Task Work Order 21, Final Report

Comparison of Performance Measurement Approaches

FINAL

prepared for

Florida Department of Transportation (FDOT)

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1.0 Introduction

1.1 BACKGROUND

The Florida Department of Transportation (FDOT) hosted two workshops in December 2012 and January 2013 to discuss overall approaches and implementation needs related to FDOT mobility performance measures. One of the topics discussed at length in these two separate workshops was perceived similarities and differences between the performance measurement approaches documented in the Highway Capacity Manual (HCM), FDOT's methods, and those approaches used by the Texas A&M Transportation Institute (TTI). A concise and objective summary of these similarities and differences is needed to reach consensus on preferred approaches.

1.2 TASK OBJECTIVE

The primary objective of this task work order was to compare and contrast three different performance measurement approaches:

1. Florida DOT (FDOT);
2. Highway Capacity Manual (HCM); and
3. Texas A&M Transportation Institute (TTI).

The comparison will be used to inform ongoing performance monitoring activities within Florida and at the national level about consensus approaches for mobility performance measures. Two elements are included in this comparison of approaches:

1. **Terms and corresponding definitions**: summarized in Section 2.0 with detailed information in Appendix A; and
2. **Measure calculation procedures and numeric results**: summarized in Section 3.0 with detailed information in Appendix B.

Section 4.0 provides the project team's conclusions and recommendations based on the results of this comparison.

2.0 Comparison of Terms and Definitions

In Subtask 2 of this task work order, the project team compared the definitions of 55 performance measure terms that have been used by FDOT, the 2010 HCM, TTI. The goal of this comparison was to better understand the key similarities and differences in terms and definitions.

This section of the report summarizes key findings from the comparison of terms and definitions. Appendix A includes all 55 terms and corresponding definitions.

2.1 LISTING OF PERFORMANCE MEASURE TERMS

The 55 terms were grouped into five categories as shown below.

Geographic extent or scale

1. Point
2. Segment
3. Link
4. Facility
5. Corridor
6. Freeway
7. Arterial street
8. Highway
9. Urbanized area
10. Urban area

Time scale

11. Peak hour
12. Peak period
13. Daily
14. Yearly

Measure concepts

15. Mobility
16. Congestion
17. Unacceptable congestion
18. Mild congestion
19. Heavy congestion
20. Severe congestion
21. Travel time reliability
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24. Stable flow
25. Indicator/context measure
26. Benchmark
27. Threshold
28. Target
29. 4 Dimensions of Congestion
30. 4 Dimensions of Mobility
31. Data aggregation and weighting methods

Measure inputs

32. Volume
33. Truck/vehicle classification
34. Capacity
35. Volume-to-capacity ratio
36. Free-flow speed
37. Base free-flow speed
38. Uncongested speed
39. Free-flow time
40. Uncongested travel time
41. 80th vs. 95th percentile for reliability measures

Performance measures

42. Level of service (LOS)
43. Density
44. Delay
45. Control delay
46. Geometric delay
47. Total delay
48. Acceptable delay
49. Unacceptable delay
50. Travel time index
51. Planning time index
52. Buffer index
53. % of on-time arrivals
54. Accessibility
55. Throughput

2.2 KEY FINDINGS IN COMPARISON OF TERMS

The following paragraphs summarize the key similarities and differences between the three approaches.

Geographic extent and scale – The main difference in terminology is the use of the term segment. HCM 2010 uses a very specific definition of segment (i.e., a link and its nodes or boundary points), whereas TTI uses the term segment in a more general, vernacular sense (i.e., a defined length of roadway for a specific application, in this case, performance reporting). Florida DOT uses the HCM definition of segment, which is the link and its boundary points. Also, HCM and FDOT definitions and analysis methods are typically outlined for a more disaggregate scale (i.e., point, link, or segment) than is common in most TTI congestion analyses (i.e., facility, corridor, or citywide).

Time scale – The peak hour is the primary time unit for HCM analyses, whereas TTI analyses more commonly report a multi-hour peak period to capture the effects of peak spreading that routinely occurs on severely congested facilities. FDOT defines both a peak hour and a peak period. Both FDOT and TTI also report daily and yearly aggregate performance measure statistics.

Performance measure concepts – The primary difference is in the definition of the term congestion. The HCM includes two definitions: 1) when demand approaches or exceeds capacity; and 2) a difference between actual performance and user expectations. TTI splits these two separate definitions into two separate terms: congestion (defined as travel time in excess of those in light or free-flow conditions) and unacceptable congestion (travel time or delay in excess of an agreed-upon norm). FDOT defines congestion in relation to levels of service (which are based on user expectations, similar to HCM definition #2)

Performance measure inputs – The primary difference is the definition of free-flow speed in the context of traffic signal control on arterial streets. In the context of urban streets, the HCM defines free-flow speed to be average midblock running speed, which removes the influence of prevailing traffic signal control. Because of past confusion in terms, TTI now uses the term uncongested speed to include the prevailing traffic signal control delay. The FDOT approach for defining free-flow speed on urban streets is consistent with the HCM, in that the FDOT definition of free-flow does not include routine traffic signal delay during light traffic. However, FDOT estimates free-flow speeds on urban streets by adding 5 mph to the posted speed limit, whereas HCM estimates free-flow speeds by applying several adjustment factors to the posted speed limit.

Performance measures – Both HCM and FDOT use level of service as an overarching performance measure, whereas TTI does not use level of service. On freeways (uninterrupted flow), level of service is defined with respect to density, which TTI also does not use. On arterial streets (interrupted flow), level of service is defined as the ratio of the average through travel speed to the base free-flow speed. TTI also uses speed-based ratios (using uncongested speed) to measure auto performance on arterial streets. However, TTI more commonly uses the travel time index, which is the inverse of the measure used to define

level of service. Additionally, TTI uses the uncongested speed (which includes prevailing signal control delay) whereas HCM and Florida DOT level of service uses a free-flow speed (i.e., midblock running speed) that does not include prevailing signal control delay.

The same subjective vs. objective definition issue that occurred with defining congestion also occurs when defining delay. The HCM defines the components of delay (control, geometric, incident, and incremental) based on objective measurements, but indicates that delay is "…additional travel time…beyond…a desired speed," thereby introducing subjectivity. TTI splits the objective and subjective definitions into delay (objective, in this case means the sum of all time lost to congestion) and unacceptable delay (subjective, in this case means the delay incurred above and beyond a target). When defining delay, FDOT provides both a subjective definition ("additional travel time beyond some norm") that, concept-wise, matches TTI's definition of unacceptable delay. FDOT also provides an objective definition for delay that more closely matches TTI's delay definition ("any additional travel time experienced by a traveler").

3.0 Comparison of Calculation Results

In Subtask 3 of this task work order, the project team used directly-measured field data to calculate several performance measures using each of the three approaches: 1) FDOT, 2) HCM, and 3) TTI. The results of these calculations illustrate the "end result" implications of the three different measurement approaches.

This section of the report summarizes key findings from the comparison of calculation results. Appendix B contains more detailed information.

3.1 Comparison Overview and Key Parameters

The comparison of measure calculation results included two roads:

1. Freeway facility: SR 826 (Palmetto Expressway) in Miami (Exhibit 1). The facility length (as analyzed) and number of included interchanges is:
    a. Northbound direction: 7.4 miles, 9 interchanges
    b. Southbound direction: 7.8 miles, 9 interchanges
2. Arterial street facility: US 27/Monroe Street in Tallahassee (Exhibit 2). The facility length (as analyzed) and number of included intersections is:
    a. Northbound direction: 3.1 miles, 13 signalized intersections
    b. Southbound direction: 3.2 miles, 13 signalized intersections

The performance measures that were calculated (using each of the 3 respective calculation approaches) were:

1. Delay (Equation 1)
2. Travel time index (Equation 2)

The delay and travel time index measures were selected because they are commonly used measures in practice and can be easily calculated from travel time and traffic volume inputs.

Equation 1
If actual monthly average hourly travel time is greater than the delay threshold travel time:

$$\underset{(\text{vehicle}-\text{hours})}{\text{Delay}} = \frac{\{average\ travel\ time\ (seconds) - threshold\ travel\ time\ (seconds)\} \times \text{traffic volume (vehicles)}}{3{,}600\ seconds/hour} \times \frac{\#\ of\ workdays}{in\ that\ month}$$

Because the average travel times used in this analysis represent a monthly average, they must be multiplied by the number of workdays (non-holiday weekdays) that are represented by that monthly average, for each respective month.

The following delay thresholds were used for the three approaches:

- **FDOT**: Travel time at LOS B
- **HCM**: Free-flow travel time, estimated using HCM procedures
- **TTI**: Free-flow (uninterrupted) and uncongested (interrupted), directly calculated from field data

Equation 2

$$Travel\ Time\ Index = \frac{average\ travel\ time\ (seconds)}{free-flow\ travel\ time\ (seconds)}$$

A "floor" value of 1.0 was set for the travel time index, such that when the average travel time was less than the free-flow travel time, the travel time index was automatically set to 1.0.

All three approaches used Equation 2 for the calculation of travel time index values. However, different index values resulted due to different free-flow travel time calculation procedures.

- **FDOT**: Free-flow travel time estimated as posted speed limit + 5 mph
- **HCM**: Free-flow travel time estimated from HCM procedures
- **TTI**: Free-flow travel time calculated from field data

Exhibit 1: Freeway Facility in Comparison: SR 826 in Miami

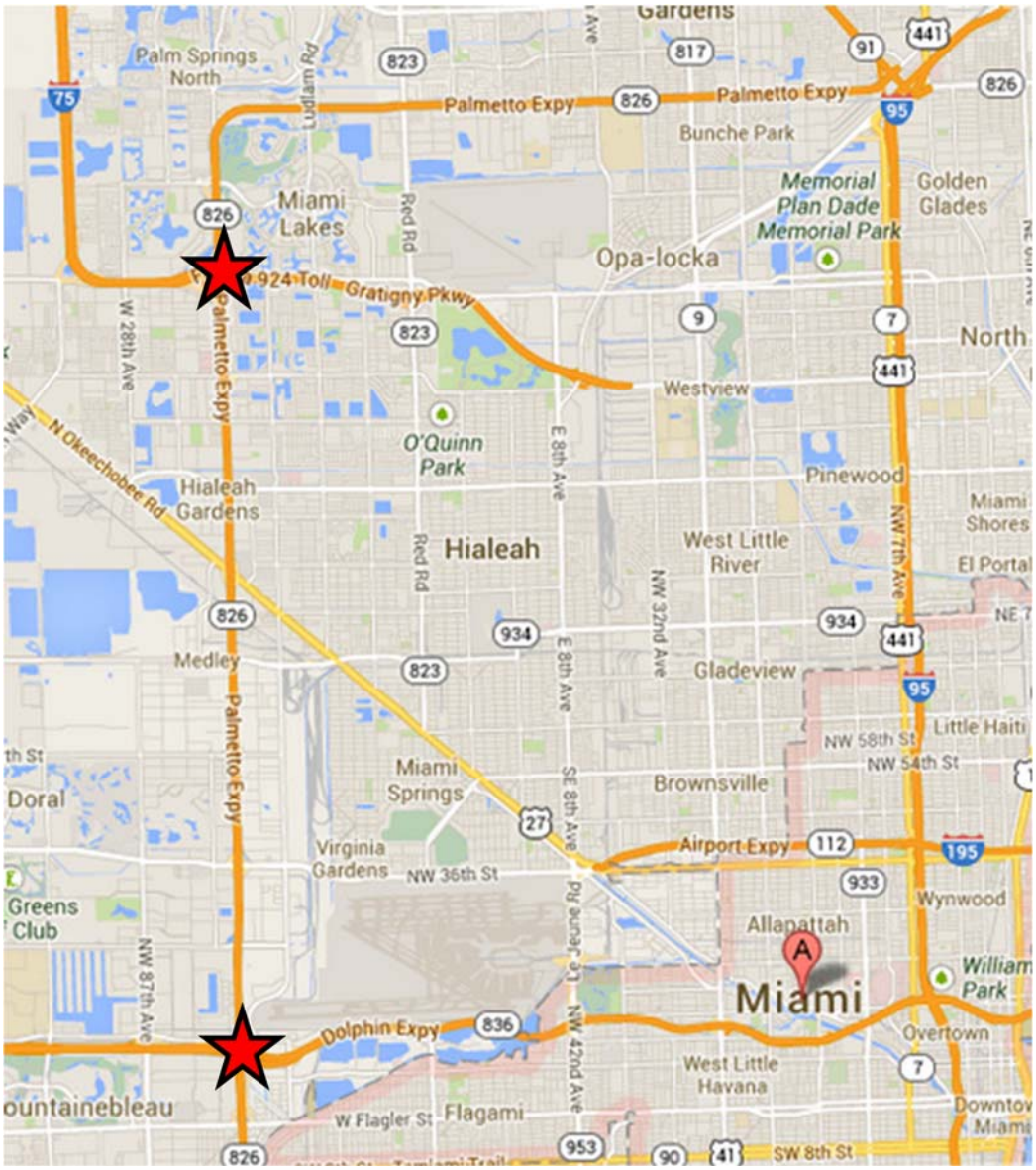
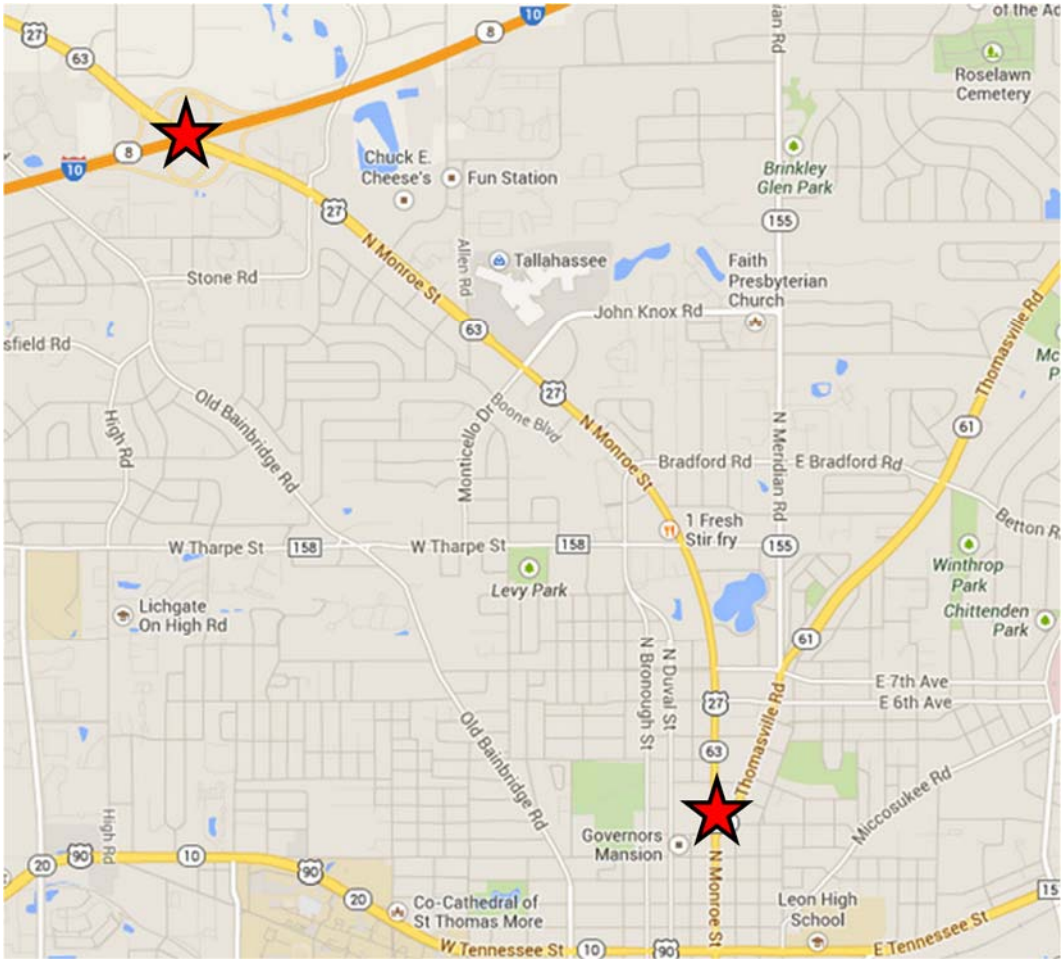


Exhibit 2. Arterial Street Facility in Comparison:

US 27/Monroe St in Tallahassee



There were four aspects considered in the comparison:

1. Comparison of free-flow and delay threshold speeds
2. Absolute comparison of values
3. Relative ranking among road segments
4. Relative change in month-to-month trends

3.2 KEY FINDINGS IN COMPARISON OF CALCULATION RESULTS

3.2.1 Comparison of free-flow and delay threshold speeds

For SR 826 (uninterrupted flow), most of the differences were less than 5% (±3 mph).

- Between TTI and HCM, free-flow speed differences ranged from 0% to -4%, HCM always slower or the same
- Between TTI and FDOT, free-flow speed differences ranged from -6% to 3%
- Between HCM and FDOT, all speed differences ranged from -4% to 6%

For US 27 (interrupted flow), TTI speeds were always slower (because TTI is uncongested speed), and HCM speeds were always slower than FDOT speeds (15% average).

- Between TTI and HCM, free-flow speed differences ranged from 3% to 16%, TTI always slower (because TTI is uncongested speed)
- Between TTI and FDOT, free-flow speed differences ranged from 14% to 39%, TTI always slower (because TTI is uncongested speed)
- Between HCM and FDOT, all speed differences ranged from 7% to 26%, HCM always slower speeds

In terms of the differences between FDOT free-flow and delay threshold speeds:

- For SR 826, FDOT free-flow and delay threshold speed were comparable (60 mph free-flow versus 59 mph delay threshold)
- For US 27 (interrupted flow), FDOT delay thresholds much lower than free-flow (22 mph vs. 40 mph; 31 mph vs. 50 mph) because FDOT has chosen to set their delay thresholds much lower than free-flow on arterial streets.

3.2.2 Absolute comparison of delay and travel time index values

Summary of delay differences:

For SR 826 (uninterrupted flow), both HCM and TTI delay were within 15% of total FDOT facility delay estimate; however, delay differences are much greater for shorter sections.

- TTI delay is consistently higher than both HCM and FDOT delay.
- HCM delay is consistently higher than FDOT delay, but consistently lower than TTI delay.

For US 27 (interrupted flow), TTI and HCM facility delay values are comparable; however, FDOT delays are much lower because of the use of LOS B threshold speeds.

- HCM delay is consistently higher than TTI delay, primarily because TTI delay does not include routine signal delay that occurs during light traffic.
- FDOT delay is much lower than both HCM and TTI delay, primarily because of the FDOT use of LOS B threshold speeds.

Summary of travel time index differences:

For SR 826 (uninterrupted flow), most differences in travel time index were less than 5% (comparable to threshold speeds):

- Between FDOT and HCM, index differences ranged from -4% to 6%, average -1%
- Between FDOT and TTI, index differences ranged from -5% to 3%, average -2%
- Between HCM and TTI, index differences ranged from -3% to 0%, average -1%

For US 27 (interrupted flow), TTI index values were consistently lower (because TTI uses an uncongested speed, a slower speed than free-flow), and HCM index values were always consistently lower than FDOT (13% average).

- Between FDOT and HCM, index differences ranged from 7% to 21%, average 13%
- Between FDOT and TTI, index differences ranged from 10% to 22%, average 17%
- Between HCM and TTI, index differences ranged from 2% to 8%, average 4%

3.2.3 Relative ranking among road segments

Summary of delay ranking differences:

For SR 826 (uninterrupted flow), all three methods provided very similar ranking results, with TTI and HCM both ranking 16 of the top 18 sections the exact same as FDOT. The rankings among the 12 lowest-ranked sections differed more than the top 18 highest rankings; however, most rankings were still within several ranking positions of the other methods.

For US 27 (interrupted flow), HCM and TTI rankings are very similar to each other, but very different from FDOT rankings. The reason for the HCM and TTI differences with FDOT is because of the FDOT use of LOS B threshold speeds (i.e., delays are much lower, if any).

Summary of travel time index differences:

For SR 826 (uninterrupted flow), all three methods provided very similar ranking results (same scenario as when using delay per mile values). TTI and HCM both ranked 8 of the top 10 sections the exact same as FDOT. For all 30 freeway sections, the HCM and TTI rank orders were within 3 positions of the FDOT rank order.

For US 27 (interrupted flow), HCM and TTI rankings are more similar to each other than to the FDOT rankings. Rankings with the travel time index are more comparable than with delay per mile values, primarily because all three measures use a free-flow or uncongested speed.

3.2.4 Relative change in month-to-month trends

Summary of delay differences:

For SR 826 (uninterrupted flow), the month-to-month delay trends were consistent at a facility level, but less consistent for shorter sections (R^2=0.52 for FDOT-HCM and R^2=0.90 for HCM-TTI)

For US 27 (interrupted flow), the month-to-month delay trends for HCM and TTI were more similar (R^2=0.62), but FDOT results were much different (R^2=0.03).

Summary of travel time index differences:

For SR 826 (uninterrupted flow), the month-to-month travel time index trends were very highly correlated, even for shorter sections (R^2=0.99).

For US 27 (interrupted flow), the month-to-month travel time index trends were very high correlated, even for shorter sections (R^2=1.00).

4.0 Conclusions and Recommendations

This section of the report provides conclusions and recommendations based on the comparisons of terms, definitions, and calculation results in this task work order.

4.1 TERMS AND DEFINITIONS

The project team's conclusion regarding terms and definitions is:

- **Using the same words to represent different concepts is confusing, even to experts in performance measures**. In particular, the team identified differences in two basic foundation words: "congestion" and "delay."

The project team's recommendations are as follows:

- **The two different FDOT delay definitions should be split into two different terms**. Currently, these two delay definitions are 1) additional travel time beyond some norm… and 2) any additional travel time experienced by a traveler. Instead, FDOT should use clarifying terms or subscripts in all delay references:
    1. *Delay at free-flow* (or $delay_{free\text{-}flow}$) is any additional travel time {beyond free-flow};
    2. *Delay at LOS B* (or $delay_{LOS\ B}$) is additional travel time beyond Level of Service B, FDOT's preferred threshold.
- **A similar distinction can be made with congestion.** For example:
    1. *Congestion at free-flow* (or $congestion_{free\text{-}flow}$) occurs when travelers experience additional travel time {beyond free-flow}
    2. *Congestion at LOS B* (or $congestion_{LOS\ B}$) occurs when travelers experience additional travel time beyond Level of Service B, FDOT's preferred threshold.

4.2 CALCULATION APPROACHES AND PROCEDURES

The project team concluded that:

- **Any change(s) to FDOT calculation procedures hinges on potential changes to FDOT definitions discussed in the previous section**. The existing FDOT calculation procedures are numerically valid and sound; however, what the resulting quantity is called (delay) may change if FDOT definitions change. For example, FDOT may continue to use the same calculation approach for delay at LOS B, but simply rename any reference to that as delay at LOS B or $delay_{LOS\ B}$.

The project team recommends that:

- **FDOT use field-measured free-flow speed for delay calculation on freeways**. This approach simplifies calculations (in that the threshold is based on directly-measured field data) and is consistent with the recommended changes to definition of delay in the previous section.

4.3 RECOMMENDATIONS TO FHWA

- **A similar recommendation regarding the distinction for congestion and delay should be made to FHWA and other public agencies, to encourage consistency in terms.** FDOT should continue its leadership role in performance monitoring and work with other agencies to gain consensus on consistent terms and "measuring sticks."

5.0 Appendix A: Detailed Tabular Comparisons of Terms and Definitions

The tables in this appendix compare the definitions for 55 performance measure terms that have been used by the 2010 Highway Capacity Manual (HCM), the Texas A&M Transportation Institute (TTI), and the Florida Department of Transportation (FDOT). The goal of this comparison is to better understand the key similarities and differences in terminology and definitions.

These appendix tables have been excerpted directly from the FDOT Subtask 2.2 Deliverable, dated October 28. 2013.

Exact quotes from published references are shown in italics within double quotation marks.

Category	Term/Element	2010 Highway Capacity Manual (HCM)	Texas A&M Transportation Institute (TTI)	Florida Department of Transportation (FDOT)
Geographic extent or scale	Point	*"A place along a facility where (a) conflicting traffic streams cross, merge, or diverge; (b) a single traffic stream is regulated by a traffic control device; or (c) there is a significant change in the segment capacity (e.g., lane drop, lane addition, narrow bridge, significant upgrade, start or end of a ramp influence area)."* (HCM 2010, pg. 9-15)	Not explicitly defined. TTI's congestion analyses are typically not at this level of detail.	*"A point is a boundary between links. In broad terms, points are where modal users enter, leave, or cross a facility, or where roadway characteristics change. In most applications of this Q/LOS Handbook, points are signalized intersections. Other points may include freeway gores, unsignalized intersections, area boundaries, bicycle lane terminals, sidewalk terminals, pedestrian mid-block crossings, and bus stops."* (Q/LOS Handbook, August 2013)
	Segment	*"**1.** For interrupted flow facilities, a link and its boundary points(s). **2.** For uninterrupted flow facilities, a portion of a facility between two points."* (HCM 2010, pg. 9-17)	Not explicitly defined. However, TTI uses the term *segment* in a more general sense to indicate a defined length of roadway that serves as the basic unit of analysis for performance reporting. Segments are typically composed of multiple links and nodes (per HCM definitions) with similar overall congestion characteristics.	*"A link and its boundary points are referred to as a segment. Segments are the primary building blocks of facility analyses."* (Q/LOS Handbook, August 2013)
	Link	*"A length of roadway between two nodes or points."* (HCM 2010, pg. 9-11)	Use prevailing definition from respective entity (public agency or private company). In some cases, this is the same as HCM; in other cases, it differs.	*"A link represents a length of roadway between two points."* (Q/LOS Handbook, August 2013) Unlike a segment, a link does not include boundary points.
	Facility	*"A length of roadway, bicycle path, or pedestrian walkway composed of a connected series of points and segments."* (HCM 2010, pg. 9-7)	Not explicitly defined or commonly used in the context of performance measures.	*"(auto) – a length of roadway composed of points and segments."* (MPM Definitions, 8/12/13) *A facility is a group of consecutive segments or sections that form logical roadway lengths based on driver perspective or the overall network system structure.* (Q/LOS Handbook, August 2013)
	Corridor	*"A set of parallel transportation facilities, for example a freeway and an arterial street."* (HCM 2010, pg. 9-5)	Not explicitly defined; however, TTI uses the term *corridor* in the same context as HCM definition.	*"(for auto mode) – (1) a set of essentially interrelated, parallel transportation facilities for moving people and goods between two points; (2) a geographic area used for the movement of people and goods; (3) highway, rail line, waterway and other exclusive-use facilities that connect major origin/destination markets."* (MPM Definitions, 9/23/13)
	Freeway	*"A fully access-controlled, divided highway with a minimum of two lanes (and frequently more) in each direction."* (HCM 2010, pg. 9-8)	Use the functional classification definition for respective public agency. In FHWA's HPMS database, freeways include *Interstate* highways (code=1) and *Other Freeways and Expressways* (code=2).	A *"…multilane, divided roadways with at least two lanes for exclusive use of traffic in each direction and full control of ingress and egress)."* (Q/LOS Handbook, August 2013)
	Arterial street	*"A street interrupted by traffic control devices (e.g., signals, STOP signs, or YIELD signs) that primarily serves through traffic and that secondarily provides access to abutting properties. See also urban street."* (HCM 2010, pg. 9-2) The HCM more commonly uses the term urban street: "A street with relatively high density of driveway access located in an urban area and with traffic signals or interrupting STOP or YIELD signs no farther than 2 mi apart."	Use the functional classification definition for respective public agency. In FHWA's HPMS database, arterial streets include *Other Principal Arterial* (code=3) and *Minor Arterial* (code=4).	*"A signalized roadway that primarily serves through traffic with average signalized intersection spacing of 2.0 miles or less; a type of roadway based on FDOT functional classification."* (Q/LOS Handbook, August 2013)
	Highway	*"A general term for denoting a public way for purposes of vehicular travel, including the entire area within the right-of-*	Not explicitly defined.	*"A general term for denoting a public way for purposes of vehicular and people travel, including the entire area with the*

Category	Term/Element	2010 Highway Capacity Manual (HCM)	Texas A&M Transportation Institute (TTI)	Florida Department of Transportation (FDOT)
		way." (HCM 2010, pg. 9-9)		*right-of-way."* (MPM Definitions, 9/23/13)
	Urbanized area	Not used.	Use ***urbanized area*** definition and designations of others (i.e., Census, FHWA, state DOTs, and local government). However, the Urban Mobility Report has abbreviated the term *"urbanized area"* to *"urban area."*	*An area within an MPO's designated urbanized area boundary. The minimum population for an urbanized area is 50,000 people.* *Based on the Census, any area the U.S. Bureau of Census designates as urbanized, together with any surrounding geographical area agreed upon by the FDOT, the relevant Metropolitan Planning Organization (MPO), and the Federal Highway Administration (FHWA), commonly called the FHWA Urbanized Area Boundary. The minimum population for an urbanized area is 50,000."* (Q/LOS Handbook, August 2013)
	Urban area	Not typically used, except in the generic sense of "not rural."	Use ***urban area*** definition and designations of others (i.e., Census, FHWA, state DOTs, and local government).	*"A place with a population between 5,000 and 50,000 and not in an urbanized area. The applicable boundary includes the Census's urban area and the surrounding geographical area agreed upon by the FDOT, the local government, and the Federal Highway Administration (FHWA). The boundaries are commonly called FHWA Urban Area Boundaries and include those areas expected to develop medium density before the next decennial census.* *A general characterization of places where people live and work."* (Q/LOS Handbook, August 2013)
Time scale	Peak hour	*"The hour of the day in which the maximum volume occurs. See also analysis hour."* (HCM 2010, pg. 9-13) A possible HCM analysis period; however, 15 minutes is more commonly used, with 15-minute flow rates converted into equivalent hourly volumes.	Not defined or commonly used, except when congestion is light and typically lasts less than one hour. In those cases, the peak hour is the hour containing the highest level of congestion delay.	*"(1) The hour in which the greatest amount of travel occurs (typically considered 5:00-6:00 pm on a weekday); (2) the hour in which the greatest amount of travel occurs for a mode."* (MPM Definitions, 9/23/13)
	Peak period	Not specifically used. However, the HCM can be used to analyze peak periods as series of one-hour analyses. The freeway facilities method can accommodate analyses spanning multiple hours.	A fixed-duration, multi-hour period during which congestion is most likely to occur. Because it includes severely congested cities, the Urban Mobility Report defines 4-hour weekday peak periods in the morning (6 to 10 am) and evening (3 to 7 pm). Other city- or state-specific analyses by TTI may use shorter or longer periods, depending upon prevailing conditions and analysis context.	*"(1) A multi-hour period in which travel is greatest; (2) for the auto mode in large urbanized areas the two-hour weekday time period of 5:00-7:00 pm at which congestion is typically highest."* (MPM Definitions, 9/23/13)
	Daily	Default *K* values are provided to convert average annual daily traffic volumes into peak hour volumes.	Refers to all hours (unless specific hours or periods are indicated) in a day, from midnight to midnight.	For the average 24-hour day.
	Yearly	Not currently used, although reliability analysis would change that.	Refers to all days (unless specified as weekday or weekend) in either a 1) calendar year or 2) a fiscal year.	Not explicitly defined, but refers to all days in a calendar year.
Performance measure concepts	Mobility	*The ability of people and goods to travel from place to place.* (HCM 2010, pg. 9-12) The term *mobility* is generally used in the HCM in the context of speed; for example, contrasting higher-speed arterial streets (mobility) with lower-speed local streets (access).	*"Mobility is the ability to reach a destination in a time and cost that are satisfactory."* (Keys, 2005) *"Mobility is the ability of people and goods to move quickly, easily, and cheaply to where they are destined at a speed that represents free-flow or comparably high-quality conditions."* (NCHRP Report 398, Quantifying Congestion)	*"The movement of people and goods."* (MPM Definitions, 9/23/13)
	Congestion	***"1.*** *Low-flow, high-occupancy traffic operations that arise*	*"Congestion is travel time or delay in excess of that normally*	*"(for the auto mode) – a condition in which traffic demand*

Category	Term/Element	2010 Highway Capacity Manual (HCM)	Texas A&M Transportation Institute (TTI)	Florida Department of Transportation (FDOT)
		when demand approaches or exceeds a system element's capacity. ***2.*** *A difference between the highway system performance expected by users and how the system actually performs—for example, an intersection that may seem very congested in a rural community may not even register as an annoyance in a large metropolitan area."* (HCM 2010, pg. 9-4) Generally used in the HCM in the context of oversaturated conditions (i.e., demand exceeding capacity).	*incurred under light or free-flow travel conditions."* (NCHRP Report 398, Quantifying Congestion)	*causes the LOS to be at or below FDOT's LOS standard. Adjectives describing the severity of congestion are: 1) Mild, 2) Heavy, 3) Severe. Adjectives describing the types of congestion are: 1) Non-recurring, 2) Recurring."* (MPM Definitions, 9/23/13)
	Unacceptable congestion	Not used.	*"Unacceptable congestion is travel time or delay in excess of an agreed-upon norm. The agreed-upon norm may vary by type of transportation facility, travel mode, geographic location, and time of day."* (NCHRP Report 398, Quantifying Congestion)	Not used.
	Mild congestion	Not used.	Not currently defined. Previous congestion estimation methods defined 4 congestion levels based on ADT per lane: 1) moderate, 2) heavy, 3) severe, and 4) extreme.	*"(for the auto mode) - a situation in which traffic demand is in the LOS range of FDOT's LOS standard."* (MPM Definitions, 9/23/13)
	Heavy congestion	Not used.		*"(for the auto mode) - a condition in which traffic demand is at a level to cause the LOS to be below FDOT's LOS standard."* (MPM Definitions, 9/23/13)
	Severe congestion	Not used.		*"(for auto mode) – a condition in which traffic demand exceeds the capacity."* (MPM Definitions, 9/23/13)
	Travel time reliability	*"**1.** The probability of "on-time" arrival (i.e., the probability that a trip is completed below a certain threshold time).* ***2.*** *The variability in travel time for a given trip due to unforeseen causes such as variations in demand or an incident."* (HCM 2010, pg. 9-20)	*"The consistency or dependability in travel times, as measured from day-to-day and/or across different times of the day."* (FHWA 2006, http://ops.fhwa.dot.gov/publications/tt_reliability/)	*"(1) The percent of trips that succeed in accordance with a predetermined performance standard for time or speed; (2) the variability of travel times that occur on a facility or a trip over a period of time – frequently used performance measures are: 1) Buffer index, 2) On-time arrival, 3) Planning time index, and 4) Travel time index."* (MPM Definitions, 9/23/13)
	Travel time variability	The variation in time required to make a trip *"…from one day to the next."* (HCM 2010, pg. 3-12) Also, referenced as an alternate definition of *travel time reliability*. (HCM 2010, pg. 9-20)	Not explicitly defined, but *travel time variability* is considered to be the theoretical inverse of travel time reliability. That is, as travel time reliability increases, *travel time variability* decreases.	*"See travel time reliability."* (MPM Definitions, 9/23/13)
	Bottleneck	*"A system element on which demand exceeds capacity."* (HCM 2010, pg. 9-3)	Not explicitly defined.	*"A segment of a transportation network that experiences significant operational problems such as oversaturated congestion."* (MPM Definitions, 9/23/13)
	Stable flow	Not defined. Used in Chapters 10 and 13 in the context of undersaturated conditions (i.e., not oversaturated).	Not explicitly defined or commonly used.	*"A flow of traffic on freeways which is not stop and go."* (MPM Definitions, 9/23/13)
	Indicator / context measure	Not used.	Not explicitly defined or commonly used.	*"(mobility performance measure) – a mobility performance measure which primarily shows a trend over time and is not used to achieve a goal or objective or used in a decision making process."* (MPM Definitions, 9/23/13)
	Benchmark	Not used.	Not explicitly defined or commonly used in the context of performance measures. The term benchmark is more commonly used in the context of accuracy evaluation: *"A*	*"A reference point used for comparisons for performance measures practices."* (MPM Definitions, 9/23/13)

Category	Term/Element	2010 Highway Capacity Manual (HCM)	Texas A&M Transportation Institute (TTI)	Florida Department of Transportation (FDOT)
			data value or set of data values considered to be the standard against which other data values are compared."	
	Threshold	Most often used in the context of the boundary between two levels of service. A *threshold speed* is used in urban streets chapters to determine when a stop occurs.	A defined boundary value, most often used in the context of identifying the boundary between "congestion" and "no congestion." The term *threshold* is also referred to as the *reference point* or *reference value*. A *threshold* is based on measured physical properties or characteristics and is considered outside the domain of value judgment (i.e, acceptable vs. unacceptable). The *threshold* is considered separate and distinct from a subjective *target* value, except in those cases where public agencies have designated a *threshold* value as their *target*.	*"The breakpoints between level of service differentiations."* (Q/LOS Handbook, August 2013)
	Target	Most often used in the context of a design value or objective (e.g., target LOS, target v/c ratio). The term *target speed* is used frequently in the Vehicle Trajectory Analysis section of Chapter 24 in the context of describing how to derive HCM performance measures from simulation tools.	An agreed-upon goal or norm, most often used in the context of identifying the boundary between "congestion" and "unacceptable congestion." A *target* value requires subjective judgment about travel conditions that are acceptable and desired, and may vary considerably among different locations in a city, region or state.	*"A value of a performance measure representing the level of desired performance reflecting an agency's goals and objectives."* (MPM Definitions, 9/23/13) "
	4 Dimensions of Congestion	Specific term not used. However, these *dimensions of system performance* are outlined: *quantity of service, intensity of congestion, duration of congestion, extent of congestion, variability, and accessibility*. (HCM 2010, pg. 2-7)	*1. Duration, 2. Extent, 3. Intensity, 4. Reliability* (NCHRP Report 398, Quantifying Congestion)	See definition of *Congestion* – adjectives are used to describe the severity (mild, heavy, severe) and type (non-recurring, recurring).
	4 Dimensions of Mobility	Specific term not used. However, these *dimensions of system performance* are outlined: *quantity of service, intensity of congestion, duration of congestion, extent of congestion, variability, and accessibility*. (HCM 2010, pg. 2-7)	Term is not commonly used. The term *4 dimensions of congestion* is more commonly used when talking about the problem or deficiency (of congestion).	*Primary dimensions of mobility are 1) the **quantity** of the travel performed (reflects the magnitude of the use of a facility or service); 2) the **quality** of travel performed (describes user's experiences with travel conditions and the effects of congestion); 3) the **accessibility** provided by the transportation system (describes the ease with which people can connect to the multimodal system); and, 4) the **utilization** of a facility or service (indicates whether or not a transportation system is properly sized from the agency's perspective and the ability to accommodate growth).*
	Data aggregation and weighting methods in system-wide measures	Not provided, as HCM 2010 doesn't present system-wide measures. Chapter 30 of HCM 2000 provided aggregation or weighting methods for measures of congestion intensity, duration, and extent.	Vehicle-miles of travel (VMT) or person-miles of travel (PMT) are used to combine average congestion measures to more aggregate facility or geographic reporting. Cumulative congestion measures (like delay) are summed across facilities or geographies.	Aggregate measures are most commonly reported as the percent of travel or highway mileage not meeting specified LOS criteria. Cumulative measures (like delay) are summed across facilities or geographies.
Performance measure inputs	Volume	*"The total number of vehicles or other roadway users that pass over a given point or section of a lane or a roadway during a given time interval, often 1 h."* (HCM 2010, pg. 9-21) The HCM is more interested in *demand* than volume.	Not explicitly defined; however, TTI uses the term *volume* in the same context as HCM definition.	*"In this Q/LOS Handbook usually the number of vehicles, and occasionally persons, passing a point on a roadway during a specified time period, often 1 hour; a volume may be measured or estimated, either of which could be a constrained value or a hypothetical demand volume."* (Q/LOS Handbook, August 2013)
	Truck / vehicle classification	Truck is defined as "A heavy vehicle engaged primarily in the	Use vehicle class definitions of respective public agency (e.g.,	*"A heavy vehicle engaged primarily in the transport of goods*

Category	Term/Element	2010 Highway Capacity Manual (HCM)	Texas A&M Transportation Institute (TTI)	Florida Department of Transportation (FDOT)
		transport of goods and materials or in the delivery of services other than public transportation." (*HCM 2010, pg. 9-20*) The HCM defines three types of heavy vehicles: trucks, buses, and RVs.	HPMS database). For Urban Mobility Report, a "truck" is considered to be FHWA Class 4 through Class 13.	*and materials (notes, [1] trucks are included in the definition of HCM definition of automobile, [2] commonly within FDOT use of the term "truck" for traffic purposes is more accurately termed "heavy vehicle")"*
	Capacity	*"The maximum sustainable hourly flow rate at which persons or vehicles reasonably can be expected to traverse a point or a uniform section of a lane or roadway during a given time period under prevailing roadway, environmental, traffic, and control conditions."* (HCM 2010, pg. 9-3)	Not explicitly defined.	*"(auto) – the maximum number of vehicles that reasonably can be expected to traverse a point or a uniform section of roadway during a given time period under prevailing conditions."* (MPM Definitions, 9/23/13)
	Volume-to-capacity ratio	*"The ratio of flow rate to capacity for a system element."* (HCM 2010, pg. 9-21)	Not used.	*"The ratio of demand to capacity."* (MPM Definitions, 9/23/13)
	Free-flow speed	*"1. The theoretical speed when the density and flow rate on a study segment are both zero. 2. The prevailing speed on freeways at flow rates between 0 and 1,000 passenger cars per hour per lane (pc/h/ln)."* (HCM 2010, pg. 9-8) In the context of urban streets, free-flow speed is *"…the average running* [midblock] *speed of through automobiles under low-volume conditions and not delayed by traffic control devices or other vehicles."* (HCM 2010, pg. 17-32)	*"The average speed that can be accommodated under relatively low traffic volumes (i.e., no vehicle interactions) on a uniform roadway segment under prevailing roadway and traffic conditions."* (Keys, 2005) Note that *free-flow speed* is the term used on uninterrupted facilities; whereas, *uncongested speed* is the corollary on interrupted-flow facilities.	• *"(for auto mode) the average speed of vehicles on a given segment, measured under low-volume conditions, when drivers are free to drive at their desired speed and are not constrained by the presence of other vehicles or downstream traffic control devices; typically 5 mph over the posted speed limit.")."* (MPM Definitions, 9/23/13)
	Base free-flow speed	*"…the traffic speed on the segment when free-flow conditions exist and speed is uninfluenced by signal spacing."* (HCM 2010, pg. 16-11) Also, the free-flow speed that would be measured on longer urban segments.	Not used.	Not used.
	Uncongested speed	Not used.	So as not to conflict with the HCM term of *free-flow speed*, TTI has adopted this term in the context of arterial streets to mean the "…*average speed that can be accommodated under relatively low traffic volumes (i.e., no vehicle interactions) on a uniform roadway segment under prevailing roadway and traffic conditions."* On arterial streets, the uncongested speed does include prevailing traffic signal control delay that occurs in light traffic.	Not used.
	Free-flow time	Not defined.	Not explicitly defined; however, can be derived from *free-flow speed*.	*"(for auto mode) The average time spent by vehicles traveling at the free flow speed over a facility length."* (MPM Definitions, 9/23/13)
	Uncongested travel time	Not used.	Not explicitly defined; however, can be derived from *uncongested speed*.	Not used.
	80^{th} vs. 95^{th} percentile for reliability measures	Not used; SHRP 2 L-08 recommends both the 80th and 95th percentile travel time index.	Depending upon context, TTI uses both 80^{th} and 95^{th} percentile for reliability measures.	FDOT currently uses 95^{th} percentile for reliability measures.
Performance Measures	Level of service (LOS)	*"A quantitative stratification of a performance measure or measures that represent quality of service, measured on an A—F scale, with LOS A representing the best operating conditions from the traveler's perspective and LOS F the worst."* (HCM 2010, pg. 9-11)	Not explicitly defined or commonly used.	*"A quantitative stratification of the quality of service to a typical traveler of a service or facility into six letter grade levels, with "A" describing the highest quality and "F" describing the lowest quality."* (MPM Definitions, 9/23/13)
	Density	*"The number of vehicles occupying a given length of a lane or*	Not explicitly defined or commonly used.	*"The number of vehicles, averaged over time, occupying a*

Category	Term/Element	2010 Highway Capacity Manual (HCM)	Texas A&M Transportation Institute (TTI)	Florida Department of Transportation (FDOT)
		roadway at a particular instant." (HCM 2010, pg. 9-6)		*given length of lane or roadway; usually expressed as vehicles per mile or vehicles per mile per lane."* (Glossary, August 2013)
	Delay	*"Additional travel time experienced by a driver, passenger, bicyclist, or pedestrian beyond that required to travel at the desired speed."* (HCM 2010, pg. 9-5)	*"The sum of time lost due to congestion."* (Keys, 2005; NCHRP Report 398, Quantifying Congestion, 1997) Therefore, delay is an objective measure that is based on comparison of actual travel conditions to a threshold value. Delay is composed of acceptable delay and unacceptable delay, which are calculated by defining a target value.	*"(auto) – (1) additional travel time beyond some norm (e.g., LOS C in urbanized areas, LOS B elsewhere) experienced by a traveler; (2) any additional travel time experienced by a traveler."* (MPM Definitions, 9/23/13)
	Control delay	*"Delay associated with vehicles slowing in advance of an intersection, the time spent stopped on an intersection approach, the time spent as vehicles move up in the queue, and the time needed for vehicles to accelerate to their desired speed."* (HCM 2010, pg. 9-4)	Not explicitly defined; however, TTI uses the term *control delay* in the same context as HCM definition.	Not explicitly defined; use HCM definition.
	Geometric delay	*"Delay caused by geometric features causing vehicles to reduce their speed in negotiating a system element."* (HCM 2010, pg. 9-9)	Not explicitly defined or commonly used/reported.	Not explicitly defined; use HCM definition.
	Total delay	*"The sum of control, geometric, incident, and traffic delay."* (HCM 2010, page 4-15).	*"The sum of time lost due to congestion."* (Keys, 2005; NCHRP Report 398, Quantifying Congestion, 1997)	Not explicitly defined; use HCM definition.
	Acceptable delay	Not used.	The amount of delay that occurs between the congestion threshold value (travel time in excess of that normally incurred in light traffic) and the target value. When the target value is set to be the same as the threshold value, then acceptable delay is equal to zero.	Not used.
	Unacceptable delay (aka undesirable delay)	Not used.	The amount of delay that exceeds the target value.	Not explicitly defined.
	Travel time index	Introduced in a discussion of performance measures produced by alternative tools. It is defined as *"…the ratio of actual travel time to ideal travel time."* (HCM 2010, pg. 7-21)	*"The ratio of travel time in the peak period to travel time during uncongested conditions. A Travel Time Index of 1.30 indicates a 20-minute free-flow trip takes 26 minutes in the peak period."* (2012 Urban Mobility Report) In analyses other than the Urban Mobility Report, the travel time index is used in a more generic sense (with respect to time period), in that travel time index is the calculated ratio of average travel time to uncongested conditions for any defined time period.	*"A performance measure defined by the ratio of an actual travel time to the free flow travel time; conceptually represents the congested travel time travelers must spend compared to an uncongested travel time. A travel time reliability performance measure defined by the ratio of an actual travel time (typically the 50th, 80th or 95th percentile travel time) to the free flow travel time; conceptually represents the extra travel time travelers must spend compared to an uncongested travel time."* (MPM Definitions, 9/23/13)
	Planning time index	Not currently used. SHRP 2 L-08 defines it as *"the ratio of the 95th percentile highest travel time to the theoretical free-flow travel time."*	*"The ratio of travel time on the worst day of the month to travel time at uncongested conditions. A Planning Time Index of 1.80 indicates a traveler should plan for 36 minutes for a trip that takes 20 minutes in free-flow conditions (20 minutes x 1.80 = 36 minutes)."* (2012 Urban Mobility Report) However, see discussion in "*80th vs. 95th percentile for reliability measures*"	*"A travel time reliability performance measure defined by the ratio of an actual 95th percentile travel time to the free flow travel time; conceptually represents the congested travel time travelers must spend compared to an uncongested travel time to arrive at their destination on time 95% of the time (a value of 3.00 indicates a traveler should allow 60 minutes to make an important trip that takes 20 minutes in uncongested traffic)."* (MPM Definitions, 9/23/13)

Category	Term/Element	2010 Highway Capacity Manual (HCM)	Texas A&M Transportation Institute (TTI)	Florida Department of Transportation (FDOT)
	Buffer index	Not currently used. It can be derived from SHRP 2 L-08's *buffer time* definition as the ratio of the 95th percentile highest travel time to the mean travel time.	*"A measure of trip reliability that expresses the amount of extra "buffer" time needed to be on time for 95 percent of the trips (e.g., late for work on one day per month)."* (Keys, 2005) Mathematically, it is calculated as the difference between the 95th percentile travel time and average travel time, then divided/normalized by the average travel time.	*"A travel time reliability performance measure defined by the ratio of an actual travel time (typically the 95th percentile travel time) to the average travel time; conceptually represent the extra travel time (or time cushion) travelers must add to their average travel time when planning trips to ensure on-time arrival (Note, this measure is not recommended for statewide reporting of travel time reliability or in project prioritization)"* (MPM Definitions, 9/23/13)
	% of on-time arrivals	Not currently used; the implicit definition is the proportion of trips that are *"…completed below a certain threshold time."* (see HCM 2010 definition of travel time reliability) Also, SHRP 2 L-08 gives *"percent of trips completed within a defined travel time threshold"* as an example of this type of measure.	Not explicitly defined or commonly reported.	Can be inferred from definition of on-time arrival: *"A travel time reliability performance measure defined by a designated travel time (typically based on a 45 mph speed or 1.33 travel time index); conceptually represents a trip that arrives or does not arrive within a defined travel time."* (MPM Definitions, 9/23/13)
	Accessibility	*"The percentage of the populace able to complete a selected trip within a specified time."* (HCM 2010, pg. 9-1)	*"Accessibility is the achievement of travel objectives within time limits regarded as acceptable."* (NCHRP Report 398, Quantifying Congestion)	*"(A dimension of mobility) – conceptually the ease in engaging in activities; ability to reach desired destinations, activities, goods, and services – mobility performance measures typically associated with this mobility dimension are: 1) Time, distance, or cost to reach a destination, 2) Number of transfers (transit), 3) Modal choices/alternatives, 4) Connectivity."* (MPM Definitions, 9/23/13)
	Throughput	Not explicitly defined, but used in several chapters, primarily in discussions of alternative tools (as a way of estimating capacity). Elsewhere, it is used as a synonym for capacity.	Not explicitly defined.	*"The maximum number of people or vehicles that reasonably can be expected to traverse a point or a uniform transportation facility section during a given time period under prevailing conditions."* (MPM Definitions, 9/23/13)

Sources: *Highway Capacity Manual 2010, Volume 1: Concepts* and *Volume III: Interrupted Flow.*
Quantifying Congestion, NCHRP Report 398, TTI et al., 1997.
2012 Urban Mobility Report, TTI, http://mobility.tamu.edu/ums/.
The Keys to Estimating Mobility in Urban Areas, TTI, 2005, http://tti.tamu.edu/documents/TTI-2005-2.pdf.
Mobility Performance Measures Definitions, Florida DOT, 9/23/13.
Transportation Glossary of Terms and Acronyms, Florida DOT, August 2013, http://www.dot.state.fl.us/planning/glossary/glossary.pdf.
2013 Quality / Level of Service Handbook. Florida DOT, 2013, http://www.dot.state.fl.us/planning/systems/SM/los/pdfs/2013%20QLOS%20Handbook.pdf

6.0 Appendix B: Detailed Comparison of Calculation Results

1. COMPARISON OF FREE-FLOW AND DELAY THRESHOLD SPEEDS

For SR 826 (uninterrupted flow), most differences less than 5% (±3 mph)

- Between TTI and HCM, free-flow speed differences ranged from 0% to -4%, HCM always slower or the same
- Between TTI and FDOT, free-flow speed differences ranged from -6% to 3%
- Between HCM and FDOT, all speed differences ranged from -4% to 6%

For US 27 (interrupted flow), TTI speeds always slower (because TTI is uncongested speed), and HCM is always slower than FDOT (15% average)

- Between TTI and HCM, free-flow speed differences ranged from 3% to 16%, TTI always slower (because TTI is uncongested speed)
- Between TTI and FDOT, free-flow speed differences ranged from 14% to 39%, TTI always slower (because TTI is uncongested speed)
- Between HCM and FDOT, all speed differences ranged from 7% to 26%, HCM always slower speeds

Differences between FDOT free-flow and delay threshold speeds

- For SR 826, FDOT free-flow and delay threshold speed were comparable (60 mph free-flow versus 59 mph delay threshold)
- For US 27 (interrupted flow), FDOT delay thresholds much lower than free-flow (22 mph vs. 40 mph; 31 mph vs. 50 mph)

Exhibit B-1. Comparison of Free-Flow and Threshold Speeds

SEQ_ID	Road & Dir	From	To	Length (miles)	TTI Free-Flow Speed	FDOT Free-Flow Speed	FDOT Threshold Delay Speed	HCM Free-Flow Speed
FL826NB01	SR 826 NB	NW 12th St	NW 25th St	0.68	58	60	59	56
FL826NB02	SR 826 NB	NW 25th St	NW 31st St	0.68	60	60	59	60
FL826NB03	SR 826 NB	NW 31st St	NW 32nd St	0.09	60	60	59	60
FL826NB04	SR 826 NB	NW 32nd St	NW 48th St	0.85	62	60	59	62
FL826NB05	SR 826 NB	NW 48th St	NW 54th St	0.45	63	60	59	62
FL826NB06	SR 826 NB	NW 54th St	NW 63rd St	0.56	62	60	59	62
FL826NB07	SR 826 NB	NW 63rd St	NW 70th St	0.42	61	60	59	61

FL826NB08	SR 826 NB	NW 70th St	NW 74th St	0.49	61	60	59	61
FL826NB09	SR 826 NB	NW 74th St	NW 76th Ave	0.24	61	60	59	60
FL826NB10	SR 826 NB	NW 76th Ave	W 41st St	0.74	62	60	59	62
FL826NB11	SR 826 NB	W 41st St	W 44th PI	0.31	61	60	59	59
FL826NB12	SR 826 NB	W 44th PI	W 56th St	0.69	61	60	59	59
FL826NB13	SR 826 NB	W 56th St	W 63rd St	0.45	61	60	59	60
FL826NB14	SR 826 NB	W 63rd St	W 68th St	0.38	61	60	59	61
FL826NB15	SR 826 NB	W 68th St	W 76th St	0.34	62	60	59	61
FL826SB01	SR 826 SB	W 79th St	W 72nd St	0.34	61	60	59	61
FL826SB02	SR 826 SB	W 72nd St	W 63rd St	0.61	62	60	59	61
FL826SB03	SR 826 SB	W 63rd St	W 54th St	0.56	61	60	59	59
FL826SB04	SR 826 SB	W 54th St	W 44th PI	0.71	62	60	59	61
FL826SB05	SR 826 SB	W 44th PI	W 41st St	0.15	63	60	59	62
FL826SB06	SR 826 SB	W 41st St	NW 76th Ave	0.64	63	60	59	62
FL826SB07	SR 826 SB	NW 76th Ave	NW 74th St	0.22	61	60	59	60
FL826SB08	SR 826 SB	NW 74th St	NW 70th St	0.58	62	60	59	62
FL826SB09	SR 826 SB	NW 70th St	NW 63rd St	0.48	62	60	59	62
FL826SB10	SR 826 SB	NW 63rd St	NW 54th St	0.55	63	60	59	62
FL826SB11	SR 826 SB	NW 54th St	NW 48th St	0.64	61	60	59	61
FL826SB12	SR 826 SB	NW 48th St	NW 32nd St	0.66	61	60	59	60
FL826SB13	SR 826 SB	NW 32nd St	NW 31st St	0.09	61	60	59	61
FL826SB14	SR 826 SB	NW 31st St	NW 25th St	0.71	60	60	59	59
FL826SB15	SR 826 SB	NW 25th St	NW 12th St	0.82	58	60	59	57
US27NB1	US 27 NB	Thomasville Rd	Bradford Rd	1.20	32	40	22	36
US27NB2	US 27 NB	Bradford Rd	Sharer Rd	1.03	33	40	22	37
US27NB3	US 27 NB	Sharer Rd	I-10	0.52	36	50	31	40
US27NB4	US 27 NB	I-10	Graves Rd	0.38	41	50	31	42
US27SB1	US 27 SB	Graves Rd	I-10	0.36	39	50	31	42
US27SB2	US 27 SB	I-10	Sharer Rd	0.60	37	50	31	41
US27SB3	US 27 SB	Sharer Rd	Bradford Rd	1.03	35	40	22	37
US27SB4	US 27 SB	Bradford Rd	Thomasville Rd	1.23	31	40	22	36

2. ABSOLUTE COMPARISON OF DELAY AND TRAVEL TIME INDEX VALUES

Summary of delay differences:

For SR 826 (uninterrupted flow), both HCM and TTI within 15% of FDOT facility delay estimate; however, delay differences are much greater for shorter sections.

- TTI delay is consistently higher than both HCM and FDOT delay.
- HCM delay is consistently higher than FDOT delay, but consistently lower than TTI delay.

For US 27 (interrupted flow), TTI and HCM facility delay values are comparable; however, FDOT delays are much lower because of the use of LOS B threshold speeds.

- HCM delay is consistently higher than TTI delay, primarily because TTI delay does not include routine signal delay that occurs during light traffic.
- FDOT delay is much lower than both HCM and TTI delay, primarily because of the FDOT use of LOS B threshold speeds.

Summary of travel time index differences:

For SR 826 (uninterrupted flow), most differences less than 5% (comparable to threshold speeds)

- Between FDOT and HCM, index differences ranged from -4% to 6%, average -1%
- Between FDOT and TTI, index differences ranged from -5% to 3%, average -2%
- Between HCM and TTI, index differences ranged from -3% to 0%, average -1%

For US 27 (interrupted flow), TTI index values consistently lower (because TTI is uncongested speed, a slower speed than free-flow), and HCM index values always consistently lower than FDOT (13% average)

- Between FDOT and HCM, index differences ranged from 7% to 21%, average 13%
- Between FDOT and TTI, index differences ranged from 10% to 22%, average 17%
- Between HCM and TTI, index differences ranged from 2% to 8%, average 4%

Exhibit B-2. Comparison of Total Delay Values

SEQ_ID	FDOT Threshold Delay Speed	HCM Free-Flow Speed	TTI Free-Flow (Uncongested) Speed	FDOT_Delay	HCM_Delay	TTI_Delay
FL826NB01	59	56	58	81,721	69,474	76,445
FL826NB02	59	60	60	20,916	23,185	24,910
FL826NB03	59	60	60	1,914	2,328	2,414
FL826NB04	59	62	62	18,209	27,822	29,385
FL826NB05	59	62	63	15,468	21,196	23,186
FL826NB06	59	62	62	39,470	47,464	48,357
FL826NB07	59	61	61	35,252	39,806	39,986
FL826NB08	59	61	61	40,006	45,241	44,580
FL826NB09	59	60	61	22,615	24,892	25,607
FL826NB10	59	62	62	69,731	78,832	79,712
FL826NB11	59	59	61	20,737	20,289	23,465
FL826NB12	59	59	61	17,570	19,044	23,697
FL826NB13	59	60	61	11,208	14,339	16,200
FL826NB14	59	61	61	8,372	11,779	12,006
FL826NB15	59	61	62	4,874	8,348	9,524
FL826SB01	59	61	61	25,776	28,870	29,312
FL826SB02	59	61	62	52,947	58,907	63,292
FL826SB03	59	59	61	34,553	35,450	41,227
FL826SB04	59	61	62	8,693	18,701	21,226
FL826SB05	59	62	63	418	2,457	3,017
FL826SB06	59	62	63	1,898	8,687	11,961
FL826SB07	59	60	61	4,027	5,773	6,810
FL826SB08	59	62	62	4,500	13,480	12,973
FL826SB09	59	62	62	8,296	16,411	16,515
FL826SB10	59	62	63	21,250	30,534	34,129
FL826SB11	59	61	61	65,926	71,884	73,640
FL826SB12	59	60	61	168,723	173,735	176,720
FL826SB13	59	61	61	27,089	27,954	28,176
FL826SB14	59	59	60	194,964	196,506	199,599
FL826SB15	59	57	58	109,711	100,581	103,804
Subtotal				**1,136,835**	**1,243,969**	**1,301,874**
US27NB1	22	36	32	0	32,690	25,985
US27NB2	22	37	33	89	35,380	33,019
US27NB3	31	40	36	163	10,988	9,846
US27NB4	31	42	41	0	3,354	2,113
US27SB1	31	42	39	147	7,152	4,697
US27SB2	31	41	37	1,864	21,284	18,276
US27SB3	22	37	35	83	40,941	36,122
US27SB4	22	36	31	0	46,433	24,354
				2,346	**198,223**	**154,412**
Grand Total				**1,139,181**	**1,442,192**	**1,456,286**

Exhibit B-3. Comparison of Total Delay Values

SEQ_ID	FDOT_Delay	HCM_Delay	TTI_Delay	FDOT-HCM	FDOT-TTI	HCM-TTI
FL826NB01	81,721	69,474	76,445	15%	6%	-10%
FL826NB02	20,916	23,185	24,910	-11%	-19%	-7%
FL826NB03	1,914	2,328	2,414	-22%	-26%	-4%
FL826NB04	18,209	27,822	29,385	-53%	-61%	-6%
FL826NB05	15,468	21,196	23,186	-37%	-50%	-9%
FL826NB06	39,470	47,464	48,357	-20%	-23%	-2%
FL826NB07	35,252	39,806	39,986	-13%	-13%	0%
FL826NB08	40,006	45,241	44,580	-13%	-11%	1%
FL826NB09	22,615	24,892	25,607	-10%	-13%	-3%
FL826NB10	69,731	78,832	79,712	-13%	-14%	-1%
FL826NB11	20,737	20,289	23,465	2%	-13%	-16%
FL826NB12	17,570	19,044	23,697	-8%	-35%	-24%
FL826NB13	11,208	14,339	16,200	-28%	-45%	-13%
FL826NB14	8,372	11,779	12,006	-41%	-43%	-2%
FL826NB15	4,874	8,348	9,524	-71%	-95%	-14%
FL826SB01	25,776	28,870	29,312	-12%	-14%	-2%
FL826SB02	52,947	58,907	63,292	-11%	-20%	-7%
FL826SB03	34,553	35,450	41,227	-3%	-19%	-16%
FL826SB04	8,693	18,701	21,226	-115%	-144%	-14%
FL826SB05	418	2,457	3,017	-489%	-622%	-23%
FL826SB06	1,898	8,687	11,961	-358%	-530%	-38%
FL826SB07	4,027	5,773	6,810	-43%	-69%	-18%
FL826SB08	4,500	13,480	12,973	-200%	-188%	4%
FL826SB09	8,296	16,411	16,515	-98%	-99%	-1%
FL826SB10	21,250	30,534	34,129	-44%	-61%	-12%
FL826SB11	65,926	71,884	73,640	-9%	-12%	-2%
FL826SB12	168,723	173,735	176,720	-3%	-5%	-2%
FL826SB13	27,089	27,954	28,176	-3%	-4%	-1%
FL826SB14	194,964	196,506	199,599	-1%	-2%	-2%
FL826SB15	109,711	100,581	103,804	8%	5%	-3%
Subtotal	**1,136,835**	**1,243,969**	**1,301,874**	**-9%**	**-15%**	**-5%**
US27NB1	0	32,690	25,985	n.a.	n.a.	21%
US27NB2	89	35,380	33,019	-39684%	-37030%	7%
US27NB3	163	10,988	9,846	-6626%	-5927%	10%
US27NB4	0	3,354	2,113	n.a.	n.a.	37%
US27SB1	147	7,152	4,697	-4777%	-3103%	34%
US27SB2	1,864	21,284	18,276	-1042%	-881%	14%
US27SB3	83	40,941	36,122	-49216%	-43411%	12%
US27SB4	0	46,433	24,354	n.a.	n.a.	48%
	2,346	**198,223**	**154,412**	**-8351%**	**-6483%**	**22%**
Grand Total	**1,139,181**	**1,442,192**	**1,456,286**	**-27%**	**-28%**	**-1%**

Exhibit B-4. Comparison of Travel Time Index Values (Combined Peak Hour: 8a-9a, 5p-6p)

SEQ_ID	FDOT Index	HCM Index	TTI Index	FDOT-HCM	FDOT-TTI	HCM-TTI
FL826NB01	1.42	1.34	1.38	6%	3%	-3%
FL826NB02	1.15	1.14	1.15	1%	0%	-1%
FL826NB03	1.13	1.13	1.13	0%	0%	0%
FL826NB04	1.23	1.26	1.27	-2%	-3%	-1%
FL826NB05	1.40	1.44	1.46	-3%	-4%	-1%
FL826NB06	1.64	1.68	1.69	-2%	-3%	0%
FL826NB07	1.72	1.74	1.74	-1%	-2%	0%
FL826NB08	1.67	1.70	1.70	-2%	-1%	0%
FL826NB09	1.75	1.77	1.78	-1%	-2%	-1%
FL826NB10	1.77	1.81	1.82	-2%	-3%	0%
FL826NB11	1.52	1.49	1.54	2%	-2%	-3%
FL826NB12	1.17	1.16	1.19	1%	-1%	-2%
FL826NB13	1.15	1.15	1.16	0%	-2%	-1%
FL826NB14	1.13	1.15	1.15	-1%	-2%	0%
FL826NB15	1.09	1.11	1.12	-2%	-3%	-1%
FL826SB01	1.74	1.76	1.77	-1%	-2%	0%
FL826SB02	1.65	1.67	1.71	-1%	-3%	-2%
FL826SB03	1.35	1.33	1.37	1%	-2%	-3%
FL826SB04	1.08	1.10	1.11	-2%	-3%	-1%
FL826SB05	1.03	1.07	1.08	-4%	-5%	-1%
FL826SB06	1.04	1.07	1.08	-3%	-5%	-1%
FL826SB07	1.12	1.12	1.14	0%	-2%	-1%
FL826SB08	1.07	1.11	1.11	-3%	-3%	0%
FL826SB09	1.14	1.18	1.18	-3%	-3%	0%
FL826SB10	1.34	1.39	1.41	-3%	-5%	-2%
FL826SB11	2.03	2.04	2.06	-1%	-2%	-1%
FL826SB12	2.79	2.80	2.83	0%	-2%	-1%
FL826SB13	2.66	2.69	2.71	-1%	-2%	-1%
FL826SB14	2.16	2.14	2.16	1%	0%	-1%
FL826SB15	1.44	1.38	1.39	4%	3%	-1%
US27NB1	1.50	1.34	1.27	11%	15%	5%
US27NB2	1.62	1.49	1.46	8%	10%	2%
US27NB3	1.55	1.23	1.21	21%	22%	2%
US27NB4	1.33	1.12	1.09	15%	18%	3%
US27SB1	1.46	1.23	1.17	16%	20%	5%
US27SB2	1.68	1.39	1.34	17%	20%	3%
US27SB3	1.49	1.39	1.34	7%	10%	3%
US27SB4	1.53	1.38	1.26	10%	18%	8%

3. RANKING SECTIONS WITH DELAY AND TRAVEL TIME INDEX VALUES (RELATIVE COMPARISON)

Summary of delay ranking differences:

For SR 826 (uninterrupted flow), all three methods provided very similar ranking results, with TTI and HCM both ranking 16 of the top 18 sections the exact same as FDOT.

- The rankings among the 12 lowest-ranked sections differed more than the top 18 highest rankings; however, most rankings were still within several ranking positions of the other methods.

For US 27 (interrupted flow), HCM and TTI rankings are very similar to each other, but very different from FDOT rankings.

- The reason for the HCM and TTI differences with FDOT is because of the FDOT use of LOS B threshold speeds (i.e., delays are much lower, if any).

Summary of travel time index differences:

For SR 826 (uninterrupted flow), all three methods provided very similar ranking results (same scenario as when using delay per mile values).

- TTI and HCM both ranked 8 of the top 10 sections the exact same as FDOT.
- For all 30 freeway sections, the HCM and TTI rank orders were within 3 positions of the FDOT rank order.

For US 27 (interrupted flow), HCM and TTI rankings are more similar to each other than to the FDOT rankings.

- Rankings with the travel time index are more comparable than with delay per mile values, primarily because all three measures use a free-flow or uncongested speed.

Exhibit B-5. Comparison of SR 826 Section Rankings Based on Delay per Mile Values

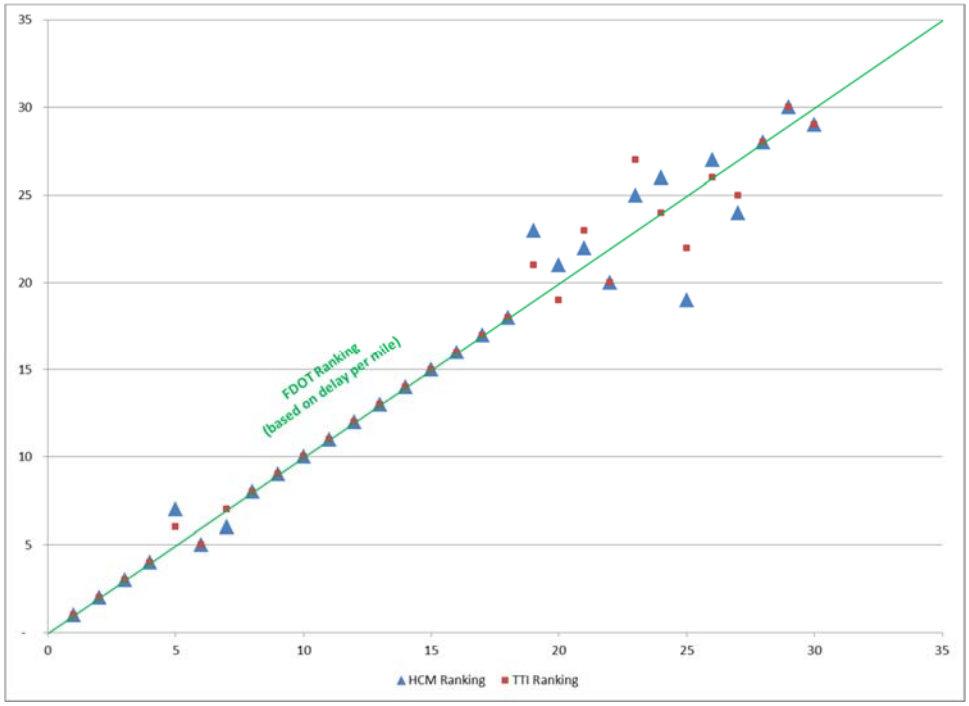


Exhibit B-6. Comparison of SR 826 Section Rankings Based on Travel Time Index Values

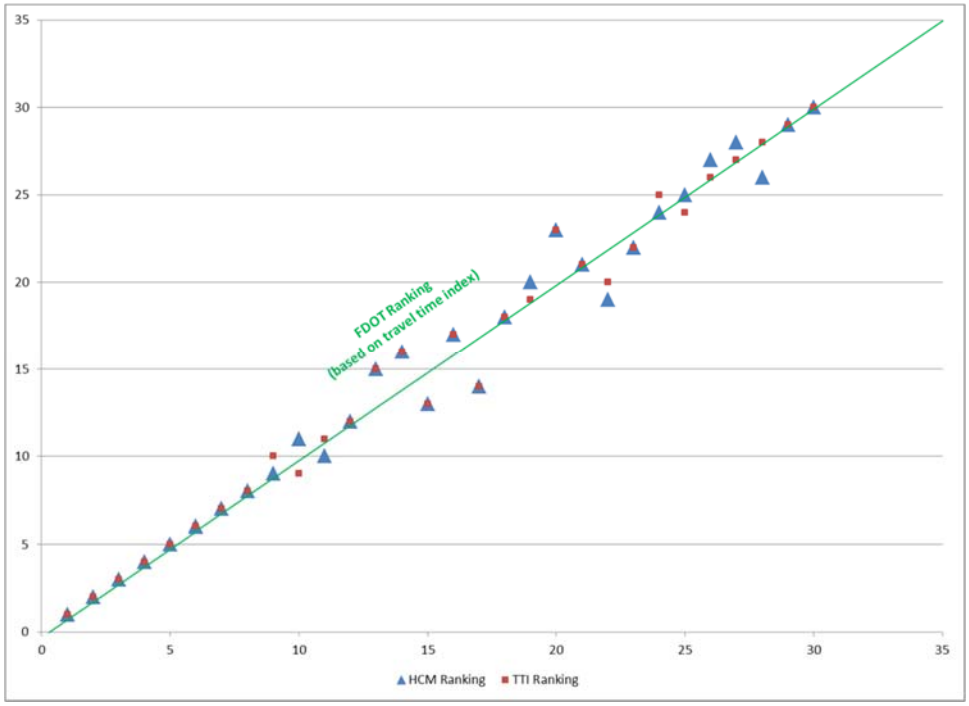


Exhibit B-7. Comparison of US 27 Section Rankings Based on Delay per Mile Values

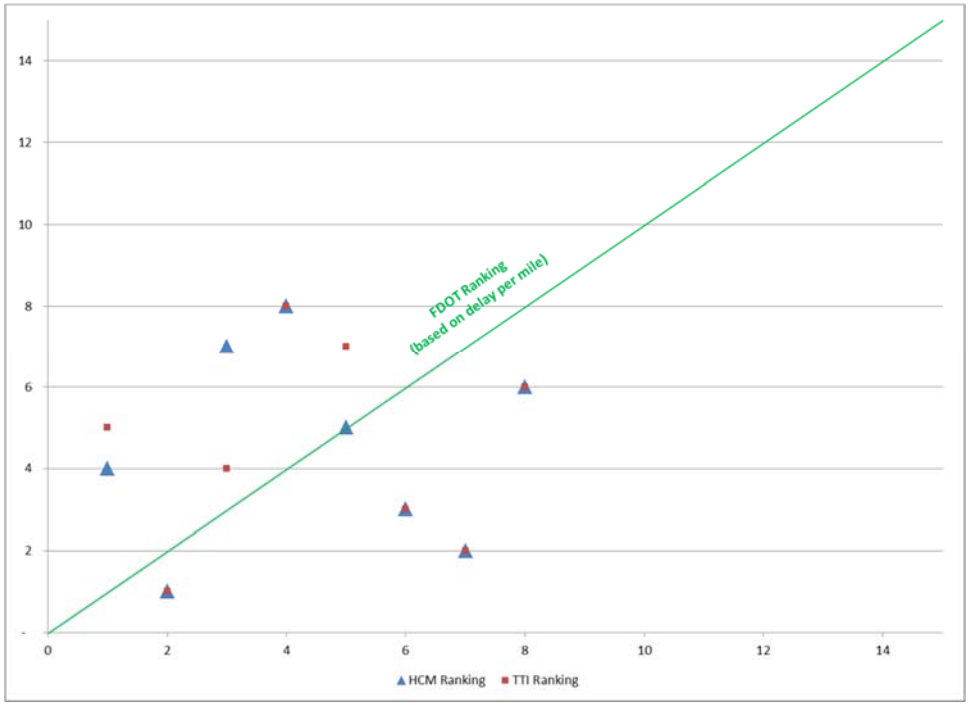


Exhibit B-8. Comparison of US 27 Section Rankings Based on Travel Time Index Values

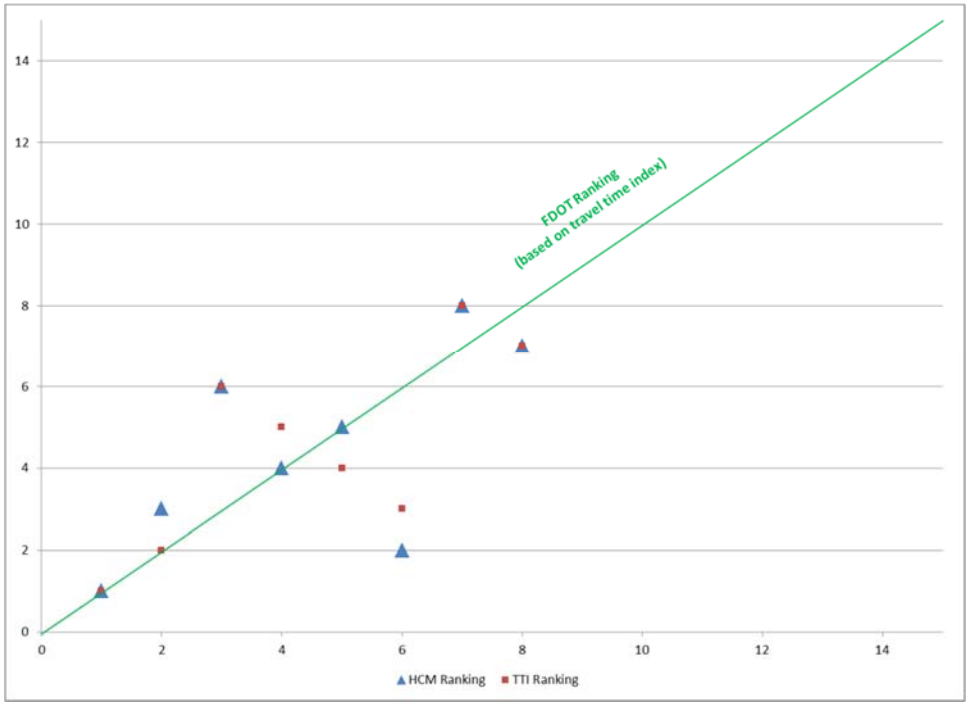


Exhibit B-9. Comparison of All Section Rankings Based on Delay per Mile Values

SEQ_ID	FDOT DelayPerMile	HCM DelayPerMile	TTI DelayPerMile	FDOT Rank	HCM Rank	TTI Rank
FL826SB13	303,786	313,488	315,976	1	1	1
FL826SB14	273,874	276,040	280,384	2	2	2
FL826SB12	257,074	264,710	269,258	3	3	3
FL826SB15	133,077	122,004	125,913	4	4	4
FL826NB01	119,806	101,852	112,071	5	7	6
FL826SB11	102,663	111,941	114,676	6	5	5
FL826NB10	94,395	106,714	107,906	7	6	7
FL826NB09	92,512	101,826	104,752	8	8	8
FL826SB02	86,232	95,938	103,080	9	9	9
FL826NB07	83,883	94,720	95,147	10	10	10
FL826NB08	81,514	92,181	90,836	11	11	11
FL826SB01	75,736	84,827	86,125	12	12	12
FL826NB06	70,224	84,447	86,036	13	13	13
FL826NB11	66,945	65,496	75,750	14	14	14
FL826SB03	62,150	63,763	74,153	15	15	15
FL826SB10	38,303	55,038	61,518	16	16	16
FL826NB05	34,212	46,880	51,282	17	17	17
FL826NB02	30,723	34,055	36,590	18	18	18
FL826NB12	25,609	27,757	34,539	19	23	21
FL826NB13	25,096	32,108	36,274	20	21	19
FL826NB14	21,850	30,741	31,334	21	22	23
FL826NB04	21,488	32,832	34,677	22	20	20
FL826NB03	21,271	25,869	26,825	23	25	27
FL826SB07	17,910	25,678	30,289	24	26	24
FL826SB09	17,130	33,884	34,100	25	19	22
FL826NB15	14,421	24,700	28,180	26	27	26
FL826SB04	12,175	26,190	29,726	27	24	25
FL826SB08	7,703	23,074	22,204	28	28	28
FL826SB06	2,978	13,631	18,768	29	30	30
FL826SB05	2,728	16,056	19,710	30	29	29
US27NB4	-	8,924	5,621	2	1	1
US27SB1	410	19,999	13,135	7	2	2
US27NB3	316	21,264	19,053	6	3	3
US27NB1	-	27,344	21,736	1	4	5
US27NB2	86	34,309	32,020	5	5	7
US27SB2	3,084	35,227	30,248	8	6	6
US27SB4	-	37,739	19,794	3	7	4
US27SB3	81	39,699	35,026	4	8	8

Yellow highlight indicates that rank orders were within 3 positions of FDOT rank. Red highlight indicates that rank order were greater than 3 positions different than FDOT rank.

Exhibit B-10. Comparison of All Section Rankings Based on Delay per Mile Values

SEQ_ID	FDOT TT Index	HCM TT Index	TTI TT Index	FDOT Rank	HCM Rank	TTI Rank
FL826SB12	2.79	2.80	2.83	1	1	1
FL826SB13	2.66	2.69	2.71	2	2	2
FL826SB14	2.16	2.14	2.16	3	3	3
FL826SB11	2.03	2.04	2.06	4	4	4
FL826NB10	1.77	1.81	1.82	5	5	5
FL826NB09	1.75	1.77	1.78	6	6	6
FL826SB01	1.74	1.76	1.77	7	7	7
FL826NB07	1.72	1.74	1.74	8	8	8
FL826NB08	1.67	1.70	1.70	9	9	10
FL826SB02	1.65	1.67	1.71	10	11	9
FL826NB06	1.64	1.68	1.69	11	10	11
FL826NB11	1.52	1.49	1.54	12	12	12
FL826SB15	1.44	1.38	1.39	13	15	15
FL826NB01	1.42	1.34	1.38	14	16	16
FL826NB05	1.40	1.44	1.46	15	13	13
FL826SB03	1.35	1.33	1.37	16	17	17
FL826SB10	1.34	1.39	1.41	17	14	14
FL826NB04	1.23	1.26	1.27	18	18	18
FL826NB12	1.17	1.16	1.19	19	20	19
FL826NB02	1.15	1.14	1.15	20	23	23
FL826NB13	1.15	1.15	1.16	21	21	21
FL826SB09	1.14	1.18	1.18	22	19	20
FL826NB14	1.13	1.15	1.15	23	22	22
FL826NB03	1.13	1.13	1.13	24	24	25
FL826SB07	1.12	1.12	1.14	25	25	24
FL826NB15	1.09	1.11	1.12	26	27	26
FL826SB04	1.08	1.10	1.11	27	28	27
FL826SB08	1.07	1.11	1.11	28	26	28
FL826SB06	1.04	1.07	1.08	29	29	29
FL826SB05	1.03	1.07	1.08	30	30	30
US27NB4	1.33	1.12	1.09	1	1	1
US27SB1	1.46	1.23	1.17	2	3	2
US27SB3	1.49	1.39	1.34	3	6	6
US27NB1	1.50	1.34	1.27	4	4	5
US27SB4	1.53	1.38	1.26	5	5	4
US27NB3	1.55	1.23	1.21	6	2	3
US27NB2	1.62	1.49	1.46	7	8	8
US27SB2	1.68	1.39	1.34	8	7	7

Yellow highlight indicates that rank orders were within 3 positions of FDOT rank. Red highlight indicates that rank order were greater than 3 positions different than FDOT rank.

TRACKING TRENDS WITH DELAY AND TRAVEL TIME INDEX VALUES (RELAVTIVE COMPARISON)

Summary of delay differences:

For SR 826 (uninterrupted flow), month-to-month trends consistent at facility level, less consistent at shorter section level (R^2=0.52 for FDOT-HCM and R^2=0.90 for HCM-TTI)

For US 27 (interrupted flow), HCM and TTI more similar (R^2=0.62), but FDOT much different (R^2=0.03)

Summary of travel time index differences:

For SR 826 (uninterrupted flow), very highly correlated, even at shorter section level (R^2=0.99)

For US 27 (interrupted flow), very high correlated, even at shorter section level (R^2=1.00)

Exhibit B-11. Comparison of Month-to-Month Total Delay Values, SR 826

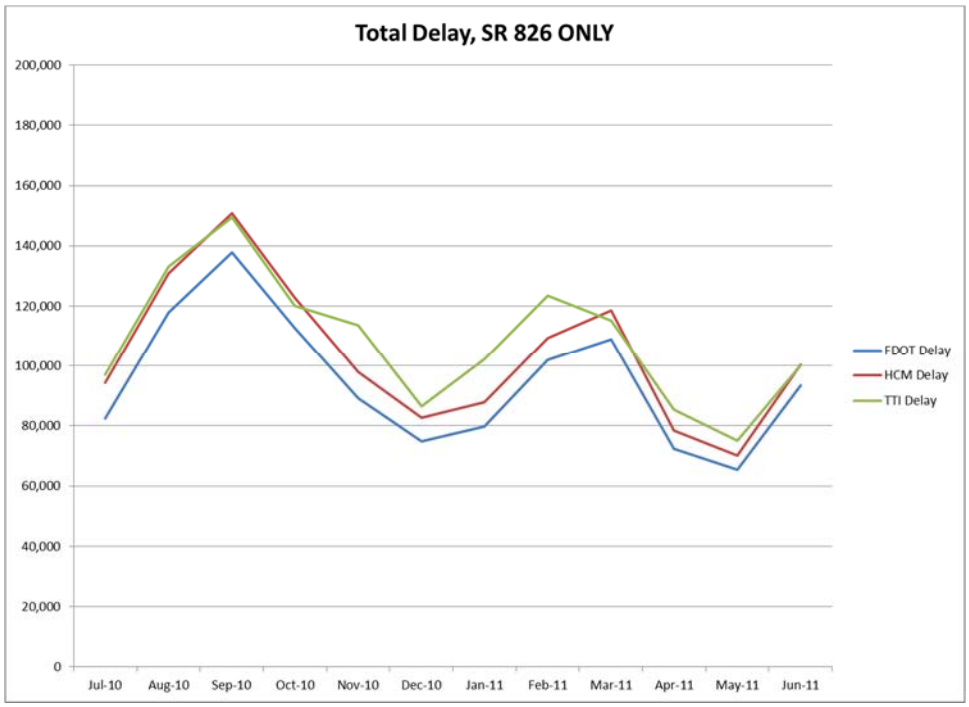


Exhibit B-12. Comparison of Month-to-Month Trends in Total Delay, SR 826

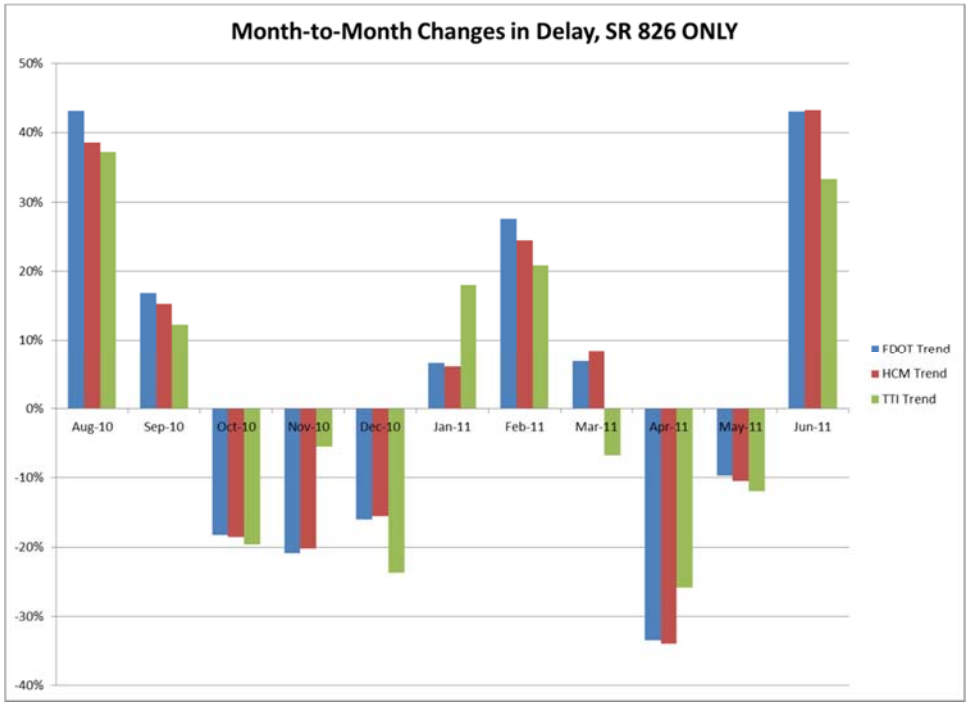


Exhibit B-13. Comparison of Month-to-Month Total Delay Values, US 27

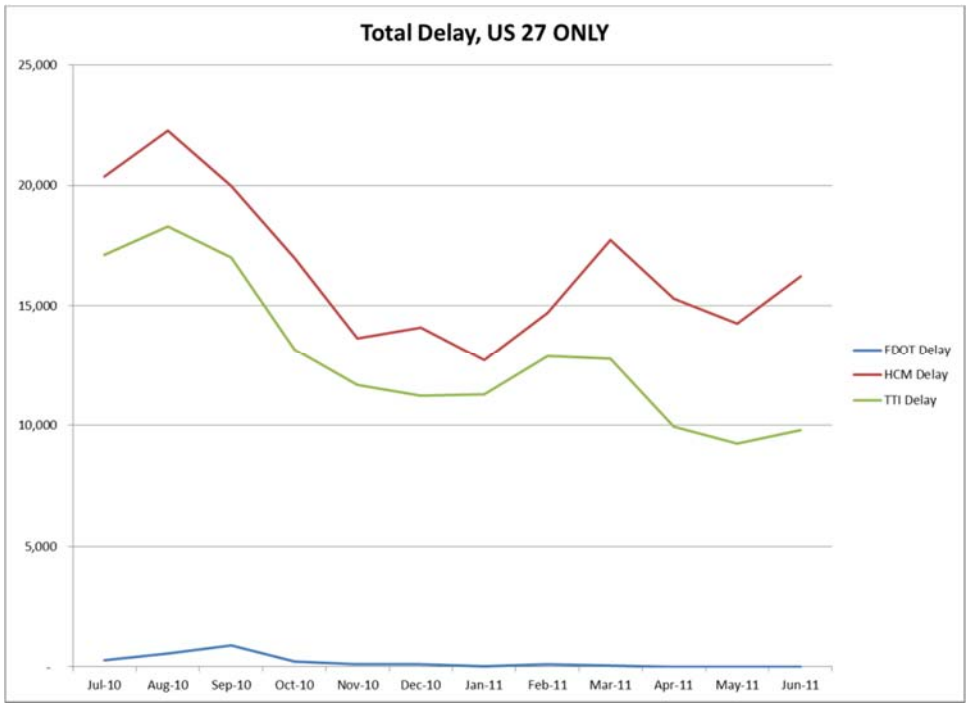


Exhibit B-14. Comparison of Month-to-Month Trends in Total Delay, US 27

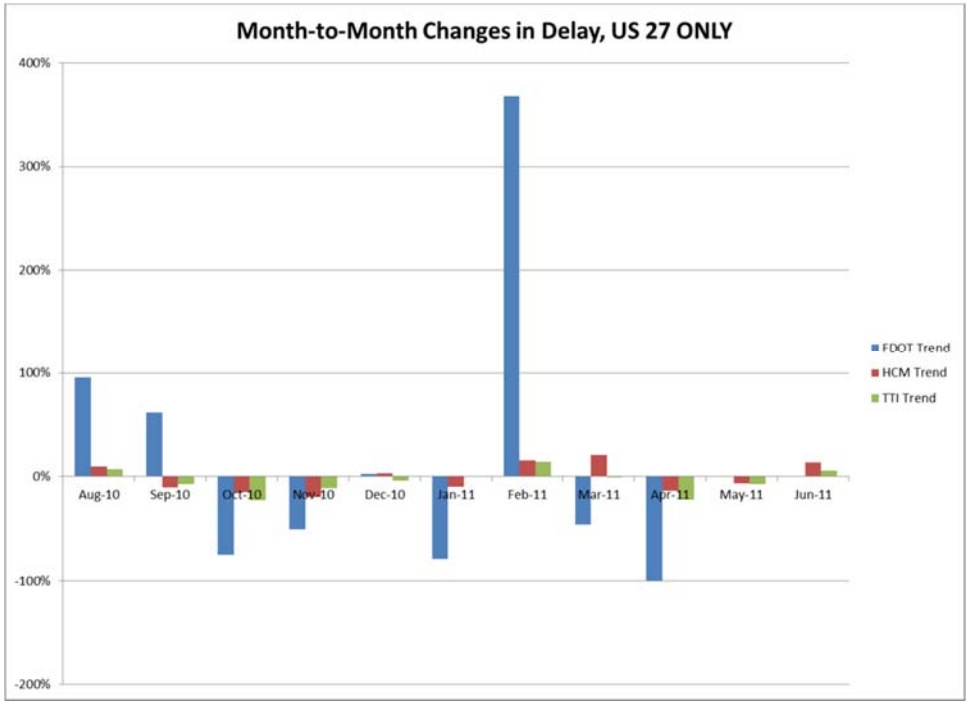


Exhibit B-15. Comparison of Month-to-Month Travel Time Index Values, SR 826

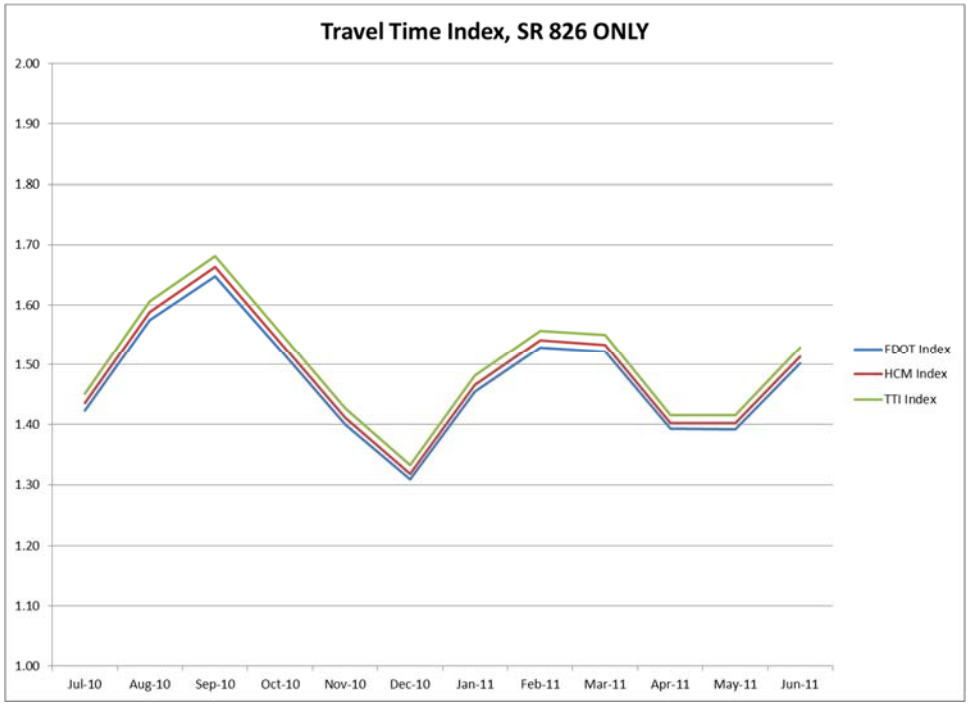


Exhibit B-16. Comparison of Month-to-Month Trends in Travel Time Index, SR 826

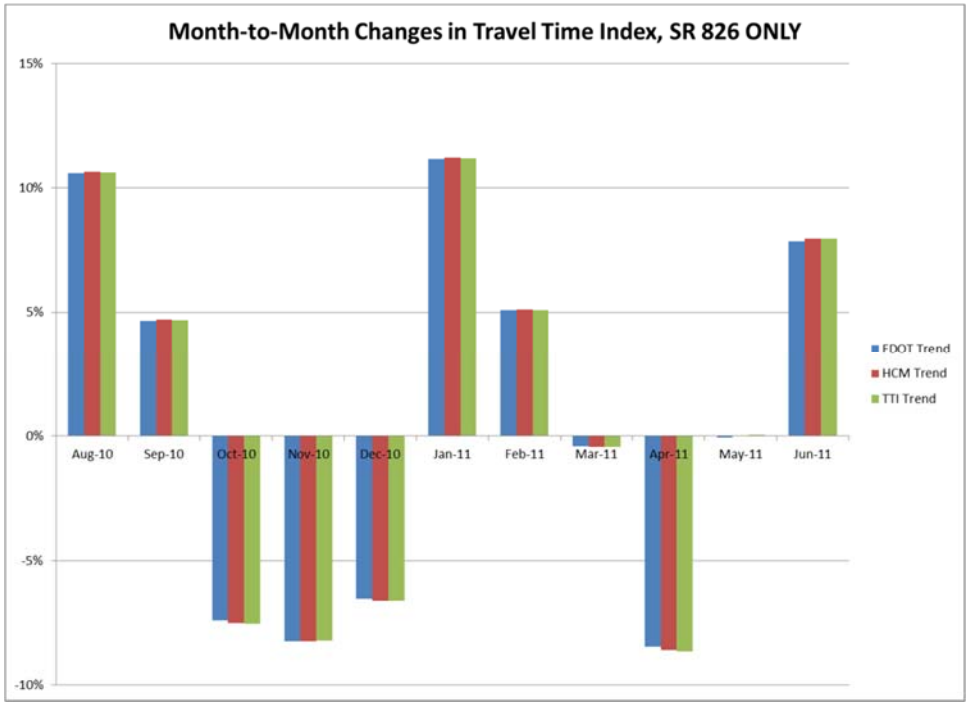


Exhibit B-17. Comparison of Month-to-Month Travel Time Index Values, US 27

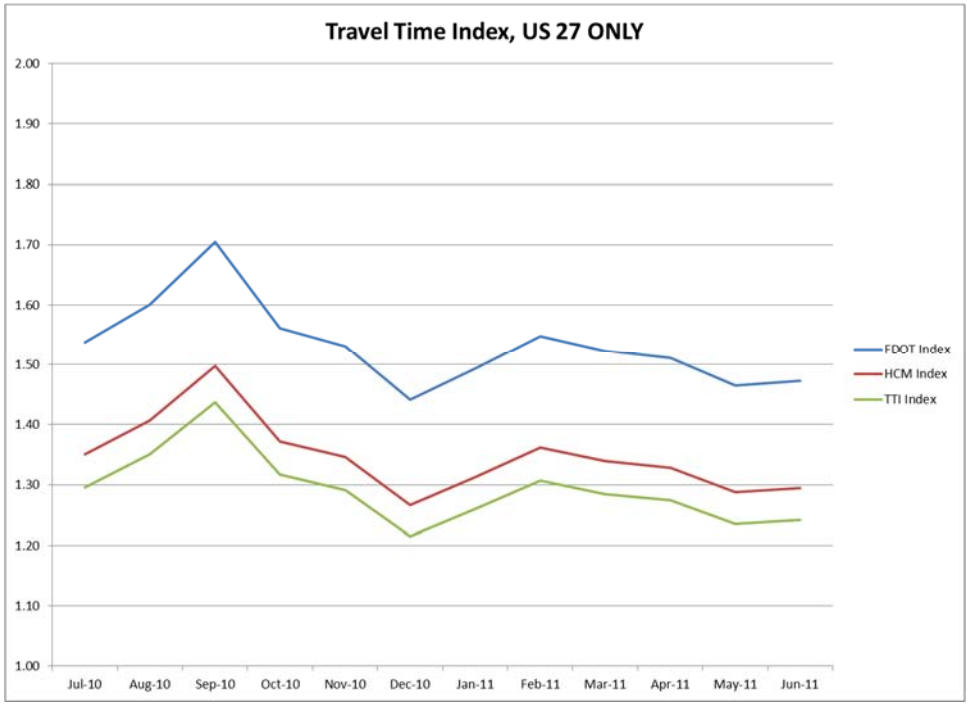


Exhibit B-18. Comparison of Month-to-Month Trends in Travel Time Index, US 27

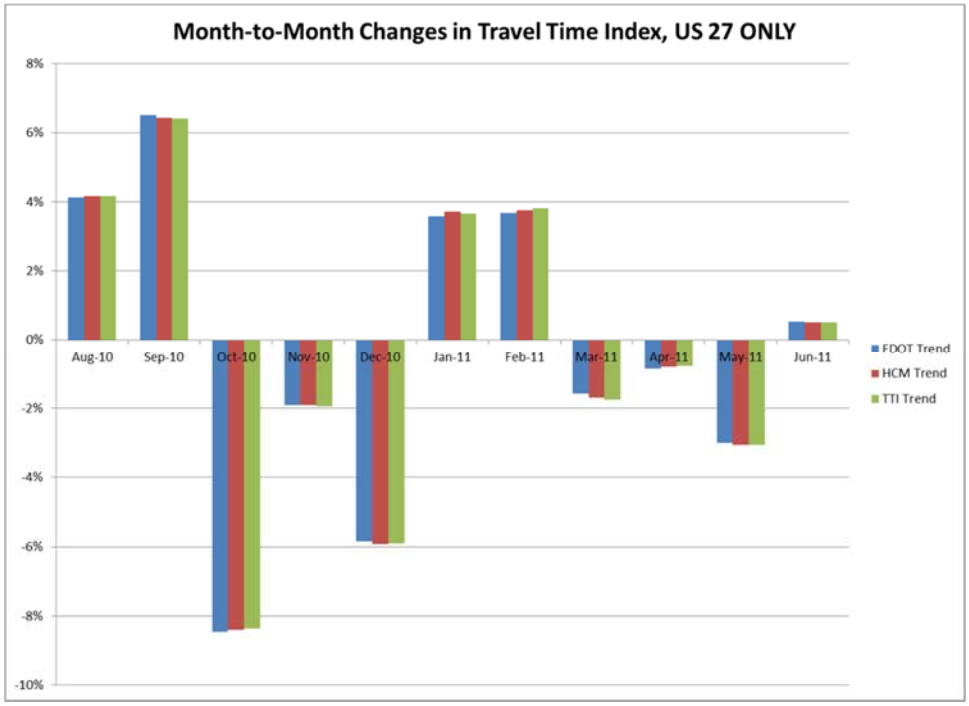


Exhibit B-19. Comparison of FDOT vs. HCM Month-to-Month Delay Trends for Individual Highway Sections, SR 826

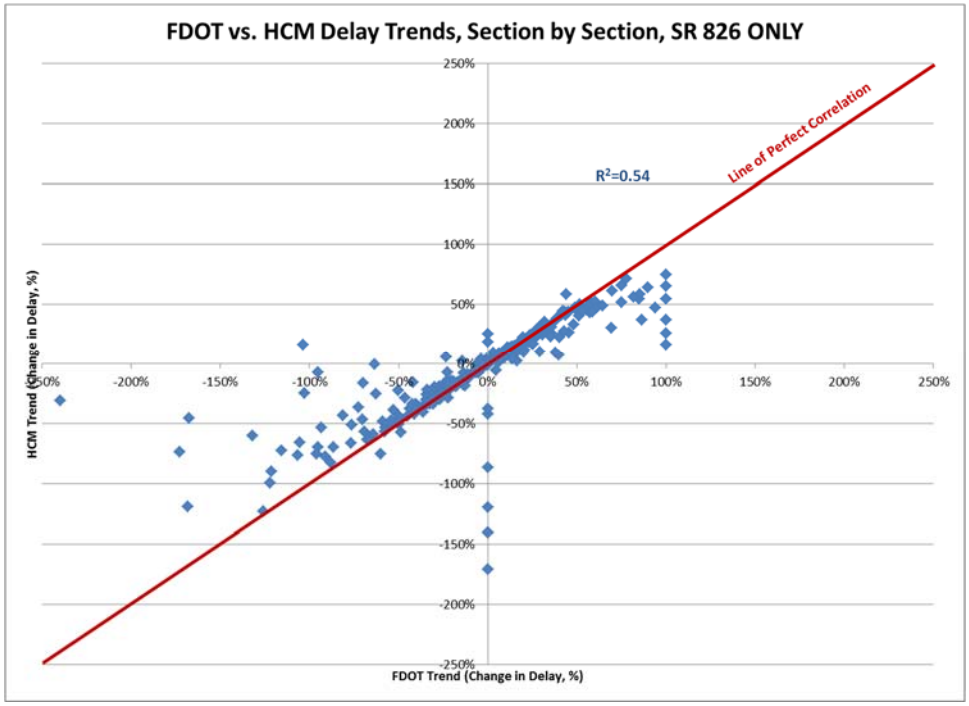


Exhibit B-20. Comparison of FDOT vs. TTI Month-to-Month Delay Trends for Individual Highway Sections, SR 826

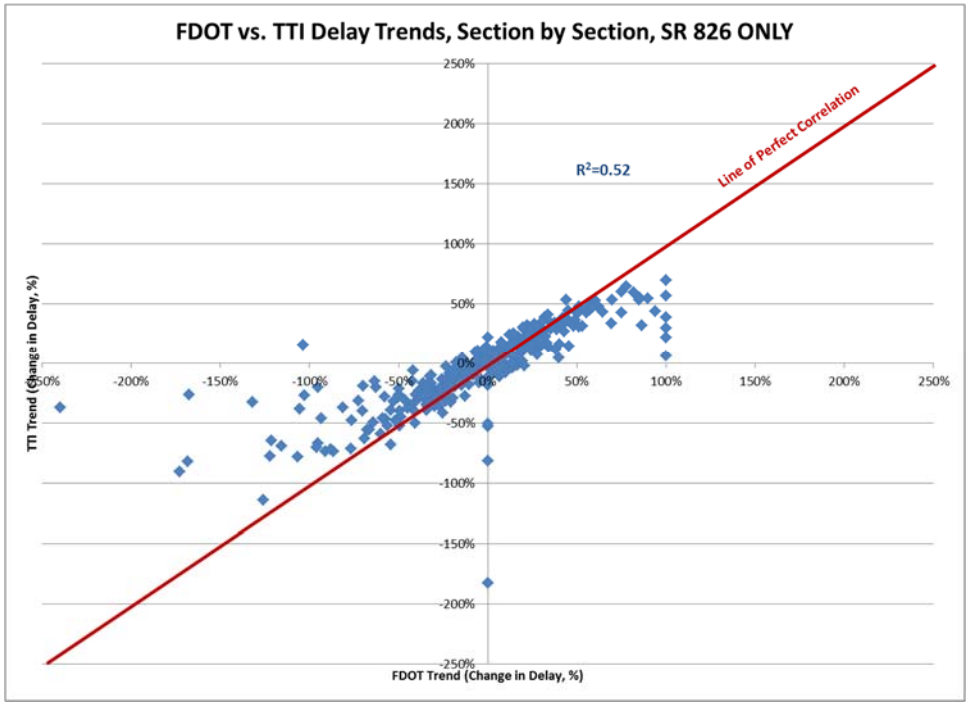


Exhibit B-21. Comparison of HCM vs. TTI Month-to-Month Delay Trends for Individual Highway Sections, SR 826

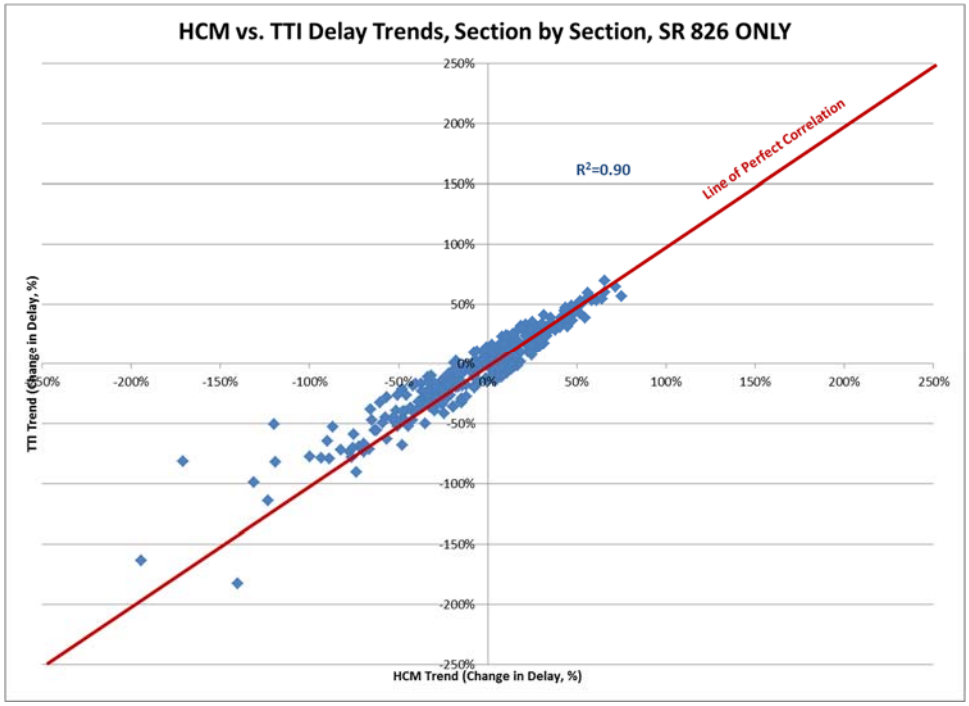


Exhibit B-22. Comparison of FDOT vs. HCM Month-to-Month Delay Trends for Individual Highway Sections, US 27

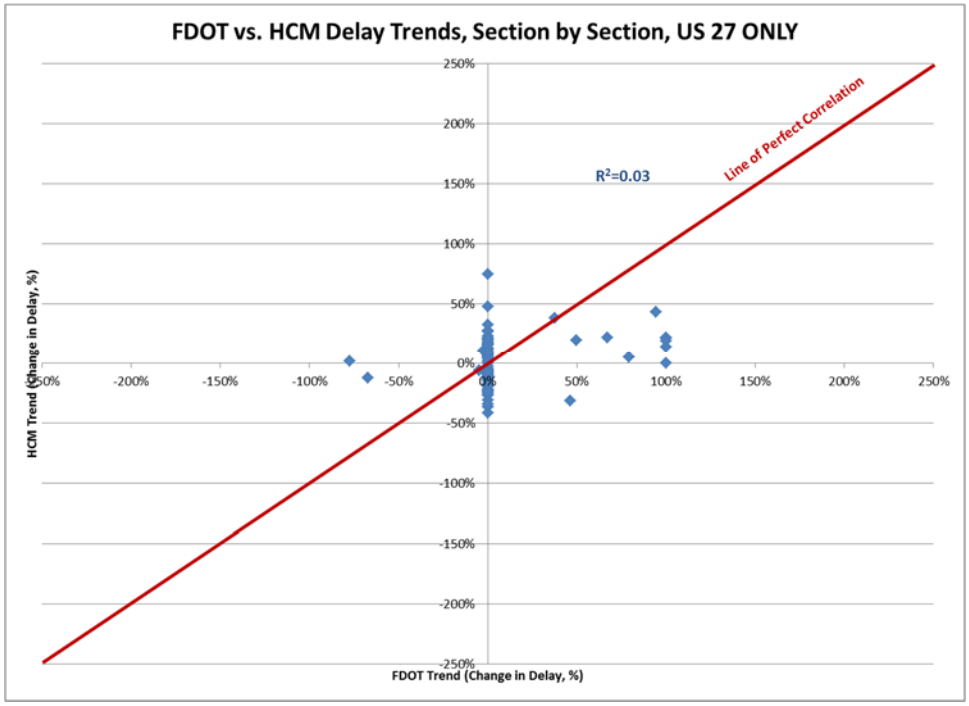


Exhibit B-23. Comparison of FDOT vs. TTI Month-to-Month Delay Trends for Individual Highway Sections, US 27

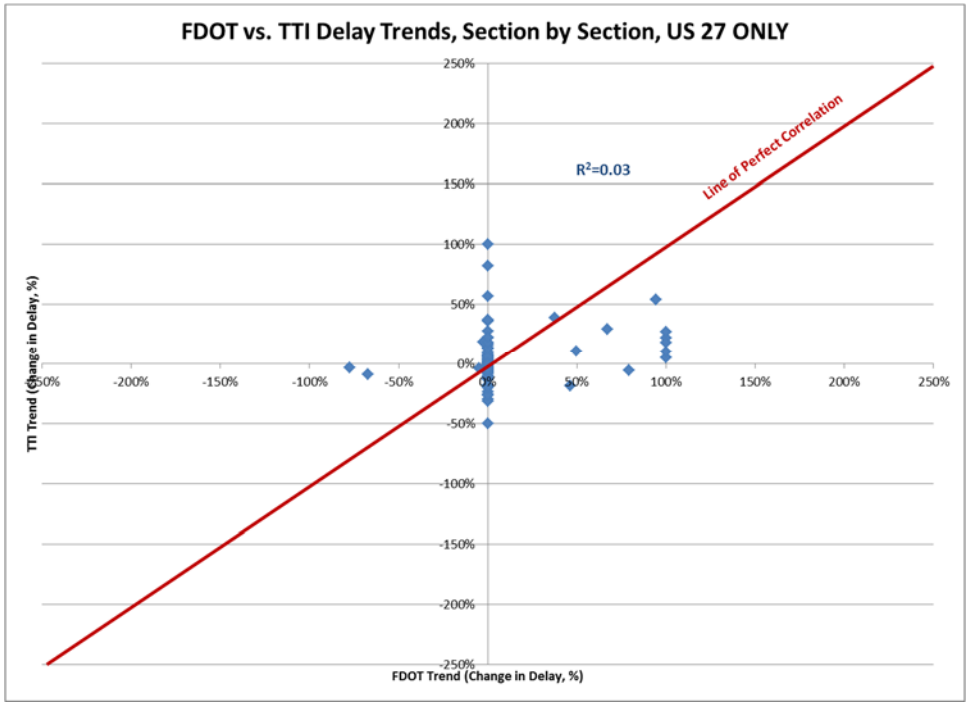


Exhibit B-24. Comparison of HCM vs. TTI Month-to-Month Delay Trends for Individual Highway Sections, US 27

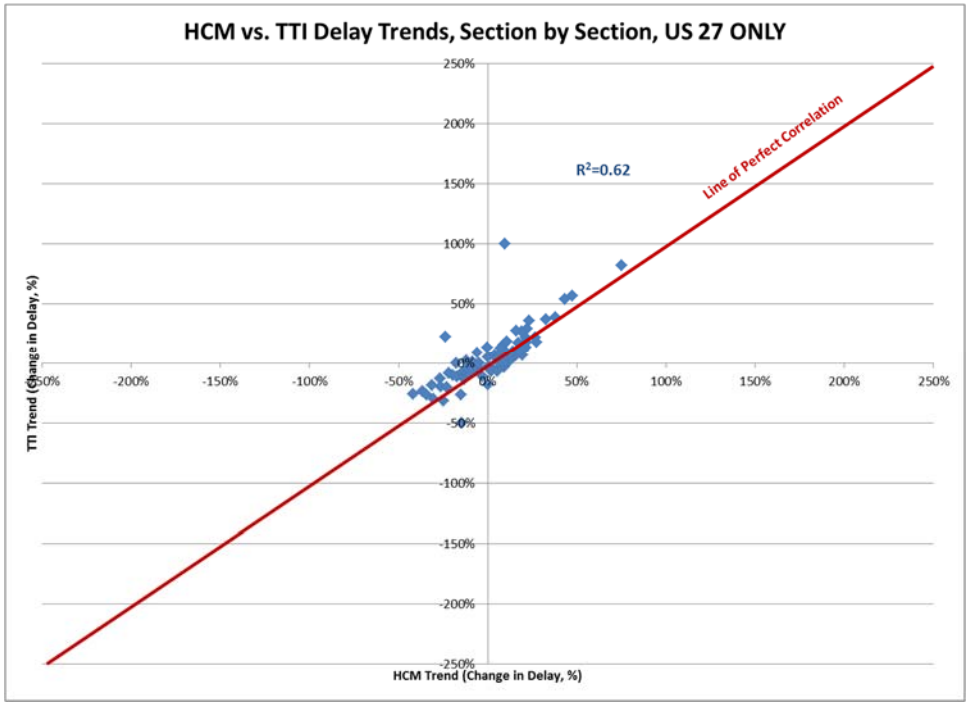


Exhibit B-25. Comparison of FDOT vs. HCM Month-to-Month Travel Time Index Trends for Individual Highway Sections, SR 826

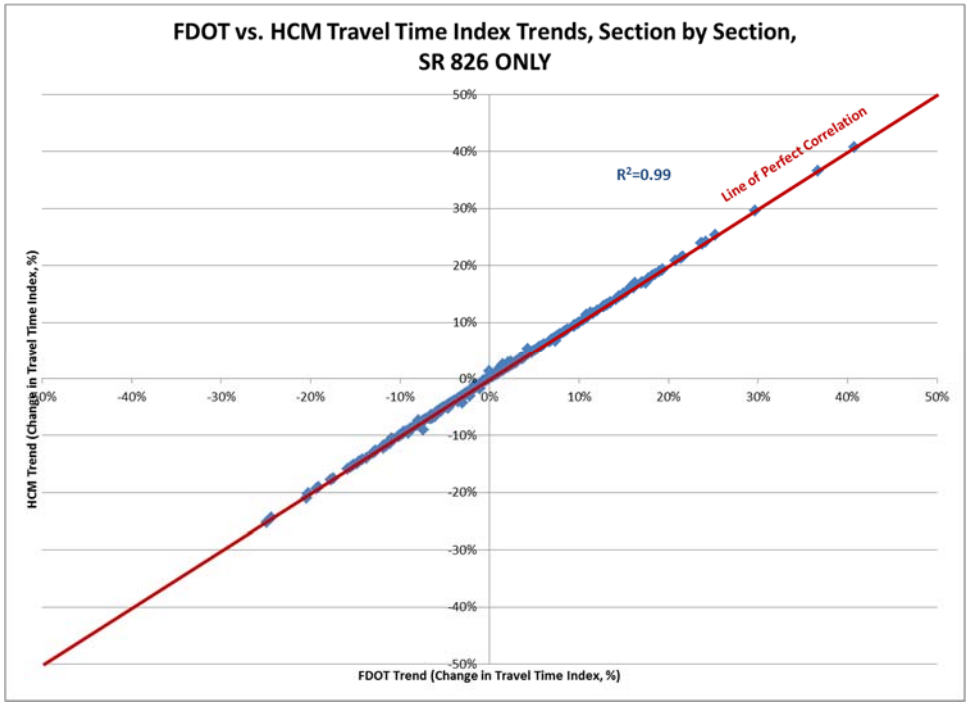


Exhibit B-26. Comparison of FDOT vs. TTI Month-to-Month Travel Time Index Trends for Individual Highway Sections, SR 826

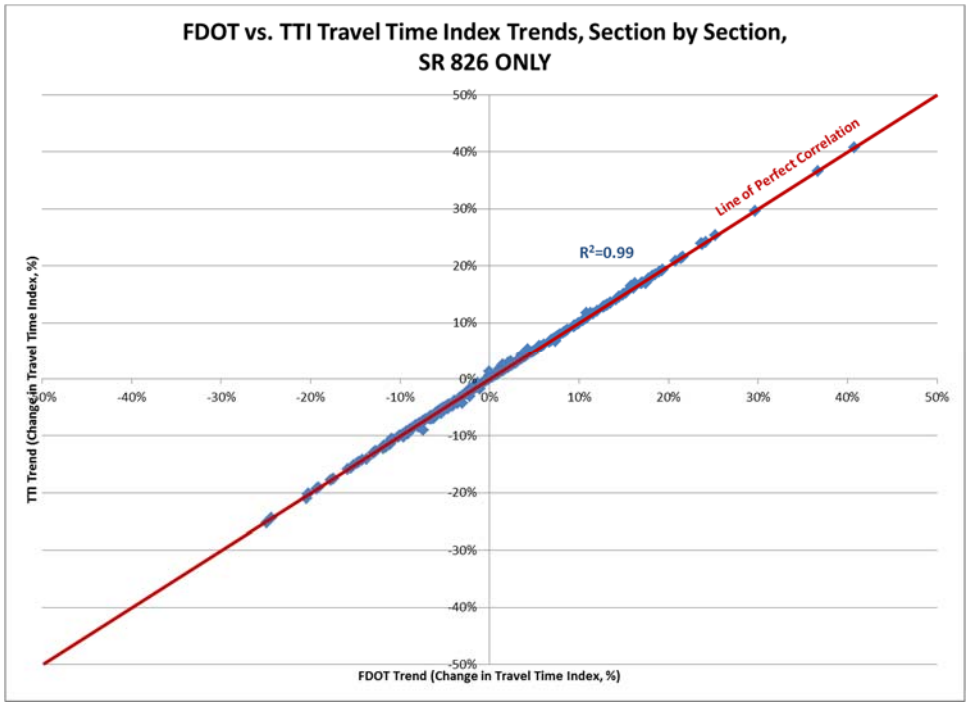


Exhibit B-27. Comparison of HCM vs. TTI Month-to-Month Travel Time Index Trends for Individual Highway Sections, SR 826

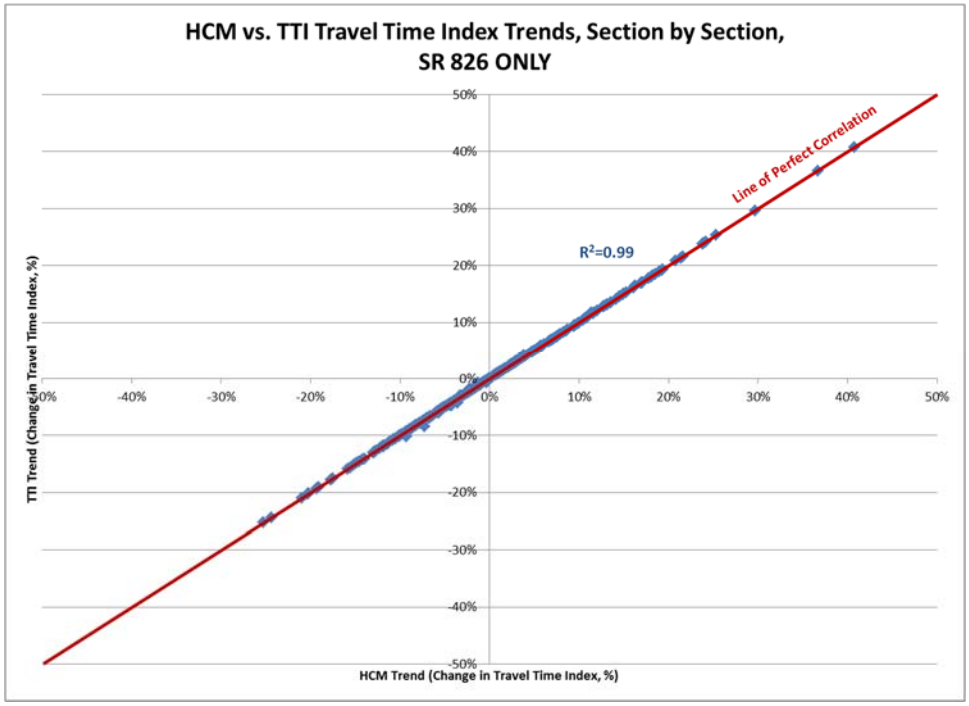


Exhibit B-28. Comparison of FDOT vs. HCM Month-to-Month Travel Time Index Trends for Individual Highway Sections, US 27

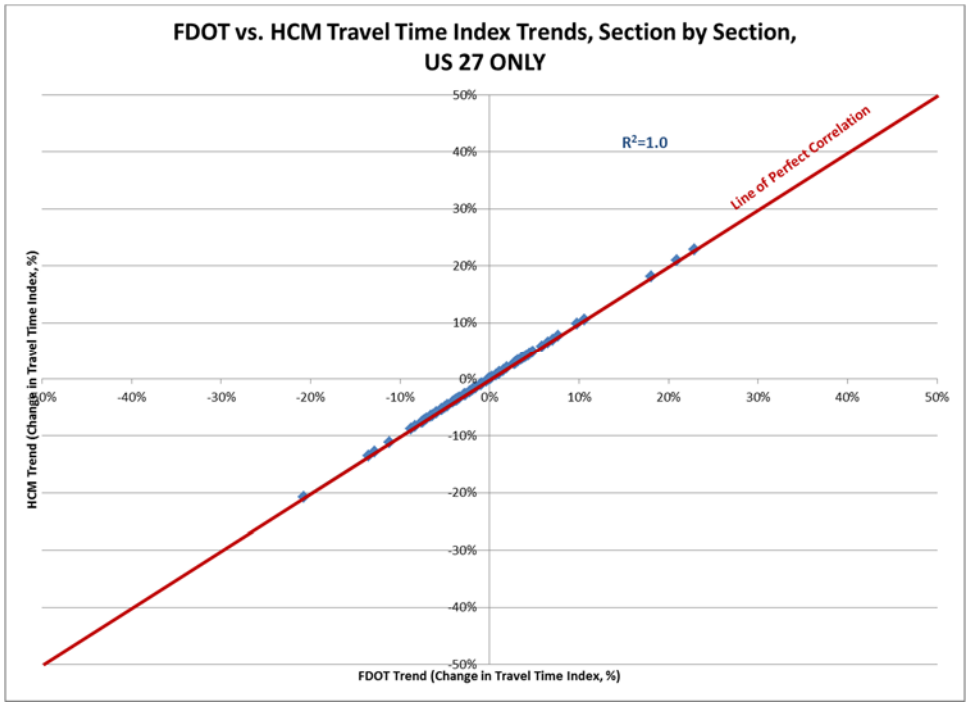


Exhibit B-29. Comparison of FDOT vs. TTI Month-to-Month Travel Time Index Trends for Individual Highway Sections, US 27

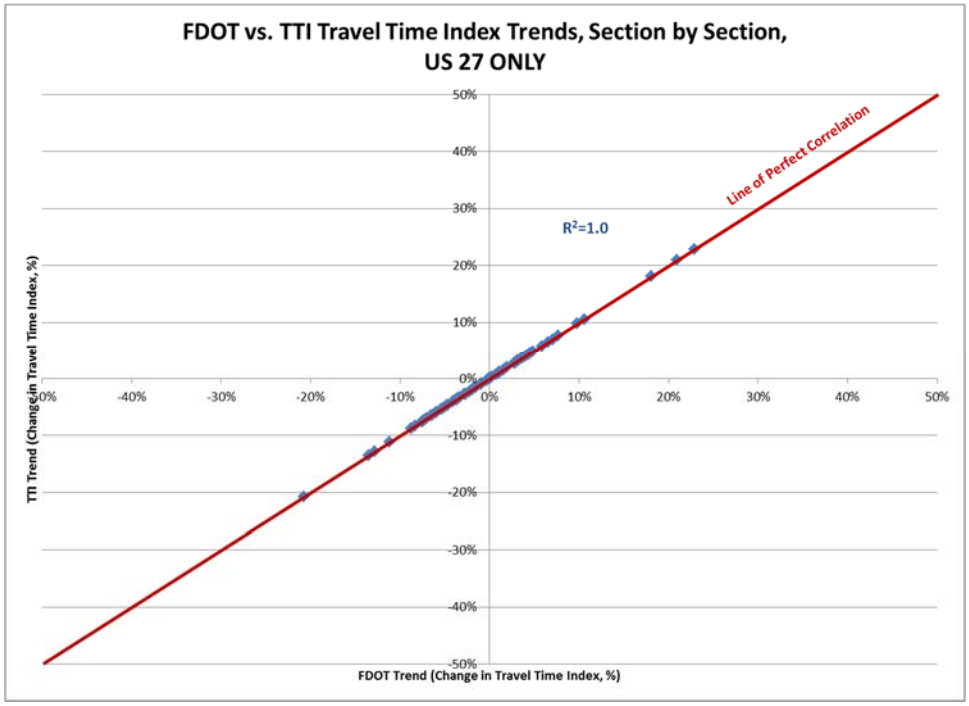


Exhibit B-30. Comparison of HCM vs. TTI Month-to-Month Travel Time Index Trends for Individual Highway Sections, US 27