	90.1%	90.1%	2.395

Table C - 3 Reliability Results for Arterials Connecting Jacksonville International Airport (JAX)

Arterial ID	All Day					Peak Hour				
	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index
1540	120.85	39.56	100.0%	100.0%	1.011	121.40	39.38	100.0%	100.0%	1.016
1542	121.45	36.84	100.0%	100.0%	1.632	127.69	34.96	99.9%	99.9%	1.716
1543	19.00	41.62	100.0%	100.0%	1.205	20.10	39.22	99.9%	99.9%	1.275
1544	17.35	31.16	100.0%	100.0%	1.125	18.00	30.00	100.0%	100.0%	1.167
1545	66.85	35.85	100.0%	100.0%	1.117	69.20	34.59	100.0%	100.0%	1.156
1546	70.20	31.82	100.0%	100.0%	1.101	72.37	30.84	100.0%	100.0%	1.135
1635	185.50	37.82	100.0%	100.0%	1.458	195.61	35.78	99.9%	99.9%	1.537
1704	101.97	42.77	100.0%	100.0%	1.406	106.98	40.68	100.0%	100.0%	1.475
1777	19.77	30.64	100.0%	100.0%	1.144	20.62	29.34	99.9%	99.9%	1.193
1778	169.48	28.03	100.0%	100.0%	1.250	176.15	26.94	99.9%	99.9%	1.299
1779	99.37	27.87	100.0%	100.0%	1.256	101.36	27.31	100.0%	100.0%	1.281

Table C - 4 Reliability Results for Arterials Connecting Orlando International Airport (MCO)

Arterial ID	All Day					Peak Hour				
	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index
1821	68.15	34.76	100.0%	100.0%	1.153	71.18	33.23	100.0%	100.0%	1.204
1825	270.34	30.14	100.0%	100.0%	1.997	285.95	28.40	100.0%	100.0%	2.112
1826	140.65	21.45	96.2%	96.2%	2.391	177.31	16.93	85.2%	85.2%	3.014
1828	68.15	13.63	23.5%	21.0%	4.854	90.61	7.75	-	-	6.454
1829	277.08	26.72	100.0%	100.0%	1.879	295.25	24.97	99.9%	99.9%	2.002
1873	160.60	26.87	98.1%	98.1%	1.889	187.26	22.83	94.2%	94.2%	2.202
1882	196.04	21.94	96.9%	96.9%	1.854	236.97	18.06	86.4%	86.4%	2.241
1902	298.38	31.24	100.0%	99.3%	1.618	338.08	27.32	100.0%	96.9%	1.834
1953	108.93	33.12	100.0%	100.0%	1.211	115.28	31.20	100.0%	100.0%	1.282

Table C - 5 Reliability Results for Arterials Connecting Miami International Airport (MIA)

Arterial ID	All Day					Peak Hour				
	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index
2467	30.43	31.96	100.0%	100.0%	1.096	31.33	31.02	100.0%	100.0%	1.128
2468	50.96	30.57	100.0%	100.0%	1.147	53.13	29.27	100.0%	100.0%	1.196
2469	59.29	28.70	99.8%	99.8%	1.224	63.11	26.87	99.5%	99.5%	1.303
2470	61.41	29.96	100.0%	100.0%	1.171	64.41	28.51	100.0%	100.0%	1.228
2568	60.74	28.44	100.0%	100.0%	1.585	63.39	27.20	100.0%	100.0%	1.654
2569	32.31	18.71	77.9%	51.1%	2.926	49.96	9.96	4.2%	4.2%	4.526
2570	76.70	11.39	96.3%	-	3.551	90.36	9.65	85.5%	-	4.183
2571	47.79	24.61	100.0%	100.0%	1.832	50.15	23.40	100.0%	100.0%	1.923
2572	182.68	24.23	100.0%	100.0%	2.066	190.02	23.27	100.0%	100.0%	2.149
2573	106.66	28.68	100.0%	100.0%	1.398	111.93	27.28	100.0%	100.0%	1.467
2574	121.03	34.75	100.0%	100.0%	1.444	128.54	32.60	100.0%	100.0%	1.534
2578	39.60	38.44	100.0%	100.0%	1.173	41.55	36.56	100.0%	100.0%	1.231
2686	121.83	21.71	100.0%	100.0%	2.078	126.74	20.82	100.0%	100.0%	2.161
2687	66.91	19.24	100.0%	100.0%	2.343	69.78	18.42	99.9%	99.9%	2.443
2688	74.51	19.80	99.3%	99.3%	2.283	81.23	18.11	97.1%	97.1%	2.489
2689	277.79	20.76	91.6%	91.6%	2.284	387.52	14.70	71.7%	71.7%	3.187
2690	249.22	22.80	93.7%	93.7%	2.056	335.57	16.67	78.2%	78.2%	2.769
2692	72.93	25.50	98.9%	98.9%	1.777	79.43	23.26	98.1%	98.1%	1.935
2693	171.05	26.45	98.3%	98.3%	1.716	189.76	23.65	96.8%	96.8%	1.904
2771	116.27	30.85	99.4%	99.4%	1.465	124.86	28.60	98.8%	98.8%	1.573
2772	71.22	20.81	100.0%	100.0%	2.166	74.17	19.95	100.0%	100.0%	2.256
2773	45.96	9.80	93.3%	-	4.671	56.40	7.98	75.8%	-	5.732
2843	273.45	24.58	99.9%	99.9%	1.837	288.46	23.23	99.6%	99.6%	1.938
2844	28.49	24.79	83.2%	83.2%	2.095	48.92	12.95	43.0%	43.0%	3.597
2845	84.56	16.47	82.9%	82.9%	2.329	132.96	9.81	42.8%	42.8%	3.662
2846	200.70	22.25	99.3%	99.3%	1.577	212.75	20.93	98.6%	98.6%	1.672
2961	146.60	17.30	87.0%	87.0%	3.191	236.95	9.97	53.0%	53.0%	5.158
2963	273.70	20.36	99.3%	99.3%	2.222	300.22	18.50	97.0%	97.0%	2.437
2965	57.36	13.13	68.3%	68.3%	3.897	90.75	7.38	20.5%	20.5%	6.165

Table C - 5 Reliability Results for Arterials Connecting Miami International Airport (Cont'd.)

Arterial ID	All Day					Peak Hour				
	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index
2998	68.82	26.27	100.0%	100.0%	1.721	73.15	24.61	99.9%	99.9%	1.829
2999	6.52	33.35	100.0%	100.0%	1.359	7.06	30.60	100.0%	100.0%	1.470
3000	74.86	20.44	99.9%	99.9%	2.207	78.66	19.41	99.6%	99.6%	2.319
3001	74.11	22.66	93.9%	93.9%	2.105	106.54	15.68	74.6%	74.6%	3.027
3003	5.60	33.66	100.0%	100.0%	1.346	6.06	30.89	100.0%	100.0%	1.457
3004	47.75	16.29	86.7%	86.7%	2.985	72.84	10.19	53.2%	53.2%	4.553
3005	55.66	33.66	100.0%	100.0%	1.346	60.21	30.91	100.0%	100.0%	1.456
3006	20.70	18.45	60.4%	60.4%	3.117	34.72	8.66	13.1%	13.1%	5.229
3007	129.47	14.34	91.0%	88.3%	2.585	189.73	9.46	64.3%	61.0%	3.788
3008	78.20	10.52	19.2%	19.2%	4.201	100.82	6.46	-	-	5.416
3010	19.47	30.87	99.9%	99.9%	1.303	21.11	28.31	99.6%	99.6%	1.413
3013	135.91	20.83	95.3%	95.3%	1.974	173.19	16.23	82.6%	82.6%	2.516

Table C - 6 Reliability Results for Arterials Connecting the Port of Tampa

Arterial ID	All Day					Peak Hour				
	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index
62	33.62	32.77	100.0%	100.0%	1.068	34.35	32.07	100.0%	100.0%	1.092
63	5.47	36.23	100.0%	100.0%	1.105	5.64	35.08	100.0%	100.0%	1.140
64	35.57	34.11	100.0%	100.0%	1.026	35.90	33.80	100.0%	100.0%	1.036
65	31.04	31.12	100.0%	100.0%	1.126	32.22	29.95	100.0%	100.0%	1.169
66	25.79	33.50	100.0%	100.0%	1.045	26.18	33.01	100.0%	100.0%	1.060
69	30.81	31.35	100.0%	100.0%	1.118	31.90	30.25	100.0%	100.0%	1.157
71	17.39	33.34	100.0%	100.0%	1.050	17.67	32.80	100.0%	100.0%	1.067
72	122.68	30.51	100.0%	100.0%	1.149	128.02	29.19	100.0%	100.0%	1.199
73	32.73	27.94	100.0%	100.0%	1.258	34.97	26.05	100.0%	100.0%	1.344
74	83.39	26.39	100.0%	100.0%	1.706	85.30	25.79	100.0%	100.0%	1.745
79	44.24	27.19	100.0%	100.0%	1.656	45.29	26.55	100.0%	100.0%	1.695
80	35.71	40.76	100.0%	100.0%	1.105	36.85	39.47	100.0%	100.0%	1.140
81	110.23	19.37	100.0%	100.0%	2.324	111.96	19.07	100.0%	100.0%	2.360
82	77.54	27.36	100.0%	100.0%	1.829	79.65	26.62	100.0%	100.0%	1.878
84	23.52	13.01	100.0%	-	2.690	23.65	12.94	100.0%	-	2.705
96	182.27	12.27	99.8%	-	3.261	186.84	11.97	99.5%	-	3.343
97	127.28	20.00	100.0%	100.0%	2.000	129.31	19.68	100.0%	100.0%	2.032
98	144.36	25.15	100.0%	100.0%	1.591	147.87	24.54	100.0%	100.0%	1.630
108	45.05	40.76	100.0%	100.0%	1.105	46.11	40.91	100.0%	100.0%	1.100
109	110.23	19.37	100.0%	100.0%	2.324	79.32	22.92	100.0%	100.0%	1.745
110	77.54	27.36	100.0%	100.0%	1.829	83.24	29.19	100.0%	100.0%	1.370
111	123.15	27.07	100.0%	100.0%	1.849	219.18	12.29	100.0%	-	2.849
134	31.77	18.26	100.0%	100.0%	2.192	32.73	17.71	100.0%	100.0%	2.259
136	93.54	19.02	100.0%	100.0%	2.104	95.51	18.62	100.0%	100.0%	2.148
137	79.85	19.83	99.9%	99.9%	2.021	83.99	18.82	99.6%	99.6%	2.126
138	161.72	22.46	99.9%	99.9%	1.786	171.70	21.10	99.6%	99.6%	1.896
157	344.41	40.04	99.6%	99.6%	1.510	378.65	36.15	98.9%	98.9%	1.660
158	166.43	32.82	100.0%	100.0%	1.679	174.42	31.25	100.0%	100.0%	1.760
160	160.12	39.60	100.0%	100.0%	1.394	170.36	37.09	100.0%	100.0%	1.483
161	191.33	21.51	100.0%	100.0%	2.096	199.82	20.56	100.0%	100.0%	2.189

Table C - 6 Reliability Results for Arterials Connecting the Port of Tampa (Cont'd)

Arterial ID	All Day					Peak Hour				
	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index
162	12.24	34.60	100.0%	100.0%	1.308	13.16	32.00	100.0%	100.0%	1.406
163	59.46	44.02	100.0%	100.0%	1.137	61.87	42.24	100.0%	100.0%	1.184
165	58.97	18.94	100.0%	100.0%	2.378	60.75	18.37	100.0%	100.0%	2.449
170	139.41	25.40	99.9%	99.9%	1.775	146.35	24.16	99.4%	99.4%	1.863
171	529.41	16.50	83.7%	83.7%	2.988	831.00	9.80	45.5%	45.5%	4.690
172	108.73	10.89	100.0%	-	3.213	109.70	10.80	100.0%	-	3.242
173	66.49	18.09	100.0%	100.0%	1.936	67.61	17.78	100.0%	100.0%	1.968
178	66.25	19.49	99.7%	99.7%	2.313	69.33	18.59	99.5%	99.5%	2.421
179	141.54	17.04	99.7%	99.7%	2.645	147.21	16.36	99.5%	99.5%	2.751
181	146.76	14.90	99.8%	26.3%	2.351	151.26	14.45	99.5%	-	2.423
187	225.61	33.80	99.5%	99.5%	1.491	247.12	30.61	99.1%	99.1%	1.634
188	349.22	31.28	97.0%	97.0%	1.810	439.17	24.46	89.9%	89.9%	2.277
199	182.36	26.67	99.4%	99.4%	1.886	237.78	19.64	82.2%	82.2%	2.870
200	367.27	21.91	95.6%	95.6%	2.108	57.13	26.47	100.0%	100.0%	2.078
201	122.29	20.68	99.1%	99.1%	2.190	605.21	13.77	73.2%	73.2%	3.807
202	167.38	17.86	96.9%	96.9%	2.856	313.79	11.93	56.9%	56.9%	4.349
207	155.49	30.75	100.0%	100.0%	1.632	165.50	28.78	100.0%	100.0%	1.737
232	339.25	33.89	99.7%	99.7%	1.482	365.43	31.32	99.1%	99.1%	1.597
234	67.71	42.43	99.7%	99.7%	1.429	74.75	38.05	99.4%	99.4%	1.577
235	119.45	42.47	99.7%	99.7%	1.427	131.70	38.13	99.5%	99.5%	1.574
237	18.11	29.30	99.8%	99.8%	1.198	19.19	27.57	99.5%	99.5%	1.269
239	119.43	19.46	99.9%	99.9%	1.800	123.00	18.88	99.8%	99.8%	1.854
240	90.25	16.88	100.0%	100.0%	2.074	91.45	16.65	100.0%	100.0%	2.102
241	43.31	19.72	100.0%	100.0%	1.777	44.82	19.04	100.0%	100.0%	1.839
242	69.60	23.77	100.0%	100.0%	1.474	72.27	22.86	100.0%	100.0%	1.531
244	120.39	39.50	100.0%	100.0%	1.272	128.87	36.74	100.0%	100.0%	1.361
245	214.50	18.34	100.0%	100.0%	1.910	220.10	17.86	99.8%	99.8%	1.960
251	203.75	24.65	99.3%	99.3%	2.043	226.77	22.04	97.1%	97.1%	2.274
252	86.26	25.91	98.5%	98.5%	1.756	98.29	22.56	95.3%	95.3%	2.001
265	91.28	29.92	99.8%	99.8%	1.509	97.35	27.96	99.4%	99.4%	1.610

Table C - 7 Reliability Results for Arterials Connecting the Port of Jacksonville

Arterial ID	All Day					Peak Hour				
	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index
1528	71.56	33.41	100.0%	100.0%	1.048	72.69	32.88	100.0%	100.0%	1.064
1537	91.80	33.77	100.0%	100.0%	1.037	92.93	33.36	100.0%	100.0%	1.049
1549	60.46	34.18	100.0%	100.0%	1.024	60.97	33.89	100.0%	100.0%	1.033
1572	163.25	26.58	99.7%	99.7%	1.509	173.28	24.97	99.3%	99.3%	1.602
1573	133.27	25.66	99.8%	99.8%	1.562	140.16	24.35	99.6%	99.6%	1.643
1605	305.75	32.88	99.5%	99.5%	1.840	333.95	29.86	99.3%	99.3%	2.009
1606	61.34	40.87	99.6%	99.6%	1.486	68.09	36.38	99.5%	99.5%	1.649
1611	258.27	28.59	99.2%	99.2%	1.764	286.13	25.60	98.1%	98.1%	1.955
1615	121.47	22.76	99.5%	99.5%	2.205	129.30	21.30	99.4%	99.4%	2.347
1635	185.50	37.82	100.0%	100.0%	1.458	195.61	35.78	99.9%	99.9%	1.537
1644	177.42	32.65	99.8%	99.8%	1.537	189.50	30.45	99.4%	99.4%	1.642
1668	148.21	21.15	100.0%	100.0%	1.656	153.38	20.42	100.0%	100.0%	1.714
1669	161.11	24.97	100.0%	100.0%	1.604	166.92	24.07	100.0%	100.0%	1.662
1670	165.38	27.21	100.0%	100.0%	1.656	172.78	26.00	100.0%	100.0%	1.731
1671	358.46	25.12	99.0%	99.0%	1.801	387.94	23.09	98.2%	98.2%	1.949
1672	133.16	22.71	99.4%	99.4%	1.989	141.37	21.32	99.0%	99.0%	2.111
1673	190.42	21.73	99.3%	99.3%	2.312	208.20	19.81	97.1%	97.1%	2.528
1674	55.41	16.36	99.5%	99.4%	3.066	59.63	15.17	97.7%	97.6%	3.300
1675	376.39	29.64	99.3%	99.3%	2.047	429.16	25.79	97.0%	97.0%	2.334
1676	197.26	25.03	99.8%	99.8%	2.007	213.05	23.08	98.9%	98.9%	2.168
1677	143.86	36.90	100.0%	100.0%	1.365	156.16	33.75	100.0%	100.0%	1.481
1678	55.04	29.78	92.1%	92.1%	1.833	85.57	18.23	68.8%	68.8%	2.850
1679	206.51	22.15	99.6%	99.6%	1.811	218.66	20.86	99.4%	99.4%	1.918
1680	178.78	23.81	99.7%	99.7%	1.685	188.96	22.46	99.5%	99.5%	1.781
1685	101.25	19.54	99.5%	99.5%	1.796	106.69	18.49	99.3%	99.3%	1.893
1686	249.17	24.88	99.7%	99.7%	1.612	263.55	23.47	99.2%	99.2%	1.704
1727	222.92	21.89	99.7%	99.7%	1.831	234.02	20.81	99.3%	99.3%	1.922
1738	377.70	32.13	99.8%	99.8%	1.561	402.48	30.06	99.3%	99.3%	1.664
1739	304.66	28.41	99.6%	99.6%	1.767	325.99	26.44	99.3%	99.3%	1.891
1740	180.18	46.42	99.9%	99.9%	1.300	195.01	42.65	99.7%	99.7%	1.407

Table C - 7 Reliability Results for Arterials Connecting the Port of Jacksonville (Cont'd)

Arterial ID	All Day					Peak Hour				
	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index
1741	79.12	43.84	100.0%	100.0%	1.142	82.41	42.03	100.0%	100.0%	1.190
1751	187.77	23.28	100.0%	100.0%	1.720	194.76	22.42	100.0%	100.0%	1.784
1752	150.22	26.16	99.5%	99.5%	1.919	160.85	24.33	99.1%	99.1%	2.055
1753	167.35	26.03	100.0%	100.0%	1.538	172.51	25.23	100.0%	100.0%	1.585
1754	121.92	29.39	100.0%	100.0%	1.707	129.13	27.66	100.0%	100.0%	1.808
1755	186.05	47.66	100.0%	100.0%	1.156	194.47	45.52	100.0%	100.0%	1.208
1758	239.51	44.90	100.0%	100.0%	1.115	247.75	43.36	100.0%	100.0%	1.153
1759	274.79	28.54	100.0%	100.0%	1.404	286.78	27.30	100.0%	100.0%	1.465
1760	112.80	36.46	100.0%	100.0%	1.374	118.31	34.69	100.0%	100.0%	1.441
1761	34.77	24.45	100.0%	100.0%	2.047	35.92	23.65	100.0%	100.0%	2.114
1762	538.84	50.56	100.0%	100.0%	1.190	567.57	47.88	100.0%	100.0%	1.253
1764	104.21	33.34	100.0%	100.0%	1.050	105.92	32.80	100.0%	100.0%	1.067

Table C - 8 Reliability Results for Arterials Connecting Port Everglades

Arterial ID	All Day					Peak Hour				
	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index
2132	22.08	32.62	100.0%	100.0%	1.073	22.59	31.87	100.0%	100.0%	1.098
2134	16.91	31.75	100.0%	100.0%	1.103	17.44	30.75	100.0%	100.0%	1.138
2135	87.86	31.70	100.0%	100.0%	1.105	90.67	30.69	100.0%	100.0%	1.140
2137	15.36	32.59	100.0%	100.0%	1.074	15.72	31.83	100.0%	100.0%	1.100
2139	18.09	31.08	100.0%	100.0%	1.127	18.78	29.90	100.0%	100.0%	1.170
2146	310.89	14.57	78.3%	78.3%	3.479	508.34	8.10	35.2%	35.2%	5.689
2147	110.01	14.33	99.6%	13.2%	2.797	115.98	13.57	98.3%	-	2.949
2148	19.95	32.94	100.0%	100.0%	1.218	21.13	31.01	100.0%	100.0%	1.290
2150	40.58	18.02	97.5%	97.5%	2.243	47.03	15.49	90.6%	90.6%	2.600
2155	165.82	22.74	99.5%	99.5%	1.765	175.76	21.39	99.2%	99.2%	1.871
2156	147.71	18.93	95.6%	95.6%	2.162	185.36	15.00	82.9%	82.9%	2.713
2157	156.20	24.36	96.8%	96.8%	1.903	201.37	18.81	86.2%	86.2%	2.453
2158	67.86	19.87	100.0%	100.0%	2.268	70.60	19.07	100.0%	100.0%	2.360
2159	106.18	22.72	94.5%	94.5%	1.832	142.97	16.68	78.2%	78.2%	2.467
2160	53.31	19.69	95.8%	95.8%	2.078	66.83	15.62	83.4%	83.4%	2.605
2161	131.90	39.03	100.0%	100.0%	1.422	144.36	35.34	100.0%	100.0%	1.556
2162	119.25	25.60	100.0%	100.0%	1.764	126.88	23.98	100.0%	100.0%	1.877
2163	115.84	33.07	100.0%	100.0%	1.059	118.04	32.45	100.0%	100.0%	1.079
2187	356.90	30.22	100.0%	100.0%	1.658	375.31	28.67	100.0%	100.0%	1.744
2188	54.85	18.92	100.0%	100.0%	2.645	56.59	18.32	100.0%	100.0%	2.729
2190	168.26	28.67	100.0%	100.0%	1.745	172.99	27.86	100.0%	100.0%	1.794
2194	292.47	24.97	100.0%	100.0%	2.007	306.67	23.76	100.0%	100.0%	2.104
2195	128.48	24.70	100.0%	100.0%	2.030	134.46	23.53	100.0%	100.0%	2.125
2196	195.84	21.49	100.0%	100.0%	2.331	203.79	20.62	100.0%	100.0%	2.425
2230	140.55	32.82	100.0%	100.0%	1.223	149.10	30.83	100.0%	100.0%	1.297
2231	17.55	31.82	100.0%	100.0%	1.101	18.09	30.84	100.0%	100.0%	1.135
2233	97.88	39.63	100.0%	100.0%	1.137	101.83	38.04	100.0%	100.0%	1.183
2234	72.37	31.71	100.0%	100.0%	1.420	74.71	30.70	100.0%	100.0%	1.466
2236	42.95	32.62	100.0%	100.0%	1.073	43.94	31.87	100.0%	100.0%	1.098
2263	67.83	29.12	99.8%	99.8%	1.206	71.95	27.37	99.6%	99.6%	1.279

Table C - 8 Reliability Results for Arterials Connecting Port Everglades (Cont'd)

Arterial ID	All Day					Peak Hour				
	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index
2264	106.72	26.54	100.0%	100.0%	1.320	110.75	25.55	99.9%	99.9%	1.370
2266	104.76	20.82	100.0%	100.0%	1.684	109.35	19.92	100.0%	100.0%	1.757
2277	189.87	17.58	100.0%	100.0%	1.994	197.44	16.88	100.0%	100.0%	2.073
2291	46.35	34.64	100.0%	100.0%	1.010	46.55	34.49	100.0%	100.0%	1.015
2292	50.61	34.64	100.0%	100.0%	1.010	50.83	34.49	100.0%	100.0%	1.015
2293	54.37	32.59	100.0%	100.0%	1.074	55.65	31.83	100.0%	100.0%	1.100
2301	131.20	30.31	99.6%	99.6%	1.826	141.73	27.89	99.4%	99.4%	1.972
2302	65.24	29.24	100.0%	100.0%	1.716	69.31	27.43	100.0%	100.0%	1.823
2303	44.14	37.21	100.0%	100.0%	1.353	47.96	34.00	100.0%	100.0%	1.470
2304	137.59	23.92	100.0%	100.0%	1.886	144.36	22.74	100.0%	100.0%	1.979
2305	54.28	26.84	100.0%	100.0%	1.680	56.77	25.62	100.0%	100.0%	1.757
2306	27.36	39.66	100.0%	100.0%	1.136	28.45	38.09	100.0%	100.0%	1.181
2327	72.80	31.64	95.8%	95.8%	1.658	99.73	22.59	83.1%	83.1%	2.271
2337	53.25	32.20	100.0%	100.0%	1.088	54.71	31.32	100.0%	100.0%	1.117
2339	114.33	28.48	99.7%	99.7%	1.234	121.95	26.60	99.5%	99.5%	1.316
2340	47.08	25.14	97.5%	95.6%	1.430	60.03	19.49	89.0%	81.4%	1.824
2408	87.87	15.51	99.8%	82.1%	2.583	91.75	14.83	99.3%	30.7%	2.697
2409	139.98	25.80	100.0%	100.0%	1.554	146.85	24.54	100.0%	100.0%	1.630
2410	237.92	19.22	99.5%	99.5%	1.826	249.86	18.25	99.3%	99.3%	1.917
2411	55.81	20.57	99.8%	99.8%	1.706	59.09	19.38	99.2%	99.2%	1.807
2426	135.12	26.26	99.4%	99.4%	1.722	145.17	24.33	99.1%	99.1%	1.850
2427	151.78	25.86	98.9%	98.9%	1.753	167.29	23.30	97.5%	97.5%	1.933
2428	269.84	21.39	98.8%	98.8%	2.116	294.97	19.46	97.1%	97.1%	2.313
2429	53.93	25.13	100.0%	100.0%	1.594	55.96	24.19	99.8%	99.8%	1.654

Table C - 9 Reliability Results for Arterials Connecting Port Miami

Arterial ID	All Day					Peak Hour				
	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index
2473	44.74	30.78	100.0%	100.0%	1.139	46.59	29.52	100.0%	100.0%	1.186
2499	53.63	21.54	78.5%	54.5%	3.575	87.45	10.32	6.7%	6.7%	5.830
2500	15.14	41.82	99.7%	99.7%	1.450	16.74	37.43	99.5%	99.5%	1.603
2501	26.55	18.89	99.7%	99.7%	3.184	27.85	17.97	99.5%	99.5%	3.339
2590	195.47	24.15	99.4%	99.4%	1.869	207.51	22.67	99.0%	99.0%	1.985
2591	65.07	17.29	99.5%	99.5%	2.317	67.82	16.56	99.4%	99.4%	2.415
2592	30.90	14.99	98.1%	74.9%	2.683	34.26	13.50	93.7%	-	2.974
2593	55.14	13.85	100.0%	-	2.529	56.57	13.49	100.0%	-	2.594
2594	57.88	17.18	99.9%	99.9%	2.330	59.48	16.70	99.7%	99.7%	2.395
2595	135.16	12.26	100.0%	-	3.265	137.58	12.04	100.0%	-	3.323
2597	141.33	10.96	100.0%	-	3.195	144.00	10.75	100.0%	-	3.256
2598	31.22	12.67	95.2%	1.1%	2.810	38.20	10.33	81.0%	-	3.439
2599	302.96	16.00	99.2%	97.8%	2.192	316.73	15.28	98.6%	93.1%	2.291
2616	10.17	31.31	99.6%	99.6%	1.284	10.95	28.93	99.4%	99.4%	1.382
2627	27.14	11.88	95.1%	-	3.426	33.30	9.65	80.8%	-	4.205
2628	315.68	14.23	92.8%	90.5%	2.877	395.90	11.25	78.0%	74.2%	3.609
2629	324.41	14.74	87.9%	87.0%	1.782	458.10	10.13	57.2%	54.8%	2.517
2702	24.77	32.57	100.0%	100.0%	1.075	25.36	31.80	100.0%	100.0%	1.100
2706	18.12	31.82	100.0%	100.0%	1.101	18.68	30.84	100.0%	100.0%	1.135
2707	15.17	33.24	100.0%	100.0%	1.053	15.43	32.66	100.0%	100.0%	1.072
2713	170.96	24.61	99.7%	99.7%	1.629	181.22	23.17	98.8%	98.8%	1.727
2715	92.42	17.74	99.8%	99.8%	2.257	95.61	17.13	99.5%	99.5%	2.335
2723	199.49	20.01	60.9%	60.9%	3.685	344.99	8.69	13.7%	13.7%	6.373
2724	661.46	15.70	62.5%	62.5%	3.496	1071.01	7.99	18.1%	18.1%	5.661
2725	139.27	12.36	100.0%	-	3.237	142.29	12.09	100.0%	-	3.307
2726	195.92	15.91	100.0%	98.2%	2.202	202.76	15.36	100.0%	94.4%	2.279
2727	34.45	5.12		-	6.836	34.65	5.09		-	6.876
2728	285.89	13.44	98.3%	1.1%	2.610	300.16	12.77	97.0%	-	2.740
2748	58.99	30.53	100.0%	100.0%	1.475	60.52	29.74	100.0%	100.0%	1.513
2749	29.07	40.42	100.0%	100.0%	1.114	30.06	39.04	100.0%	100.0%	1.153

Table C - 9 Reliability Results for Arterials Connecting Port Miami (Cont'd)

Arterial ID	All Day					Peak Hour				
	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index	Average Travel Time (sec)	Average Speed (mph)	On Time Arrival (10mph)	On Time Arrival (15mph)	Travel Time Index
2891	82.51	18.79	99.5%	99.5%	1.866	86.32	17.93	98.9%	98.9%	1.952
2893	140.08	15.32	100.0%	95.4%	2.285	142.32	15.08	100.0%	93.6%	2.322
2894	129.26	17.41	100.0%	100.0%	2.011	131.74	17.08	100.0%	99.9%	2.049
2896	130.30	23.73	99.9%	99.9%	1.477	135.34	22.82	99.6%	99.6%	1.534
2958	46.96	30.11	100.0%	100.0%	1.165	49.30	28.62	99.8%	99.8%	1.223