FINAL

Technical Memorandum #5:

Congestion Management Process (CMP) Update

October 2020

MARTIN MPO
Metropolitan Planning Organization

Martin Metropolitan Planning Organization (MPO)
2045 Long Range Transportation Plan (LRTP)

This technical memorandum was developed based on data and analyses during the time period from December 2019 through May 2020. Subsequently the Martin MPO Policy Board approved the Draft 2045 Cost Feasible Plan – *Martin in Motion* in June 2020*. The Final* 2045 Cost Feasible Plan was adopted by the Martin MPO Policy Board in October 2020.

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1. Introduction

The purpose of Technical Memorandum #5 (TM 5) is to serve as separate standalone Congestion Management Process (CMP) Update document to meet federal requirements but still be integrated into the Martin MPO's 2045 Long Range Transportation Plan's (LRTP) – *Martin in Motion.*

This technical memorandum is organized as described below:

***Chapter 1: Introduction* –** states the purpose of the technical memorandum, summarizes report organization, and provides background and key elements required to complete CMPs.

***Chapter 2: Goals, Objectives, and Performance Measures* –** describes goals and objectives of the CMP Update and their relationship to the overall LRTP goals, LRTP goals, national and state goals.

Chapter 3: Network Analysis – discusses definition of the CMP network, multimodal performance measures, and describes the data and methodology used to identify congested corridors.

Chapter 4: Congestion Mitigation Strategies – discusses potential multimodal strategies appropriate to mitigate congestion that could be incorporated into the Florida Department of Transportation's (FDOT) Transportation Systems Management and Operations (TSM&O) strategies and Martin County Traffic Engineering Division's improvement needs.

Chapter 5: Implementation and Monitoring – discusses funding sources and programmatic recommendations for congested corridors in Martin County. Further, it also discusses monitoring mechanism to evaluate the effectiveness of various mitigation strategies consistent with Fixing America's Surface Transportation (FAST) Act Performance Measure requirements as well as the FDOT's and Martin County's processes.

1.1 Background and Key Elements

The Code of Federal Regulations (CFR Title 23 § 450.322 or federal regulations) requires MPOs serving an urbanized area with a population over 200,000 persons (i.e., a Transportation Management Area or TMA) to manage congestion by developing a process that integrates modes to improve the operation of infrastructure and services that are eligible to receive federal aid. This process must be reflected in the LRTP and Transportation Improvement Program (TIP). Maintenance of a Congestion Management Process (CMP) is a requirement for all MPOs under Florida law. With respect to defining congestion, the federal regulations recognize that congestion is relative and unique to each community. Accordingly, the federal regulations provide MPOs flexibility in determining what is an acceptable level of delay upon which strategies can be developed to meet this level (i.e., to mitigate "excessive delay"). Federal regulations also include an implementation component. This includes creating a schedule for advancing CMP strategies, assigning responsibilities for their advancement, and identifying potential funding sources so that they can be advanced.

A key requirement of CMPs is the monitoring and evaluation of the effectiveness of the strategies identified and implemented as part of it with an assessment of progress provided to decisionmakers and the public at intervals determined by the MPO. Inherent in monitoring and evaluation is the need to establish objectives and related performance measures for identifying if excessive delay is occurring, and this requires associated data. Collection or purchase of data should complement publicly available data sources and be coordinated with operations managers such as the Martin County and Florida Department of Transportation (FDOT) transportation management centers (TMCs). Per the Federal Highway Administration (FHWA)'s *Congestion Management Process: A Guidebook* (2011), the key phases or steps of a CMP[1] can be summarized as shown in **Figure 1-1**.

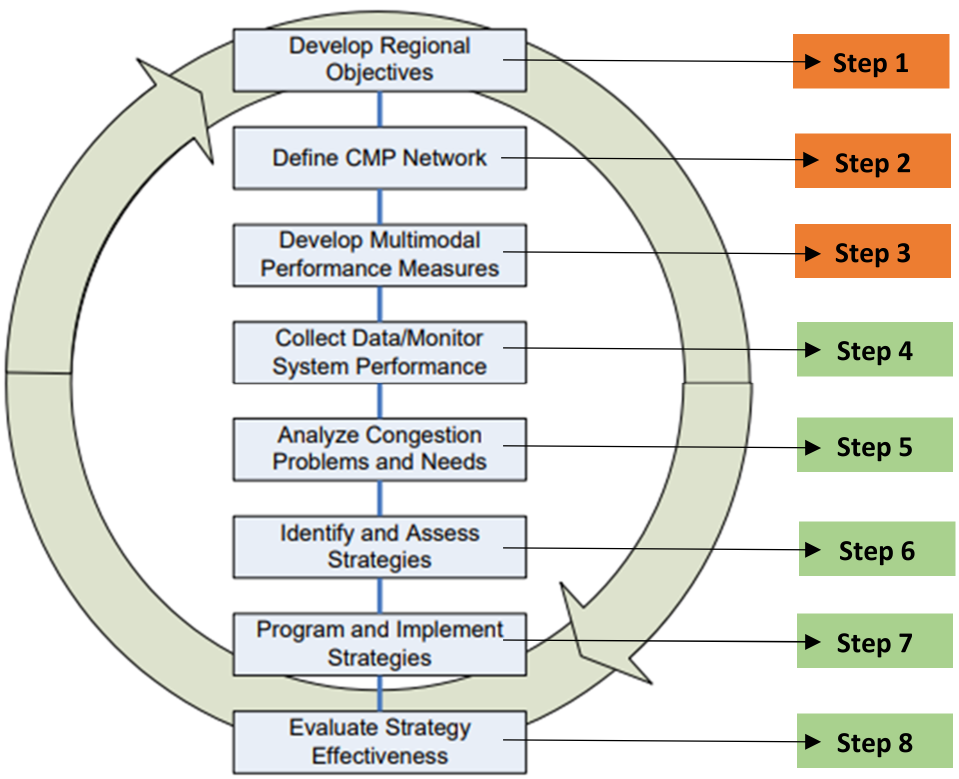


Figure 1-1: Congestion Management Process

The Martin MPO's CMP mirrors FHWA's eight-step process (**Figure 1-1**). Typically, Steps 1 through 3 are preformed as part of the LRTP development process while Steps 3 to 8 occur during implementation phase and are likely updated on a regular basis, either annually or every six months.

[1] A congestion management process (CMP) is a systematic and regionally accepted approach for managing congestion that provides accurate, up-to-date information on transportation system performance and assesses alternative strategies for congestion management that meet State and local needs.

2. Goals and Objectives

This chapter describes goals and objectives of the CMP Update and their relationship to the overall LRTP goals, national and state goals.

2.1 CMP Goals and Objectives

Consistent with federal rules and guidance, the first step in the CMP is the definition of goals and objectives to guide the overall process. To maintain consistency with overall goals of Martin MPO's 2045 LRTP - *Martin in Motion*, the CMP's goals and objectives were selected from the LRTP. While some of the objectives listed below are more applicable than others, it is appropriate for CMP to address each area identified below.

Infrastructure Maintenance and Congestion Management Goal

An efficient multimodal transportation system that supports economic growth and enhances the quality of life.

<u>Objectives:</u>

- Prioritize improvements that maintain or improve acceptable travel performance.
- Support improvements to transit service.
- Manage traffic congestion.
- Support improvements to major freight corridors.
- Implement strategies to reduce per capita vehicle miles of travel.

Safety Goal

A safe multimodal transportation system that meets the needs of all the users.

<u>Objectives:</u>

- Prioritize projects and programs that improve safety on corridors with highest number of crashes involving fatalities and incapacitating injuries for all modes and users.
- Implement strategies to enhance bicycle and pedestrian safety.

Environmental and Equity Goal

Preserve natural environment and promote equity and healthy communities.

<u>Objectives:</u>

- Increase bicycle facility coverage throughout the planning area.
- Increase sidewalk coverage on roadways serving concentrations of population and employment in urban areas.
- Implement strategies that increase the miles of shared used path to support the trail network.
- Prioritize improvements that provide non-motorized access to recreational opportunities.

Project Streamlining and Delivery Goal
A transportation system that reflects the community's needs and desires.

Objectives:
- Advance projects that the community supports.

2.1.1 CMP Goals vs. National and State Goals

National Goals – The current federal surface transportation authorizing legislation Fixing America's Surface Transportation Act (FAST Act) retained the *Moving Ahead for Progress in the 21st Century (MAP-21)* goals stated below.

FAST Act National Goals

- ***Safety*** - *To achieve a significant reduction in traffic fatalities and serious injuries on all public roads.*
- ***Infrastructure Condition*** - *To maintain the highway infrastructure asset system in a state of good repair*
- ***Congestion Reduction*** - *To achieve a significant reduction in congestion on the National Highway System*
- ***System Reliability*** - *To improve the efficiency of the surface transportation system*
- ***Freight Movement and Economic Vitality*** - *To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.*
- ***Environmental Sustainability*** - *To enhance the performance of the transportation system while protecting and enhancing the natural environment.*
- ***Reduced Project Delivery Delays*** - *To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices.*

While it is evident the CMP goals are consistent with national goals, the national goals - *"Congestion Reduction"* and *"System Reliability"* provide an explicit linkage between the two.

State Goals – The FDOT's *2017 Transportation Systems Management and Operations (TSM&O) Strategic Plan* delineates the Department's TSM&O program vision, mission, and goals.

FDOT TSM&O Program Vision, Mission and Goals

Vision: *To increase the delivery rate of fatality-free and congestion-free transportation systems supporting the FDOT vision and Florida Transportation Plan goals.*

Mission: *To identify, prioritize, develop, implement, operate, maintain, and update TSM&O program strategies and measure their effectiveness for improved safety and mobility.*

TSM&O Program Goals

- ***Performance Goals (Goals)*** *- Goals apply to on-going O&M of existing TSM&O systems and strategies.*
- ***Performance Enhancement Goals (PEG)*** *- PEG apply to the O&M of existing systems to the extent the current performance has not yet attained goals and/or to the extent a district desires to improve goals above current levels.*
- ***Project-Performance Enhancement Goals (P-PEG)*** *- P-PEG apply to outcomes for TSM&O strategies and projects planned and funded for implementation.*

To achieve Strategic Plan goals, the FDOT has identified a comprehensive list of actions and strategies in this Plan and list below:

- Ramp signals
- Advanced Traffic Management Systems (ATMS)
- Severe Incident Response Vehicles
- Managed lanes
- Incident management
- Rapid Incident Scene Clearance
- Traveler information
- Arterial management
- Work zone traffic management
- Weather information
- Variable speed limits

Overall, the goals of CMP are consistent with state goals with the key difference being that the TSM&O program goals cover the entire transportation network while the CMP focuses on congested corridors.

3. Network Analysis

This chapter discusses definition of the CMP network, multimodal performance measures, and describes the data and methodology used to identify congested corridors.

3.1 Congestion Management Process (CMP) Network

Defining CMP network establishes a geographic area and identifies transportation network to be considered for analyzing congested travel corridors. The Martin MPO used a tiered approach to define a comprehensive multimodal CMP network. This entailed a review of all highway, transit, bicycle, and pedestrian infrastructure and services to identify subsets based on importance to the overall transportation system. This review included both data driven analysis as well as professional judgment. The latter was particularly important when data was not available and the cost to collect it was prohibitive, such as with collecting bicycle and pedestrian counts for the entire County. Further, professional judgment applies to modes that do not comprise a significant amount of travel and experience a general absence of congestion-related issues based on public comment and observation by the staff of the jurisdiction that owns the infrastructure or provides the service.

3.1.1 Bicycle and Pedestrian Network

In the absence of robust data on the number of pedestrians or bicyclists, the Martin MPO relied on public input and day-to-day observation by agency planners and engineers to identify congestion problems. Given the lack of public comment on crowded sidewalks, bike lanes, or shared-use paths coupled with staff observations, there was sufficient evidence to demonstrate that congestion was not an issue for bicycle and pedestrian modes in the County. Since no congestion was present on bicycle and pedestrian components on the network, it was removed from the CMP network.

3.1.2 Transit Network

Typically, transit network is considered congested when transit vehicles are overcrowded, which is defined as passenger volumes exceeding crush loads. Martin County Public Transit, MARTY, operates five bus routes. These routes comprising the MARTY system include the following two fixed-routes (Routes 1 and 3), one deviated fixed route (Route 2) and two express routes for commuters (Route 20x and 30x during peak hours). Recently, Route 30x service was terminated and a new fixed route bus service (Route 4) became operational. Based on ridership data, it is apparent that the transit network does not experience congestion. Therefore, MARTY's bus routes were removed from the CMP network.

3.1.3 Freight Network

In Martin County, I-95 is included in the Primary Highway Network System (PHNS), which is a critical component of the freight transportation network. In addition, the County's designated SIS facilities that include Florida's Turnpike, State Road 710, and US 98 as well as Atlantic Intracoastal Waterway (AIW) are part of the regionally significant freight network. While Martin County has not designated any local roadways as truck routes, all the major and minor arterials comprise regionally significant freight network.

Through the MPO's Freight and Goods Movement Study, October 2020 proposed the freight network comprising freight corridors[2] and freight supportive corridors[3] were identified (**Figure 3-1**).

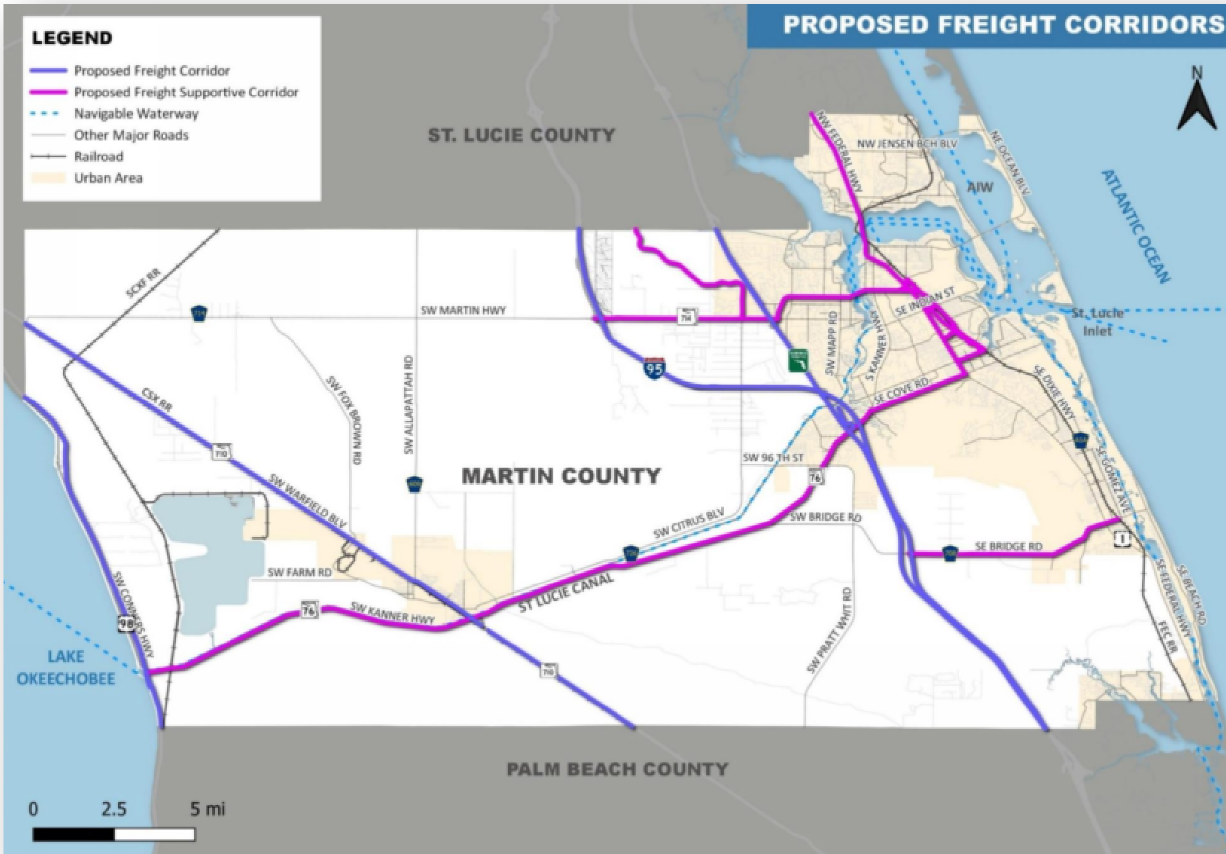


Figure 3-1: Proposed Freight Network

Since all the freight corridors and freight support corridors overlap with the roadway/highway network identified in Section 3.1.4, the proposed freight network for Martin County is considered as the part of the CMP network.

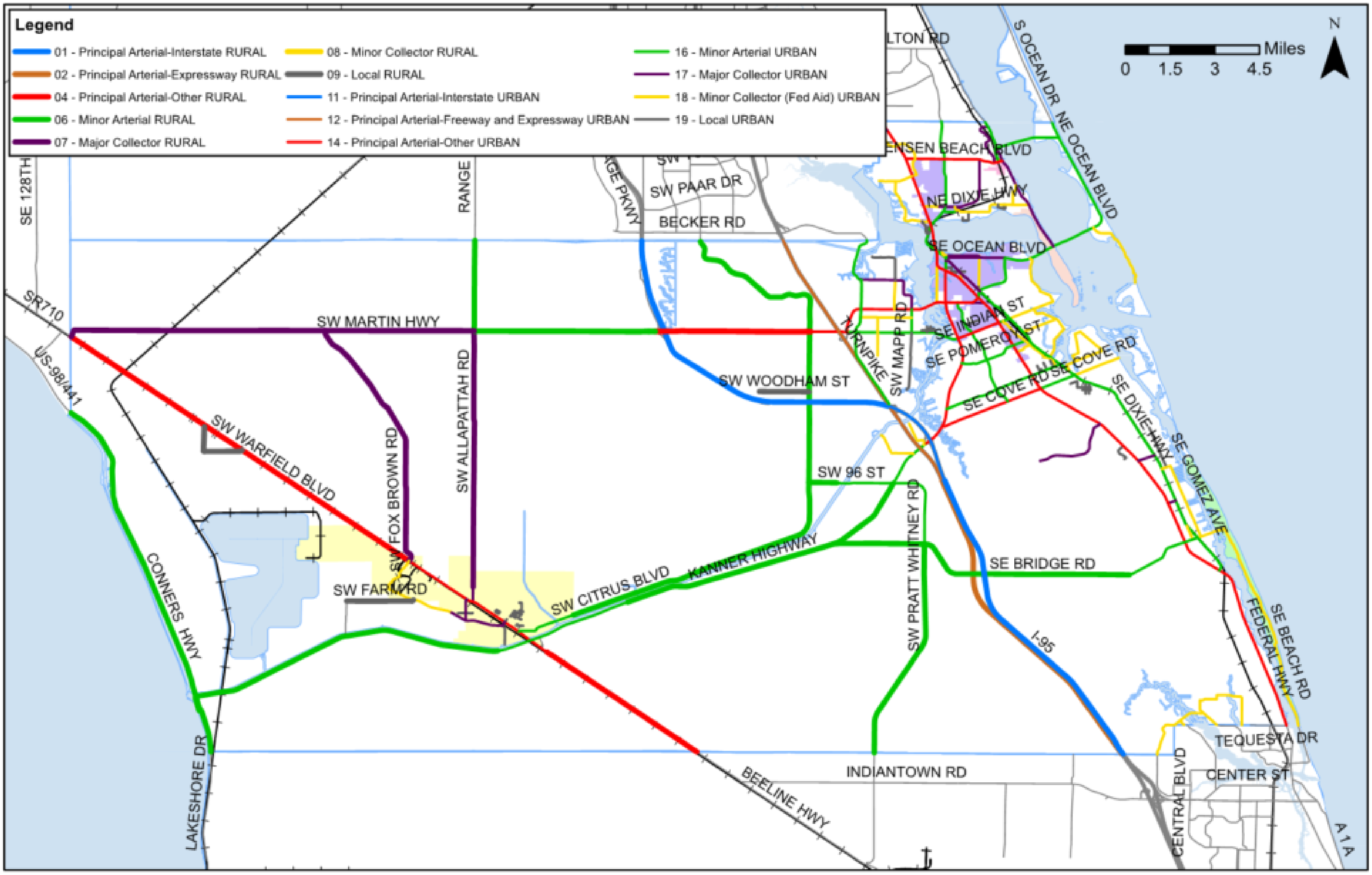
3.1.4 Roadway/Highway Network

Given the importance of roadway network and that majority of the travel comprises automobiles, all the roadways with functional classification Major Collector and above were included in the CMP network (**Figure 3-2**).

[2] Freight Corridors were identified as corridors of national and interregional significance including corridors with a Federal Highway Administration (FHWA) NHFN designation or a FDOT SIS Highway, Railroad, and Strategic Growth Railroad Designation.

[3] The Freight Supportive Corridors include: Bridge Road from I-95 to US 1, Kanner Highway from US 98 to I-95, Cove Road from I-95 to Dixie Highway, Monroe Street from US 1 to Commerce Avenue, Indian Street from US 1 to Dixie Highway, SR 714/Martin Highway/Martin Downs Boulevard/Monterey Road from I-95 to Dixie Highway, Citrus Boulevard from St. Lucie County Line to Martin Highway, US 1 from Cove Road to St. Lucie County, Commerce Avenue from Salerno Road to Indian Street, and Dixie Highway from Salerno Road to SR 714.

Figure 3-2: Congestion Management Process (CMP) Network, Martin County



Source: CMP Update, Martin MPO, June 2020

3.2 Multimodal Performance Measures

Performance measures provide metrics that are used to identify congested corridors, evaluate congestion management strategies, and monitor effectiveness and efficacy of various CMP strategies during monitoring and implementation. The performance measures required by MAP-21 and continued in the FAST Act that the Martin MPO is already required to measure and report on that are relevant to CMP are Level of Travel Time Reliability on the Interstate System; Level of Travel Time Reliability on the non-Interstate NHS; and Truck Travel Time Reliability on the Interstate System.

Consistent with federal requirements and state guidance, the Martin MPO used Planning Time Index[4] (PTI) - one of the most common travel-time reliability related performance measures to assess CMP network and identify congested travel corridors.

In addition of travel time reliability, a variety of multimodal performance measures corresponding to specific evaluation criteria and relative to the CMP goals and objectives were developed (**Table 3-1**). These multimodal performance measures will be used evaluate travel corridor and transportation system performance during implementation and monitoring phase of the CMP.

[4] The PTI represents the extra time that is necessary to arrive at a destination on time 95 percent of the time and is easily comprehended. In other words, a traveler needs to leave X minutes earlier than they would under free flow or light traffic conditions to be on time almost all the time. A PTI of 1.5, for example, means that a traveler should plan for 50% more time for their trip compared to light traffic conditions for a 95% probability of arriving on time.

Table 3-1: CMP Goals, Objectives, and Performance Measures

Goal	Goal Statement	Objectives	Evaluation Criteria	Performance Measure[1]	Data Source (s)	Potential Application(s)[2]	Meets FAST Act PM Rules
Infrastructure Maintenance and Congestion Management Goal	An efficient multimodal transportation system that supports economic growth and enhances the quality of life.	Prioritize improvements that maintain or improve acceptable travel performance.	Level of service	Vehicle miles of travel operating at or better than adopted level of service standard. (Higher is better)	Martin County LOS Report, TCRPM 5.0	Systemwide; Corridor	
		Support improvements to transit service.	Transit supply, demand, and cost	Changes in frequency or headway. *(Lower is better)*	MARTY, TCRPM 5.0	Systemwide; Corridor	
				Changes in geographic coverage. *(Higher is better)*	Bus routes, GIS	Systemwide	
				Change in revenue hours of service relative to base year. *(Higher is better)*	MARTY, TCRPM 5.0	Systemwide; Corridor	
				Change in revenue miles of service. *(Higher is better)*	MARTY, TCRPM 5.0	Systemwide; Corridor	
				Ridership *(Higher is better)*	MARTY, TCRPM 5.0	Systemwide; Corridor	
				Riders per revenue hour. *(Higher is better)*	MARTY, TCRPM 5.0	Systemwide; Corridor	
				Total annualized capital cost and O&M cost per rider. *(Lower is better)*	MARTY, TCRPM 5.0	Systemwide; Corridor	
			System reliability	On-time performance (Mini-bus). *(Higher is better)*	MARTY	Systemwide; Corridor	X
				On-time performance (Cutaway Bus). *(Higher is better)*	MARTY	Systemwide; Corridor	X
			System performance	Missed runs due to major breakdown, as a percentage of total runs by mode (Minibus). *(Lower is better)*	MARTY	Systemwide	X
				Missed runs due to major breakdown, as a percentage of total runs by mode (Demand Response). *(Lower is better)*	MARTY	Systemwide	X
				Missed runs due to major breakdown, as a percentage of total runs by mode (Cutaway Bus). *(Lower is better)*	MARTY	Systemwide	X
		Manage traffic congestion.	Delay	Vehicle hours of delay per capita compared to base year conditions. *(Lower is better)*	TCRPM 5.0	Systemwide; Corridor	
			Travel time reliability	Travel time reliability index on congested corridors on non-NHS facilities. *(Lower is better)*	Regional Integrated Transportation Information System (RITIS)	Systemwide; Corridor	
				% of person-miles traveled on the Interstate that are reliable. *(Higher is better)*	Available from FDOT	Systemwide; Corridor	X
				% of person-miles traveled on the non-Interstate NHS that are reliable. *(Higher is better)*	Available from FDOT	Systemwide; Corridor	X
		Support improvements to major freight corridors.		Truck Travel Time Reliability Index (TTTRI) on the Interstate. *(Lower is better)*	Available from FDOT	Systemwide; Corridor	X
		Implement strategies to reduce per capita vehicle miles of travel.	Vehicle miles traveled	Vehicle miles of travel per capita. *(Lower is better)*	TCRPM 5.0	Systemwide; Corridor	
			Travel demand management	High occupant vehicle (HOV) person trips. *(Higher is better)*	TCRPM 5.0	Systemwide; Corridor	

Goal	Goal Statement	Objectives	Evaluation Criteria	Performance Measure[1]	Data Source (s)	Potential Application(s)[2]	Meets FAST Act PM Rules
Safety Goal	A safe multimodal transportation system that meets the needs of all the users.	Prioritize projects and programs that improve safety on corridors with highest number of crashes involving fatalities and incapacitating injuries for all modes and users.	Fatal and serious injury crashes	Number of fatalities *(Lower is better)*	Crash Analysis Reporting System, Signal Four Analytics, Crash Modification Factors (CMFs)	Systemwide; Corridor	X
				Rate of fatalities per 100 million vehicle miles traveled (VMT). *(Lower is better)*			X
				Number of serious injuries. *(Lower is better)*			X
				Rate of serious injuries per 100 million vehicle miles traveled (VMT). *(Lower is better)*			X
		Implement strategies to enhance bicycle and pedestrian safety.	Bicycle and pedestrian crashes	Number of non-motorized fatalities and serious injuries. *(Lower is better)*			X
Environmental and Equity Goal	Preserve natural environment and promote equity and healthy communities.	Reduce on-road mobile source emissions	Air pollution and greenhouse gas emissions	Change in pollutants (tonnage) including carbon dioxide/greenhouse gas. *(Lower is better)*	TCRPM 5.0, FTA	Systemwide; Corridor	
		Increase the sidewalk coverage on roadways serving concentrations of population and employment in urban areas.	Pedestrian facilities	Miles of pedestrian facilties on the major roadway system in areas with high population and employment density. *(Higher is better)*	Martin County	Systemwide; Corridor	
		Increase the bicycle facility coverage throughout the planning area.	Bicycle infrastructure	Miles of bicycle facilties on the major roadway system. *(Higher is better)*	Martin County	Systemwide; Corridor	
		Implement strategies that increase the miles of shared used path to support the trail network.	Shared use path	Miles of shared use facility. *(Higher is better)*	Martin County	Systemwide; Corridor	
Project Streamlining and Delivery Goal	A transportation system that reflects the community's needs and desires.	Advance projects that the community supports.	Community support	Level of support for improvements in the community. *(Higher is better)*	Martin MPO, FDOT	Systemwide; Corridor	

Notes:

[1]All the performance measures may not be operationalized during the implementation and monitoring phase. Select performance measures could be used to evaluate competing congestion management strategies.
[2]Some performance measures can be applied at systemwide level while others may be more appropriate at corridor level.

3.3 Network Analysis Methodology

Collect Data/Monitor System Performance **-** The effectiveness of the performance measures for selecting strategies and monitoring and evaluating progress require the requisite data. This includes the accuracy and granularity of the data. Datasets that have too high of a margin of error, have numerous gaps in time or location covered, and/or are not available except at larger geographies (e.g., county, city, town, etc.) are not adequate to analyze delay, monitor performance, or make decisions. Collection of data can be expensive and the cost of doing so must be carefully considered. The same is true of proprietary data; though, vendors typically provide applications to enhance the analytic capabilities of their customers.

Datasets that are available and sufficient for the Martin County CMP included the National Performance Management Research Data Set (NPMRDS) that is provided to state DOTs and MPOs by FHWA; Treasure Coast Regional Household Travel Survey; Regional Integrated Transportation Information System (RITIS); FDOT Crash Analysis Reporting System (CARS for Unanticipated Non-Recurring delay); United State Census Bureau American Community Survey (the most recent is 2013-2017 American Community Survey 5-Year Estimates and 2017 American Community Survey 1-Year Estimates); those provided by the Martin County and FDOT TMCs; and StreetLight. The NPMRDS is used to calculate the FAST Act reliability measures discussed earlier. Data available from the TMCs needs to be further investigated. StreetLight is a proprietary dataset with associated application for conducting analysis. Discussions with Martin County Transit will be required to determine what metrics (e.g., load factors, pass ups, etc. along specific routes) it uses to assess its performance and how this may supplement and complement the highway-based datasets. To identify Unanticipated Non-Recurring delay, data on the locations of crashes, date/time of crashes, and time to clearance/restoration of typical operating conditions is valuable.

Analyze Congestion Problems and Needs **-** Congestion should be assessed at the system level and along specific corridors to identify those corridors/hot spots that deserve more detailed analysis. In analyzing congestion, the major elements of delay are intensity (how bad will it be), duration (how long will it last), extent (how many people/amount of freight will be affected), and predictability (how likely is it to happen). At the systemwide level and initial analysis of corridors, a combination of travel demand modeling and “big data” is useful. For more detailed corridor analysis and intersection investigation, operational analysis using microsimulation is required to account for intersection delay. The results of this analysis determine how to best apply strategies to address delay: high-priority intersections and corridor segments require more detailed concept-level planning recommendations as part of the CMP while regularly-occurring delay on less-traveled corridors with minimal intensity that does not last long can benefit from an identification of broader strategies that can be further refined through additional planning as resources allow.

3.3.1 Congested Roadway Segments Identification

A three-phase process was used to evaluate and identify potential congested roadway segments in Martin County to address recurring, unanticipated non-recurring, and planned event-related types of delay[5]. Regardless of the type of delay, each result in frustration for travelers, increased fuel consumption and emissions, and lost productivity. The difference is that Recurring and Planned Event-Related delay is predictable and can be incorporated into trip planning.

Table 3-2 presents the specific datasets and tools used to conduct the analysis in each of the three phases of the congestion segments identification process.

Table 3-2: Tools and Datasets for Congested Segments Identification Process

Tools/Datasets		Phase 1 Identify Potential Congested Spots	Phase 2 Develop Preliminary Congested Segments	Phase 3 Determinate and Verify Potential Congested Segments	Timeframe
RITIS (HERE)	**Bottleneck Ranking Function**	X			March and April, 2018
	Congestion scan Function		X		Specific Congested Period
	Massive Data Downloader (Travel Time Data)			X	January 2018 - December 2018, averaged by hour
FDOT Crash Analysis Reporting System (CARS)		X			Five Years (2012-2016) Historical Crash Data
TCRPM 5 Model				X	2015 Base Year Volume to Capacity Ratio
2018 Martin County Roadway Level of Service (LOS) Inventory Reports				X	Year 2018

Figure 3-3 provides an overview of the three-phase roadway evaluation process used to identify congested roadway segments. **Appendix A** includes a detailed description of the methodology, data sources and key findings related to CMP network evaluation.

[5] Recurring – typically the result of a lack of throughput where volumes exceed capacity at specific times on a regular basis, such as morning and evening peak periods. For transit, this happens when buses are at capacity and must "pass up" passengers, requiring them to wait for the next bus.
Unanticipated Non-Recurring – primarily created by crashes that can exacerbate delay on roadways that experience (or are approaching levels of) excessive recurring delay. For transit, this happens when buses breakdown and passengers must wait for a replacement bus or take the next bus on the route, subject to available room on the bus.
Planned Event-Related – occurs as the result of scheduled activities at known locations such as parks, stadiums, and schools, as well as in work zones during road construction. For transit, the experience may not be similar for riders as buses can be given preference in accessing and exiting event sites to incentivize more people to use the service.

Figure 3-3: Three-Phase Congested Segment Identification Process

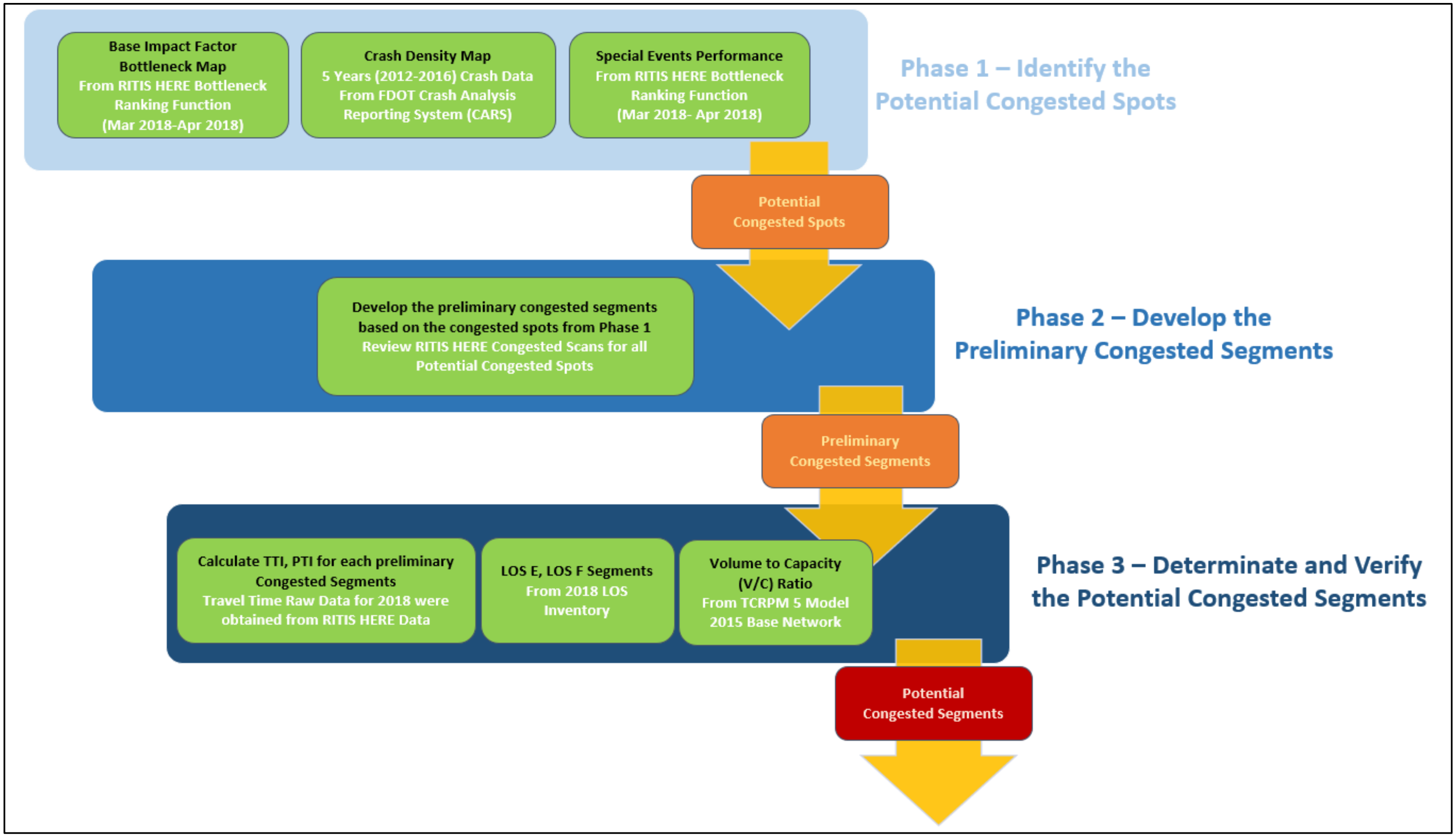
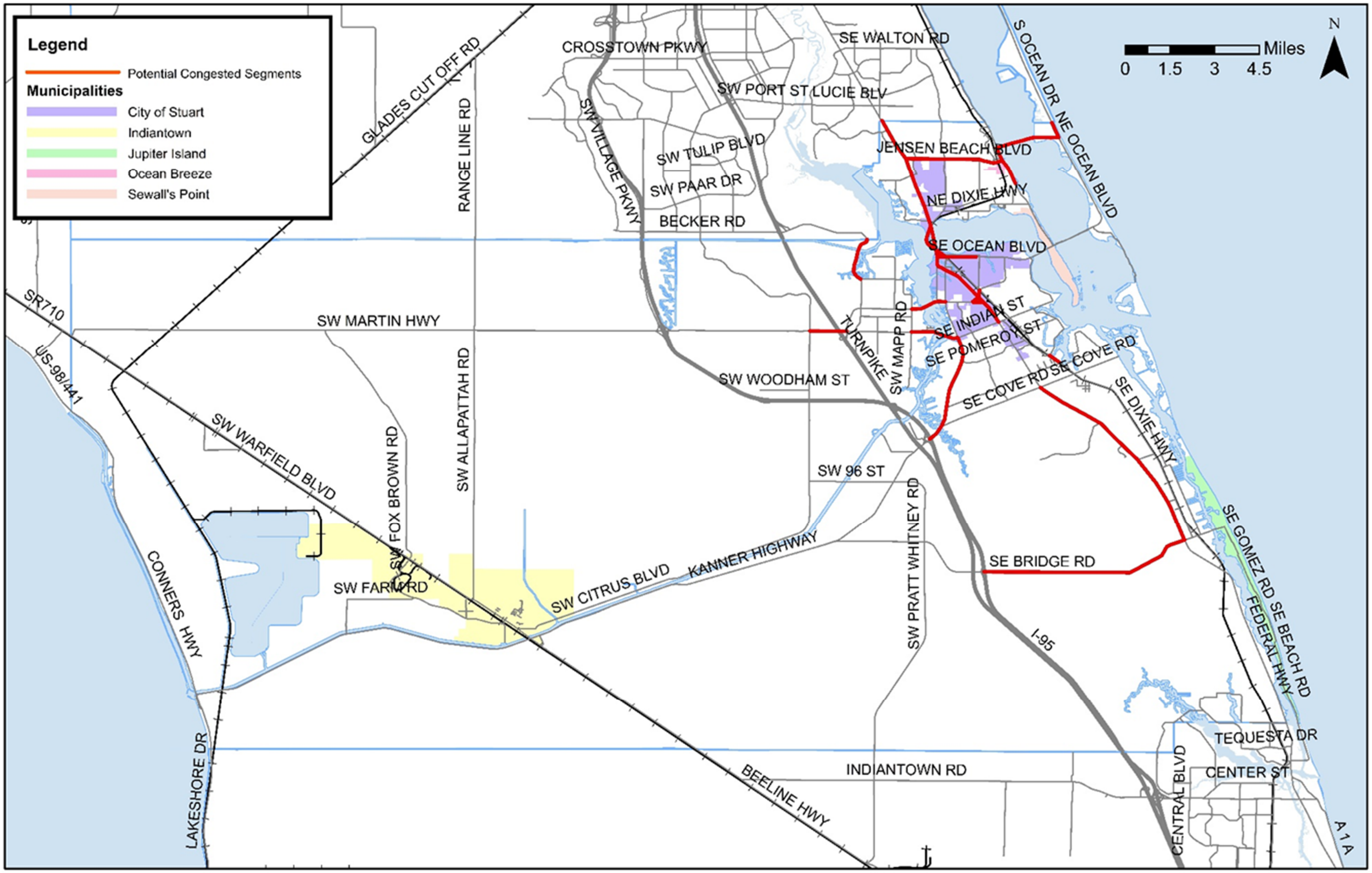


Figure 3-4 and **Table 3-3** shows congested roadway segments based on travel time reliability (Travel Time Index (TTI) of 1.25 and Planning Time Index (PTI) of 1.30), volume to capacity ratio, and level of service analyses along the following travel corridors in Martin County.

- Bridge Road
- Jensen Beach Boulevard
- SW Kanner Highway/SR-76
- SW Martin Highway/CR-714
- SE Monterey Road
- US-1/Federal Highway
- SW Murphy Road
- SR-714
- Dixie Highway
- SW Ocean Boulevard
- SW Joan Jefferson Way
- Indian River Drive
- CR-732
- SR-A1A

Figure 3-4: Congested Roadway Network, Martin County



Source: CMP Update, Martin MPO, June 2020

Table 3-3: Congested Roadway Segments, Martin County

Segment ID	Segment	From	To	Direction	Traffic Message Channel (TMC) Code (HERE Data)
1	Bridge Road	I-95	US 1	Eastbound	102+09806
2	Bridge Road	I-95	US 1	Westbound	102-07506
3	Jensen Beach Blvd	US 1	Savannah Road	Eastbound	102+17398
4	Jensen Beach Blvd	US 1	Savannah Road	Westbound	102-17397
5	Jensen Beach Blvd	Savannah Road	Indian River Drive	Eastbound	102+17399,102P17399,102+17400
6	Jensen Beach Blvd	Savannah Road	Indian River Drive	Westbound	102-17399,102N17399,102-17398
7	SW Kanner Highway	at I-95		Northbound	102+07516, 102P07501
8	SW Kanner Highway	at I-95		Southbound	102-07501, 102N07501
9	SW Kanner Highway	I-95	SR 714	Northbound	102+07518
10	SW Kanner Highway	I-95	SR 714	Southbound	102-07516
11	SW Martin Highway (Turnpike)	SW Citrus Blvd	SW Martin Downs Blvd	Westbound	102-11783, 112N11784
12	SW Martin Highway (Turnpike)	SW Citrus Blvd	SW Martin Downs Blvd	Eastbound	102+11784, 112P11784
13	SW Martin Highway	SW Mapp Rd	S Kanner Hwy	Westbound	102-11785
14	SW Martin Highway	SW Mapp Rd	S Kanner Hwy	Eastbound	102+50062
15	SE Monterey Road	US 1	SE Dixie Hwy	Eastbound	102+07493, 102P07493, 102+09799
16	SE Monterey Road	US 1	SE Dixie Hwy	Westbound	102-07493, 102N07493, 102-09798
17	SE Monterey Road (Ext)	US 1	SE Dixie Hwy	Eastbound	102P11442, 102+11443, 102P11443
18	SE Monterey Road (Ext)	US 1	SE Dixie Hwy	Westbound	102N11443, 102-11442, 102N11442
21	US 1 (North)	North County Line	Dixie Hwy	Southbound	102-07529
22	US 1 (North)	North County Line	Dixie Hwy	Northbound	102+08772
23	US 1 (North)	Dixie Hwy	SR 76	Southbound	102N07529, 102-07528, 102-07527
24	US 1 (North)	Dixie Hwy	SR 76	Northbound	102P07529, 102+07528, 102+07529
25	US 1 (North)	SR 76	SE Dixie Cutoff Rd	Southbound	102-07526
26	US 1 (North)	SR 76	SE Dixie Cutoff Rd	Northbound	102+07527, 102P07526
27	US 1 (North)	SE Dixie Cutoff Rd	SR 714	Southbound	102-07525
28	US 1 (North)	SE Dixie Cutoff Rd	SR 714	Northbound	102+07526
29	US 1 (North)	SR 714	Monterey Rd	Southbound	102N07525
30	US 1 (North)	SR 714	Monterey Rd	Northbound	102P07525
31	US 1 (North)	Monterey Rd	SE Indian Street	Southbound	102-07524
32	US 1 (North)	Monterey Rd	SE Indian Street	Northbound	102+07525
33	SW Murphy Road	High Meadow Ave	St.Lucie County Line	Northbound	102+56918
34	SW Murphy Road	High Meadow Ave	St.Lucie County Line	Southbound	102-56917
35	SR 714 (Martin Downs Blvd)	Mapp Rd	SR 76	Eastbound	102+07492
36	SR 714 (Martin Downs Blvd)	Mapp Rd	SR 76	Westbound	102-07491
37	Dixie Highway	Salerno Rd	St.Lucie Blvd	Northbound	102+17351
38	Dixie Highway	Salerno Rd	St.Lucie Blvd	Southbound	102-17350
39	SW Ocean Blvd	US 1	SR A1A	Westbound	102-09699
40	SW Ocean Blvd	US 1	SR A1A	Eastbound	102+09700
41	SW Joan Jefferson Way	US 1	Dixie Hwy	Westbound	102-22436
42	SW Joan Jefferson Way	US 1	Dixie Hwy	Eastbound	102+22437
45	Dixie Highway	US 1	SW Ocean Blvd	Northbound	102+17384
46	Dixie Highway	US 1	SW Ocean Blvd	Southbound	102-17383
47	Indian River Drive	NE Dixie Hwy	Jensen Beach Blvd	Northbound	102+17413
48	Indian River Drive	NE Dixie Hwy	Jensen Beach Blvd	Southbound	102-17412
49	Indian River Drive	Jensen Beach Blvd	CR 732	Northbound	102+17414
50	Indian River Drive	Jensen Beach Blvd	CR 732	Southbound	102-17413
51	CR 732 (Jensen Beach Cswy.)	Indian River Drive	SR A1A	Eastbound	102+17372
52	CR 732 (Jensen Beach Cswy.)	Indian River Drive	SR A1A	Westbound	102-17371
53	SR A1A	CR 732 (Jensen Beach Cswy.)	North County Line	Northbound	102+09703
54	SR A1A	CR 732 (Jensen Beach Cswy.)	North County Line	Southbound	102-09702

3.3.2 Prioritization of Congested Corridors/TSM&O Projects

In addition to the congested network analysis, the FDOT's Transportation Systems Management and Operations (TSM&O) Master Plan, March 2019 and the congestion hotspot analysis conducted in early 2020 as part of FDOT District Four Congestion Assessment were used as reference data to prioritize congested corridor through this CMP Update.

TSM&O Master Plan, FDOT District Four, March 2019 – This Plan identified potential TSM&O projects at a high level – corridor level and Intelligent Transportation System (ITS) service area level based on traffic, transit, and safety data. Further, potential projects were prioritized based on volume to capacity ratio, signal density, bottlenecks, transit ridership, and crash density as well as its synergy with planned and programmed projects at the time. As shown in **Table 3-4** and **Figure 3-5**, the following potential projects or corridors were included in the TSM&O Master Plan for Martin County.

Table 3-4: Potential TSM&O Projects, Martin County

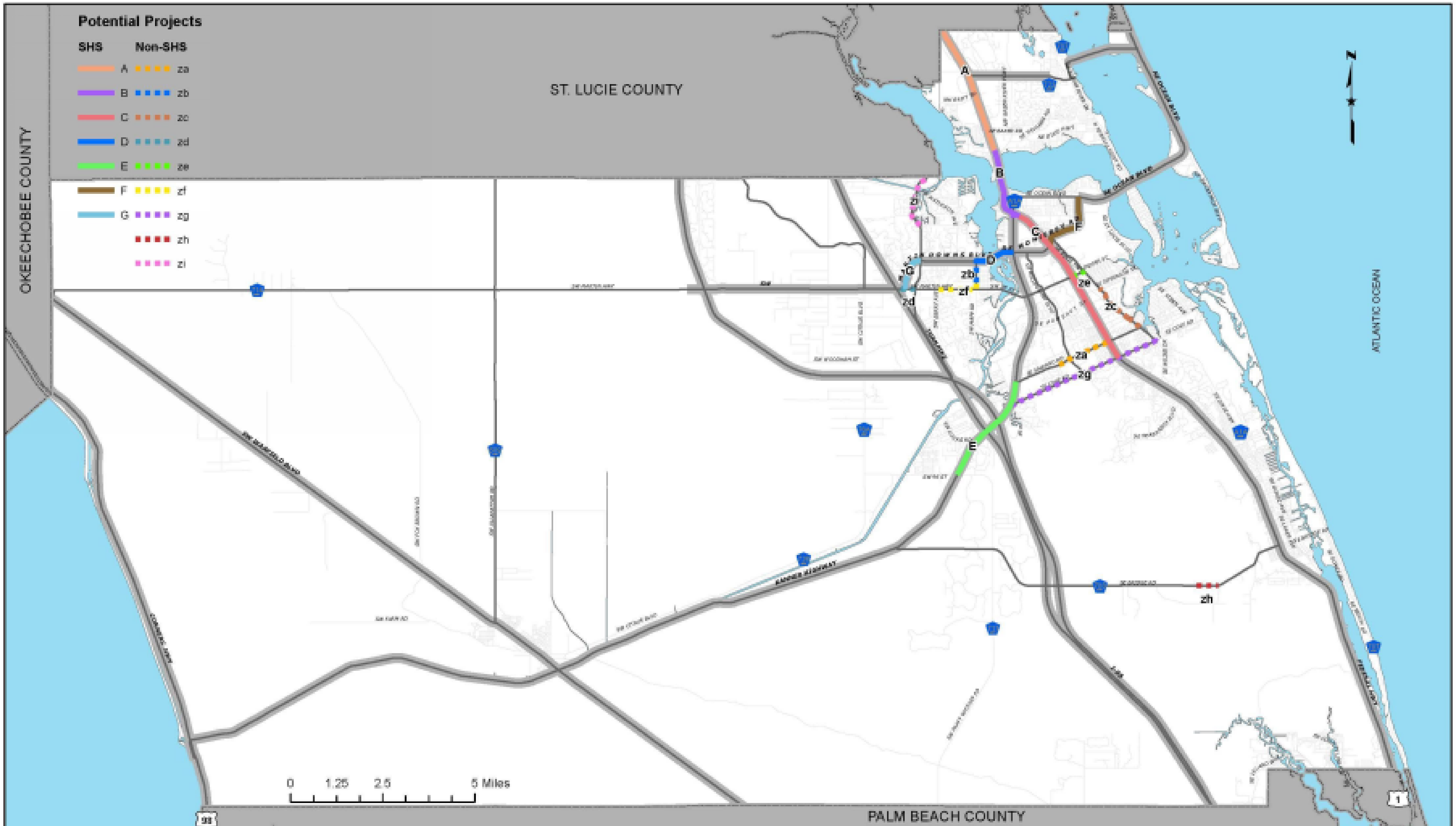
Map ID	Facility	From	To	Length (miles)	Project Description
A	US-1/Federal Highway	NW Forest Drive	County Line	3.60	-
B	US-1/Federal Highway	NW Forest Drive	SE Johnson Avenue	2.22	-
C	US-1/Federal Highway	SE Johnson Avenue	SE Cove Road	4.74	-
D	SW Martin Downs Boulevard	SW Mapp Road	Kanner Highway	1.07	-
E	Kanner Highway	SW 96th Street	SE Salerno Road	3.08	-
F	SR-714/SE Monterey Road	Federal Highway	SE Ocean Boulevard	1.85	-
G	Martin Downs Boulevard	SW Martin Highway	SW High Meadow Avenue	0.96	-
za	SE Salerno Road	SE Ault Road	Federal Highway	1.50	-
zb	SW Mapp Road	SW 36th Street	SW Martin Downs Boulevard	0.57	-
zc	SE Dixie Highway	SE Salerno Road	SE Jefferson Street	1.60	-
zd	SW Martin Highway	SW High Meadow Avenue	SW Armellini Avenue	0.37	-
ze	SE Indian Street	Federal Highway	SE Dixie Highway	0.36	-
zf	SW Martin Highway	SW Berry Avenue	SW Mapp Roaad	1.22	-
zg	SE Cove Road	Kanner Highway	SE Dixie Highway	4.34	-
zh	SE Bridge Road	SE Powerline Road	SE Otter Lake Drive	2.15	-
zi	SW Murphy Road	SW High Meadow Avenue	County Line	1.57	-
n/a	SR-714/Martin Highway	at I-95	-	-	Advanced Digital Message Sign (ADMS) in Eastbound and WestboundDirection
n/a	Martin County Rest Area (Southbound)	at I-95	-	-	Dynamic Truck Parking, Touch-Screen Informational Kiosk
n/a	Martin County Rest Area (Northbound)	at I-95	-	-	Dynamic Truck Parking, Touch-Screen Informational Kiosk
n/a	High Meadow Avenue	at I-95	-	-	Advanced Digital Message Sign (ADMS) in Southbound Direction
n/a	SR-76/Kannery Highway	at I-95	-	-	Advanced Digital Message Sign (ADMS) in Eastbound and WestboundDirection, CCTV under Bridge, Signal Priority, ADMS at Proposed Park-and-Ride
n/a	Bridge Road	at I-95	-	-	Advanced Digital Message Sign (ADMS) in Eastbound and WestboundDirection

Source: TSM&O Master Plan, Martin, St. Lucie, and Indian River Counties, FDOT District Four, March 2019

Further, the TSM&O Master Plan also includes six ITS projects proposed in the I-95 Treasure Coast Multimodal Master Plan. Project 'E' overlaps with SR-76/Kanner Highway interchange improvements.

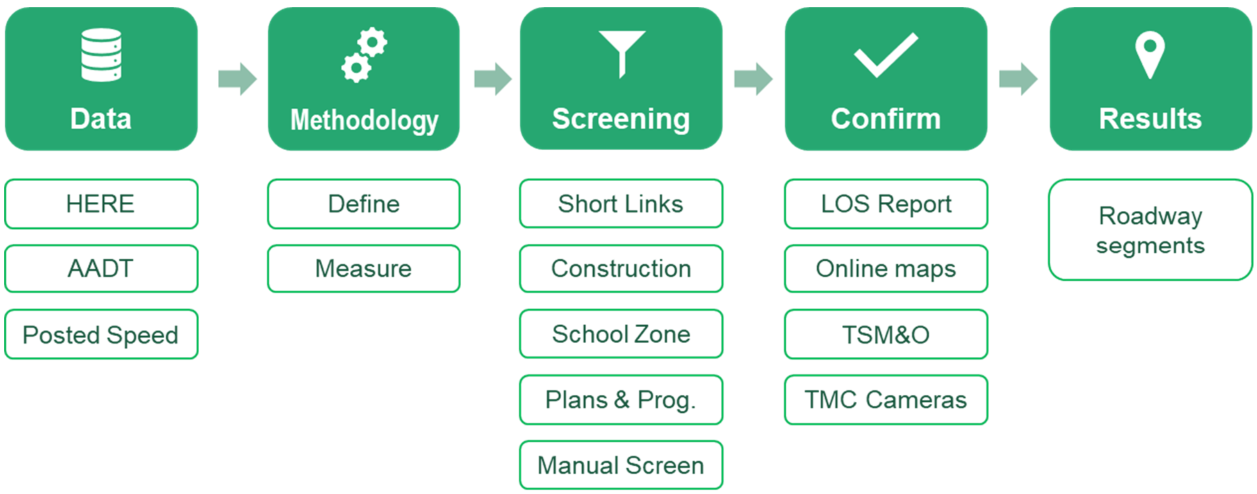
All the projects identified in **Table 3-4** and **Figure 3-5** overlap with the congested roadway segments identified through the CMP network analysis.

Figure 3-5: Potential TSM&O Projects, Martin County



Source: TSM&O Master Plan, Martin, St. Lucie, and Indian River Counties, FDOT District Four, March 2019

Treasure Coast Congestion Assessment, FDOT District Four, June 2020 – This study focused on identifying congestion hotspots on arterial streets in the Treasure Coast Region based on intensity (how slow traffic was) and duration (how long slow traffic lasts) of congestion defined as level of service (LOS) E or worse. **Figure 3-6** shows a snapshot of the analysis process. The congestion hotspot analysis used March 2018 HERE speed data.



Source: Treasure Coast Congestion Assessment, FDOT District Four

Figure 3-6: Congestion Hotspots Analysis Process

Table 3-5 and **Figure 3-7** show high-ranked locations identified as congestion hotspots. It should be noted that all the high-ranked (top 20) congestion hotspots included in the FDOT's Congestion Assessment study are part of the 25 congested roadway segments identified through the CMP network analysis. In other words, the congestion hotspots in Martin County are a subset of the TSM&O projects included in the CMP.

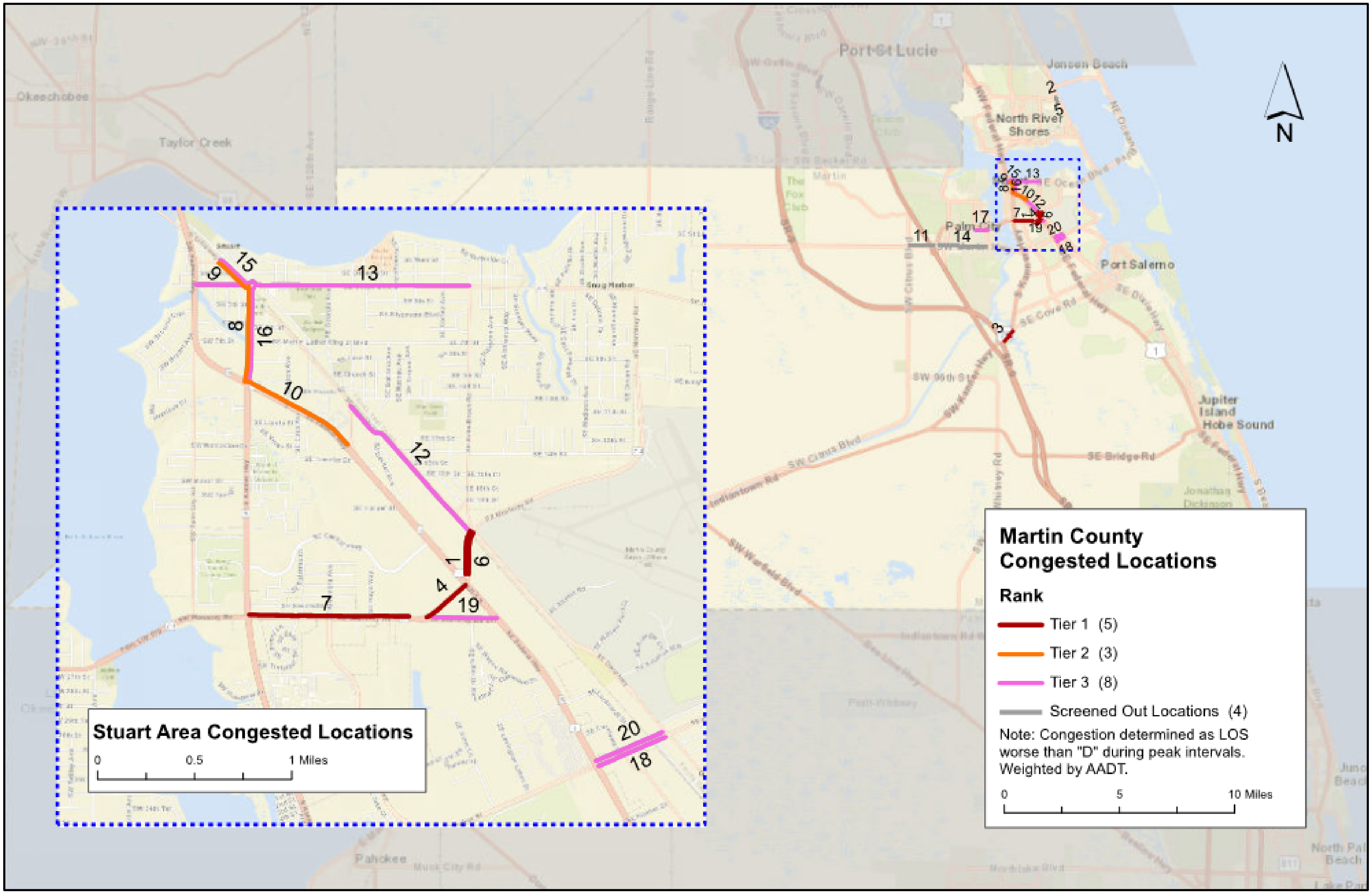
Table 3-5: High-Ranked Congested Locations, Martin County

System Rank	County Rank	Road Name	SR #	Between	And	County	Dir	AM Speed (mph)	PM Speed (mph)	Posted Speed (mph)	AM Dur. (min)	PM Dur. (min)	# of Lanes	AADT	AM Score (0,1000)	PM Score (0,1000)	Total Score (0,2000)
1	1	Monterey Rd	714	Dixie Hwy	US-1	M	SB	13.7	8.0	40	120	120	4	24,500	507	1,000	1,507
5	2	Jensen Beach Blvd	-	Pineapple Ave	Indian River Dr	M	WB	11.8	6.2	35	90	120	2	20,500	68	567	634
7	3	Kanner Hwy	76	I-95	Cove Rd	M	NB	16.1	10.5	50	15	75	6	40,500	58	408	466
8	4	Monterey Rd	714	Monterey Rd Ext	US-1	M	EB	16.0	12.8	40	45	120	4	28,000	86	366	452
9	5	Jensen Beach Blvd	-	Pineapple Ave	Indian River Dr	M	EB	12.7	7.1	35	30	120	2	20,500	11	418	429
12	6	Monterey Rd	714	Dixie Hwy	US-1	M	NB	18.5	12.7	40	0	120	4	24,500	0	368	368
16	7	Monterey Rd	714	Kanner Hwy	Monterey Rd Ext	M	WB	21.1	10.4	40	0	120	4	28,000	0	340	340
22	8	Colorado Ave	-	Ocean Blvd	US-1	M	SB	12.4	10.0	30	30	105	2	18,500	11	145	157
26	9	Dixie Hwy	-	Joan Jefferson Way	Ocean Blvd	M	SB	11.5	9.8	25	30	120	2	9,200	19	100	119
29	10	US-1	5	Colorado Ave	Dixie Cutoff Rd	M	NB	20.1	11.6	40	0	30	6	33,000	0	107	107
41	11	Martin Hwy	714	Citrus Blvd	Armellini Ave	M	WB	27.1	15.5	45	0	45	2	27,000	0	38	38
46	12	Dixie Hwy	-	Dixie Cutoff Rd	Monterey Rd	M	SB	15.5	15.6	40	30	45	2	6,400	22	8	30
50	13	Ocean Blvd	-	US-1	Palm Beach Rd	M	WB	16.1	11.3	30	0	30	2	14,100	0	23	23
52	14	Martin Hwy	714	Martin Downs Rd	Mapp Rd	M	WB	21.8	16.2	40	0	30	4	20,500	0	20	20
53	15	Dixie Hwy	-	Joan Jefferson Way	Ocean Blvd	M	NB	13.6	10.4	25	0	30	2	9,200	0	17	17
54	16	Colorado Ave	-	Ocean Blvd	US-1	M	NB	12.9	12.0	30	15	45	2	18,500	3	13	16
55	17	Martin Downs Rd	714	Mattheson Ave	Mapp Rd	M	EB	17.3	25.1	45	15	0	4	32,500	16	0	16
63	18	Indian St	-	US-1	Dixie Hwy	M	EB	16.9	11.8	35	0	15	4	12,500	0	7	7
64	19	Monterey Rd Ext	-	Monterey Rd	US-1	M	WB	13.5	11.6	35	0	15	2	8,000	0	5	5
71	20	Indian St	-	US-1	Dixie Hwy	M	WB	16.7	13.0	35	0	15	4	12,500	0	0.2	0.2

Notes:
1. This analysis applied HERE speed data of March 2018. Spring break days were excluded.
2. Locations are ranked by total scores.
3. Grayed rows indicate locations that are removed from further consideration.
4. Lane underlines in "# of Lanes" field indicate one-way streets.

Source: Treasure Coast Congestion Assessment, FDOT District Four

Figure 3-7: High-Ranked Congested Locations



Source: Treasure Coast Congestion Assessment, FDOT District Four

<u>*TSM&O Project Prioritization*</u> – A comprehensive list of high level TSM&O and ITS projects[6] or congested corridors was identified based on congested network analysis conducted for Martin MPO's CMP Update. In addition, this comprehensive list of projects was reconciled to ensure that projects and congestion hotspots identified through FDOT District Four's *TSM&O Master Plan* and *Treasure Coast Congestion Assessment* were inclusive. The TSM&O and ITS projects included in this CMP Update were also included in the 2045 Needs Assessment and Needs Plan.

As shown in **Table 3-6,** the TSM&O and ITS projects were stratified in three priority tiers – Tier 1 through Tier 3. Projects and congested corridors that were identified in more than the three studies and/or analyses, namely, the CMP Update, TSM&O Master Plan and Treasure Coast Comprehensive Assessment, roadway needs assessment (TCRPM 5.0 volume to capacity ratio more than 1.0) and Martin County Public Works TSM&O needs were considered as Tier 1 priority, while those that were identified in any two of the five studies/analyses were assigned Tier 2 priority and the remaining were Tier 3 priority projects. Adjustments were made to incorporate known safety projects and roadway segment contiguity. These priority tiers serve as an initial framework for the Martin MPO and its partners to discuss various improvements. It should be noted that the priority could be modified based on funding availability under specific programs.

[6] As such, preparation of specific TSM&O/ITS solutions and corresponding cost estimates for specific improvements for a corridor were not explored. Additional planning and/or design studies will be needed to identify corridor specific congestion mitigation strategies, including equipment, funding, and operational and maintenance agreements.

Table 3-6: TSM&O/ITS Projects Priority

Map ID	Facility	From	To	Length (miles)	Project Description	Priority Tier
M-3	Dixie Highway	US-1/Federal Highway	SW Ocean Blvd	0.42	-	Tier 1
M-5	Dixie Highway	SE Anchor Avenue	St. Lucie Blvd	0.74	-	
M-4	Dixie Highway	Dixie Cutoff Rd	Monterey Rd	0.85	-	
M-6	Jensen Beach Blvd	US-1/Federal Highway	Indian River Drive	2.92	-	
E	Kanner Highway	SW 96th Street	SE Salerno Road	3.08	-	
C-2	Martin Downs Boulevard/Monterey Road	Turnpike Entrance	US-1/Federal Highway	4.85	Adaptive Corridor	
M-11	SE Monterey Road (Ext)	US-1/Federal Highway	SE Dixie Hwy	0.58	-	
za	SE Salerno Road	SE Ault Road	Federal Highway	1.50	-	
F	SR-714/SE Monterey Road	Federal Highway	SE Ocean Boulevard	1.85	-	
M-15	SW Joan Jefferson Way	US-1/Federal Highway	Dixie Hwy	0.10	-	
n/a	SR-76/Kanner Highway	at I-95	-	-	Advanced Digital Message Sign (ADMS) in Eastbound and Westbound Direction, CCTV under Bridge, Signal Priority, ADMS at Proposed Park-and-Ride	
C-3	US-1/Federal Highway	Summerfield Way	SE Westmoreland Blvd.	10.35	Adaptive Corridor	
n/a	Bridge Road	at I-95	-	-	Advanced Digital Message Sign (ADMS) in Eastbound and Westbound Direction	Tier 2
M-17	Bridge Road	I-95	US-1/Federal Highway	6.43	-	
M-1	Colorado Avenue (SW Kanner Highway)	SE Lonita St	Ocean Boulevard	0.62	-	
n/a	High Meadow Avenue	at I-95	-	-	Advanced Digital Message Sign (ADMS) in Southbound Direction	
n/a	Martin County Rest Area (Northbound)	at I-95	-	-	Dynamic Truck Parking, Touch-Screen Informational Kiosk	
n/a	Martin County Rest Area (Southbound)	at I-95	-	-	Dynamic Truck Parking, Touch-Screen Informational Kiosk	
M-9	NE Ocean Blvd	S Sewalls Point Rd	NE MacArthur Blvd	4.77	-	
zg	SE Cove Road	Kanner Highway	SE Dixie Highway	4.34	-	
M-10	SE Green River Pkwy	NW Wright Blvd	NW Dixie Hwy	0.40	-	
ze	SE Indian Street	Federal Highway	SE Dixie Highway	0.36	-	
n/a	SR-714/Martin Highway	at I-95	-	-	Advanced Digital Message Sign (ADMS) in Eastbound and Westbound Direction	
M-14	SW High Meadow Ave	SW Sunset Tr	SW Town Center Way	0.20	-	
zi	SW Murphy Road	SW High Meadow Avenue	County Line	1.57	-	
M-16	SW Ocean Blvd	US-1/Federal Highway	SR-A1A	1.28	-	
M-2	CR-732 (Jensen Beach Cswy.)	Indian River Drive	SR-A1A	1.90	-	Tier 3
C-1	High Meadow Avenue	SR-714/Martin Highway	Golden Bear Way	1.05	Install Fiber Optic	
M-8	NE Indian River Drive	NE Dixie Hwy	CR-732 (Jensen Beach Cswy.)	1.35	-	
zc	SE Dixie Highway	SE Salerno Road	SE Jefferson Street	1.60	-	
n/a	Signalized Intersections	Countywide (Approximately 120 intersections)			Install Bluetoad Devices	
C-4	SR-710/Warfield Blvd.	Jackson Avenue	Dr. Martin Luther King Jr. Drive	1.55	Install Fiber Optic	
M-12	SR-A1A	CR-732 (Jensen Beach Cswy.)	North County Line	0.80	-	
M-13	SW 36th Street (Martin Highway)	SW Mapp Rd	Kanner Hwy	1.88	-	
zb	SW Mapp Road	SW 36th Street	SW Martin Downs Boulevard	0.57	-	
zd	SW Martin Highway	SW High Meadow Avenue	SW Armellini Avenue	0.37	-	
zf	SW Martin Highway	SW Berry Avenue	SW Mapp Road	1.22	-	

4. Congestion Management Strategies

This chapter discusses potential multimodal strategies that could mitigate congestion consistent with FDOT Transportation Systems Management and Operations (TSM&O) initiatives and Martin County Traffic Engineering Division's plans.

4.1 Congestion Mitigation Toolbox of Strategies

A toolbox was developed to include strategies for all types of delay at all locations in Martin County. Strategies can be categorized as Supply-Driven and Demand-Driven. As with any toolbox, the selection of the appropriate tool from it is dependent on an analysis of what needs to be fixed and potential options for doing so. The more complex the issue, the more likely it is that multiple tools will be needed to obtain successful resolution. The selection of strategies also needs to consider the impacts of emerging technologies but should not rely on automated/connected vehicles to reduce delay absent the Supply-Driven and Demand-Driven strategies. Continuing the process of conducting a cost-benefit analysis for potential strategies as project development progresses and the required details become known is strongly recommended.

The congestion mitigation toolbox is presented in **Table 4-1** with the type of congestion that each strategy has the potential to solve denoted. Descriptions of each of the strategies are provided. Supply-Driven strategies include traffic signal coordination, roadway/incident monitoring, intersection/interchange improvements, travel information systems, parking management, work zone management/maintenance of traffic, expanded transit and bicycle networks, and access management. Demand-Driven strategies include flexible work hours, transit-supportive development, alternative work locations, and ridesharing. In many instances, the strategies will have their maximum effect when combined with other strategies (i.e., the "multiple tools" analogy referenced above). An example would be the detection of a crash based on roadway/incident monitoring and associated actions taken to modify the phasing and timing plans of traffic signals while also alerting other users of the system to avoid the area via traveler information systems.

Table 4-1: Congestion Management Strategies

Strategy	Recurring	Unanticipated Recurring	Planned Event-Related
Traffic Signal Coordination	X	X	X
Roadway/Incident Monitoring	X	X	X
Intersection/Interchange Improvements	X	X	
Traveler Information Systems	X	X	X
Parking Management	X		X
Work Zone Management/Maintenance of Traffic		X	X
Expanded Transit and Bicycle Networks	X		X
Access Management	X	X	
Flexible Work Hours	X		
Transit-Supportive Development	X		
Alternative Work Locations	X		
Ridesharing	X		

4.1.1 Supply-Driven CMP Strategies

Traffic Signal Coordination: Involves ensuring that traffic signals are timed to work in a synchronized manner. This can be accomplished through pre-set phasing and timing plans for existing signals with the plans updated at regular intervals based on real-world data, the introduction of adaptive traffic signal control via enhanced communications capabilities with existing signals (where possible), and the installation of new signals that allow for remote management to optimize the signal network.

Roadway/Incident Monitoring: Includes detection and verification of deteriorating operating conditions resulting from all forms of congestion to provide for efficient response to and clearance of the source of delay, allowing for return to normal conditions. Quick clearance can reduce the potential for secondary incidents such as rear end crashes resulting from sudden backups and braking. Some incidents, such as disabled vehicles, can be cleared relatively quickly. In the event of crashes, the safety needs of first responders need to be incorporated into incident management protocols.

Intersection/Interchange Improvements: The convergence of roadways can result in delay both at the immediate location and throughout the system. This results as traffic is controlled to allow for the safe movement of vehicles and people through the intersection or interchange, creating delay that can affect locations “downstream.” Changes to the design of intersections and interchanges can take the form of dedicated turn lanes, channelization, and other measures that reduce conflict points and are more intuitive for drivers, bicyclists, and pedestrians. Enhanced intersections and interchanges are more effective when traffic signals that are present or introduced are optimized to take full advantage of the physical design.

Traveler Information Systems: Informing users of the transportation network of existing and potential areas of congestion can lessen the overall amount of delay by averting the influx of additional vehicles, which results in longer times until non-congested operations resume. Information to travelers on network conditions comes in many forms. Alerts and routing via mobile phone and in-vehicle apps are becoming more prevalent. Still, publicly provided services such as FL511, dynamic messaging signs, emails, text alerts, and highway advisory radio that disseminate timely information on congestion remain an integral part of a holistic CMP.

Parking Management: Parking strategies offer the opportunity to address the timing, destination, and type of trips made through pricing and supply. Raising prices (especially, during certain times) and limiting supply for single occupancy vehicles can induce the use of other modes (e.g., public transportation, biking, ridesharing, etc.) by commuters. Conversely, discounts during certain time periods and for high occupancy vehicles can achieve similar effects.

Work Zone Management/Maintenance of Traffic: Repair of roads and bridges is a necessary activity to ensure their safety and suitability for the volumes they carry. The associated construction can result in delays. Managing work zones to limit their impact on traffic can take the forms of limiting construction to off-peak travel hours; ensuring roadways in close proximity or those that serve as alternate routes for each other are not repaired at the same time; and using traditional and social media to make the public aware of the construction and alternate routes in advance of the work commencing.

Expanded Transit and Bicycle Networks: Increasing coverage and frequency of public transportation services and expanding and enhancing facilities for bicyclists can result in mode shift. The extent to which travelers will use public transportation and choose to bicycle depends on the location of origins and destinations relative to public transportation routes and the connectivity and comfort of facilities for lesser-experienced bicyclists. Public awareness campaigns of the availability and benefits (e.g., monetary, environmental, health, etc.) of riding transit and bicycling can increase usage and their contributions to congestion mitigation.

Access Management: Increasing the space between access points, altering the design and location of driveways, and requiring left turns at dedicated points can improve traffic flow and reduce crashes, resulting in decreases in Recurring and Unanticipated Recurring congestion. Outreach to businesses to explain the benefits of access management and clear directions to drivers via signage and visual cues are recommended components of access management implementation.

4.1.2 Demand-Driven CMP Strategies

Flexible Work Hours: Employers can provide alternative schedules for their workers to avoid all or some of their travel during traditional commuting periods. This can be achieved through staggered or flexible shift start and end times to occur either before or after existing peak periods; instituting compressed work weeks with longer but fewer workdays; and staggering employees start times so not all or a large majority of workers are arriving and departing at the same time.

Transit-Supportive Development: Encouraging and incentivizing land uses that promote the use of public transportation can increase ridership and reduce existing as well as future trips that would be made by private automobile. Transit Supportive Development generally includes denser, mixed-use development, enhanced transit stops with shelters and other amenities, and street configurations that promote connectivity for pedestrians and bicyclists.

Alternative Work Locations: Some types of industries allow for employers to offer portions of their workforce the option of working from home on either a partial- or full-time basis. Work from home policies have gained popularity during the COVID-19 pandemic and current research indicates that losses in productivity were not experienced by many employers, making it feasible that these policies may continue following the pandemic. Beyond working from home, some employers have multiple locations and can allow employees to work from satellite offices to reduce commuting times.

Ridesharing: Participants of ridesharing programs are matched with other commuters that carpool or vanpool. These programs can be offered and/or encouraged by employers. Many ridesharing programs offer participants a guaranteed ride home in the event of illness, family emergency, or other situation that requires leaving work before the scheduled carpool or vanpool. Guaranteed rides home can reduce the hesitancy that keeps some people from participating in the ridesharing.

There are other congestion mitigation strategies that can be employed in Martin County if congestion increases either through more intense delay during peak periods or the lengthening of peak periods. At this time, strategies such as ramp metering (controlling flow onto highways), congestion pricing (implementing user charges during certain times of the day), and trip reduction ordinances are not warranted.

4.1.3 Safety Strategies

Improving safety through capital improvements and non-structural strategies, such as educational and enforcement campaigns by traffic safety and law enforcement agencies, are a primary means for reducing Unanticipated Recurring congestion. This type of congestion has the greatest impacts on reliability and can be the most frustrating for commuters, freight shippers, and businesses. The safety strategies of *Martin in Motion* can and should be considered important elements of the CMP.

4.1.4 Cost-Effectiveness & Responsibility

CMP requirements include the assignment of responsibilities for implementing strategies. With the emphasis on cost-effective improvements to reduce delay, identifying and considering the potential return on investment of congestion management strategies is also an important step. **Table 4-2** presents the CMP strategies of the toolbox along with their associated generalized potential effectiveness, cost, and responsibility for implementation.

Table 4-2: Cost-Effectiveness and Responsibility

CMP Strategy	Potential Effectiveness	Cost	Responsible Agency
Traffic Signal Coordination	High	Low	Martin County
Roadway/Incident Monitoring	High	Low	FDOT/Martin County
Intersection/Interchange Improvements	Medium	Medium	FDOT/Martin County
Traveler Information Systems	Medium	Low	FDOT/Martin County
Parking Management	Low	Low	FDOT/Martin County
Work Zone Management/Maintenance of Traffic	High	Low	FDOT/Martin County
Expanded Transit and Bicycle Networks	Low	High	FDOT/Martin County
Access Management	Medium	High	FDOT
Flexible Work Hours	Low	Low	Employers
Transit-Supportive Development	Low	High	Martin County
Alternative Work Locations	High	Low	Employers
Ridesharing	Medium	Low	Commuters

5. Implementation and Monitoring

This chapter discusses funding sources and programmatic recommendations for congested corridors in Martin County. Further, it also discusses monitoring mechanism to evaluate the effectiveness of various mitigation strategies consistent with Fixing America's Surface Transportation (FAST) Act Performance Measure requirements as well as the FDOT's and Martin County's processes.

5.1 Program and Implement Strategies

Programming strategies from the CMP to address delay is dependent on reasonably-expected revenues since the CMP is part of the MPO's 2045 LRTP – *Martin in Motion*, which is subject to fiscal constraint requirements. The analysis of congestion problems and needs as well as TSM&O/ITS projects priority tiers provides the MPO, County and FDOT a framework to collaborate and implement TSM&O/ITS projects, including identifying available funding, adjusting and selecting priority projects, evaluating specific improvements through planning and design efforts, and finally operations and maintenance protocols.

The TSM&O/ITS projects are moved forward to programming in the MPO's Transportation Improvement Program (TIP) or FDOT's Work Program (WP) based on availability of funds. These projects would be phased over time, which is consistent with the current Martin MPO CMP process for the TIP, which identifies candidate road sections through quantitative analysis, eliminates projects that are currently programmed, and "sorts the remaining projects by the timeframe in which a major capacity improvement was deemed financially feasible in the LRTP."

While FDOT takes the lead in programing and implementing TSM&O/ITS projects on limited access and SIS facilties, robust inter-agency collaboration is required to these projects to come to fruition on arterials. A common practice is FDOT support the initial planning, design, and deployment of arterial TSM&O projects while local agencies are responsible for the operations and maintenance.

5.2 Funding Sources

Typically, TSM&O/ITS projects on limited access facilities, such as, I-95 and Florida's Turnpike are funded through statewide ITS Set Aside Funds (DITIS). Certain TSM&O/ITS projects on SIS corridor may also be eligible for DITIS funds if they meet specific requirements. It is important

Consistent with previous LRTPs, the 2045 LRTP - *Martin in Motion* has utilized a "box" set-aside of federal funds for implementing TSM&O/ITS projects. Approximately, $69.2 million (Year of Expenditure) have been set-aside to implement these projects. Funds from FDOT's safety program as well as federal programs, such as, Surface Transportation Block (STBG), National Highway Performance Program (NHPP), and Congestion Mitigation and Air Quality (CMAQ) could also be used. In addition to these state and federal sources, funds may become available through the Martin County's maintenance and operations projects included in its Capital Improvement Plan (CIP).

5.3 Monitoring Strategy Effectiveness

The initial step in determining if the strategies in the CMP are effective is to monitor systemwide performance. From this level, an evaluation of the impacts of strategies on specific corridors and intersections can be conducted. The federally required LRTP system performance report and TIP anticipated effects narrative provide Martin MPO members and the public with opportunities to consider and comment on the progress made in mitigating or reducing excessive delay. It is recommended that Martin MPO also develop a concise, CMP report that incorporates and expands on the federally required system performance measures by including corridor level and intersection-specific data and analysis. This report would be produced at the midpoint between LRTP updates (every two years). The CMP would continue to be updated as part of the LRTP update, this would provide for bi-annual evaluations of effectiveness to be conducted as part of the development of the LRTP.

APPENDIX - 1: CMP Network Evaluation

Congested Segments Identification

Technical Memorandum:

Congestion Management Process Update: Congested Segments Identification

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1. Introduction

This Technical Memorandum describes the Congestion Management Process (CMP) as part of the Martin County MPO's 2045 Long Range Transportation Planning (LRTP) update. **Figure 1** illustrates the three-phase process used to evaluate the roadways and identify the potential congestion segments. **Figure 2** shows the existing major roadways in Martin County where congestion management policies and procedures need to be applied. **Table 1** presents the specific datasets and tools used to conduct the analysis in each of the three phases of the congestion segments identification process.

Table 1 - Tools and Datasets of Congested Segments Identification Process

Tools/Datasets		Phase 1 Identify Potential Congested Spots	Phase 2 Develop Preliminary Congested Segments	Phase 3 Determinate and Verify Potential Congested Segments	Date
RITIS (HERE)	Bottleneck Ranking Function	X			March and April, 2018
	Congestion scan Function		X		Specific Congested Period
	Massive Data Downloader (Travel Time Data)			X	January 2018 - December 2018, averaged by hour
FDOT Crash Analysis Reporting System (CARS)		X			Five Years (2012-2016) Historical Crash Data
TCRPM 5 Model				X	2015 Base Year Volume to Capacity Ratio
2018 Martin County Roadway Level of Service (LOS) Inventory Reports				X	Year 2018

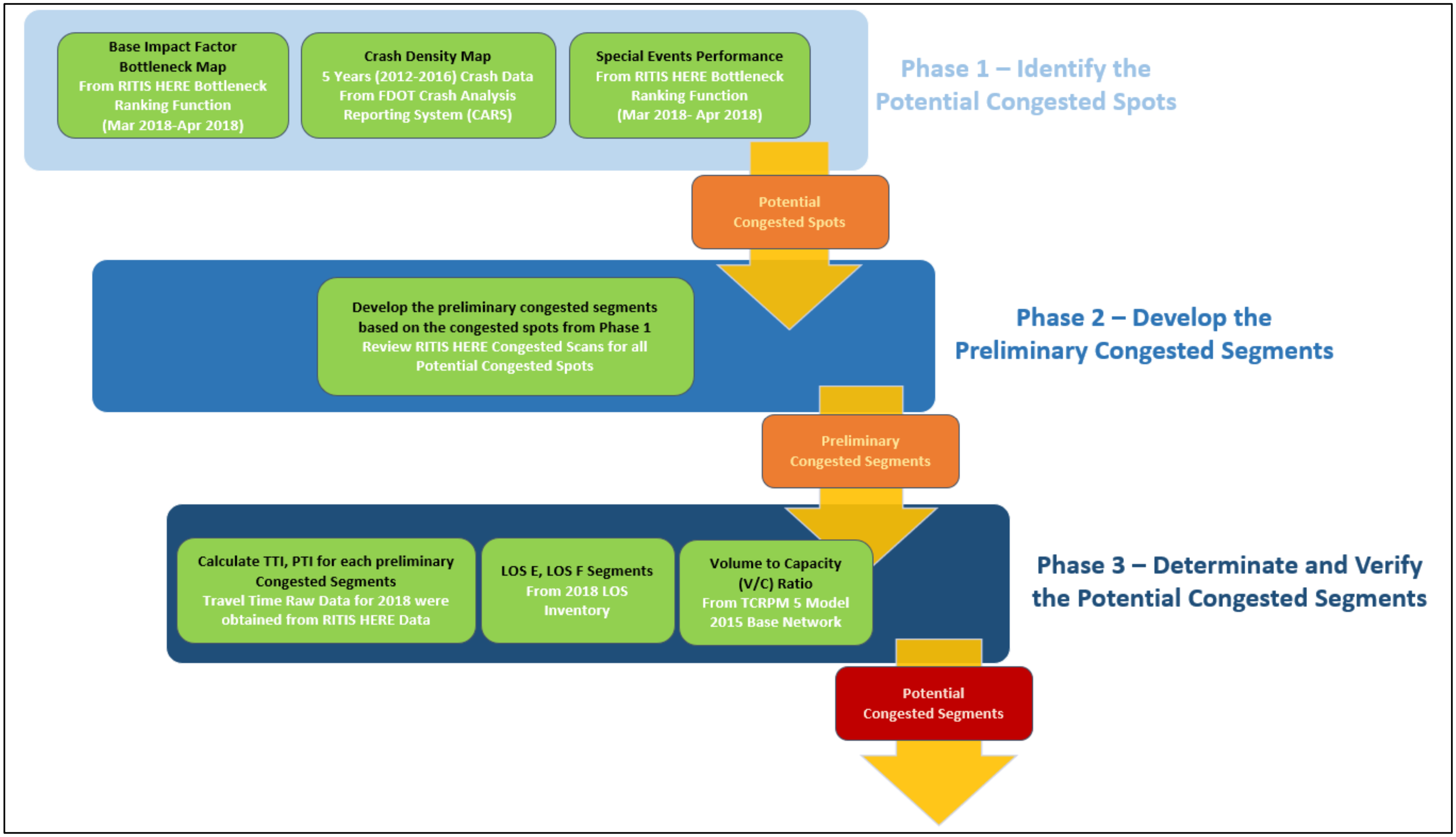

Figure 1 – Three-Phase Congested Segments Identification Process

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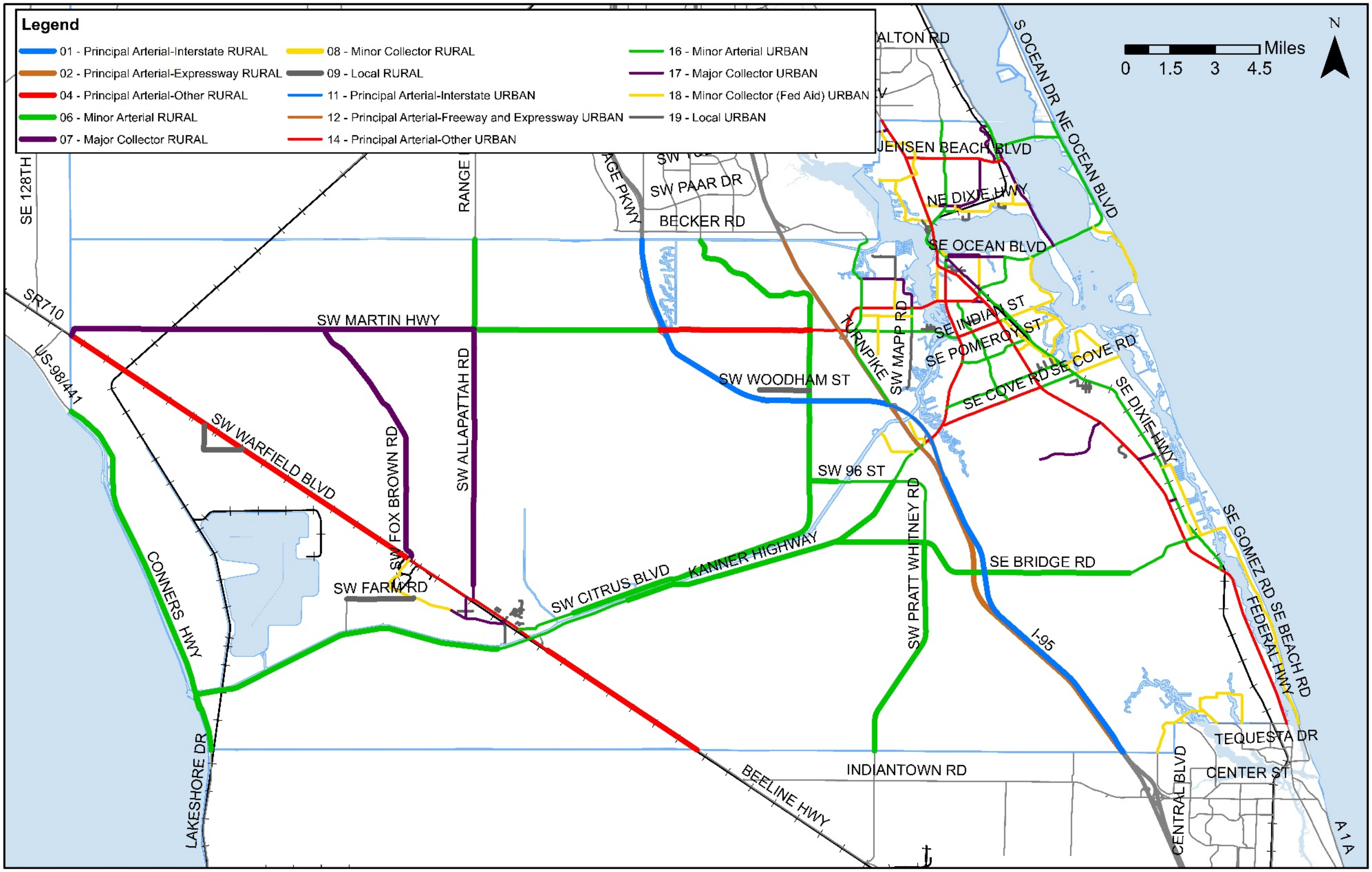


Figure 2 – Martin County Roadway System Network Showing Functional Classifications

2.Data Sources used in CMP Update

To examine in detail the exiting congestion conditions in Martin County, data included in the Regional Integrated Transportation Information System (RITIS) was explored. RITIS is an automated data sharing, dissemination, and archiving system that includes many performance measure and visual analytics tools, used by many transportation agencies across the nation. RITIS integrates data from various sources including INRIX, HERE, and NPMRDS.

INRIX primarily works with freight operators, fleet vehicles (such as taxicabs, United Parcel Service, FedEx, etc.), individual original equipment manufacturers (OEMs), and their custom APP users to collect location data over time. INRIX aggregates individual probe readings per roadway segment to calculate segment-based speed and travel time in near real time. In addition to speed-readings and travel time calculations, INRIX provides confidence scores that implicitly indicate the number of probes used to generate data and the level of modeling/imputing/archived data used to supplement low probe count.

HERE works with smartphone manufacturers and cell service providers, as well as OEMs, to collect location data over time. HERE and INRIX data formats are very similar, with slight differences in how they define data quality measures. Both INRIX and HERE provide speed, travel time, and confidence value per segment of the road at frequencies as low as once per minute.

According to a research conducted by FDOT in May 2015, Bluetooth and HERE datasets provide remarkably similar estimates of “average” time-of-day travel speeds, even at the segment-level. Therefore, for a planning study, if the HERE data is available for a corridor, then HERE data should be used instead of INRIX data. It should be noted that although there is no need to collect Bluetooth or floating car speed data, a filtering process for HERE data is necessary to remove the data noise.

The National Performance Management Research Data Set (NPMRDS) is a vehicle probe-based travel time data set acquired by the Federal Highway Administration (FHWA) for its use in various performance measurement programs, such as its Freight Performance Measures, Urban Congestion Report, and other programs. The NPMRDS is also provided to state departments of transportation (DOTs) and metropolitan planning organizations (MPOs) for their performance management activities. The NPMRDS is a FHWA procured and sponsored archived speed and travel time data set, and its associated location referencing data, covering the National Highway System (NHS). Currently, RITIS website provides NPMRDS INRIX data from February 1st, 2017 onward and NPMRDS HERE data is only available between October 1st, 2011 and January 31st, 2017.

The NPMRDS data was not considered as a data source in this study due to its two major limitations. First, NPMRDS covered less Traffic Message Channel (TMC) codes than HERE, which is primarily because the NPMRDS only covered the National Highway System. There is a total of 378 TMC codes for Martin County in RITIS HERE Dataset. Twenty percent of them (about 75 TMC codes) were randomly selected and compared with those in NPMRDS. The results indicate that only 65 of the 75 TMC codes were included in NPMRDS. In addition, the 2018 speed and travel time data were only available for 42 of 65 TMC codes in NPMRDS. Second, NPMRDS data presented a higher fluctuation than HERE data. As an example, **Figure 3** shows the fluctuation of HERE and NPMRDS data for a same segment during the same period.

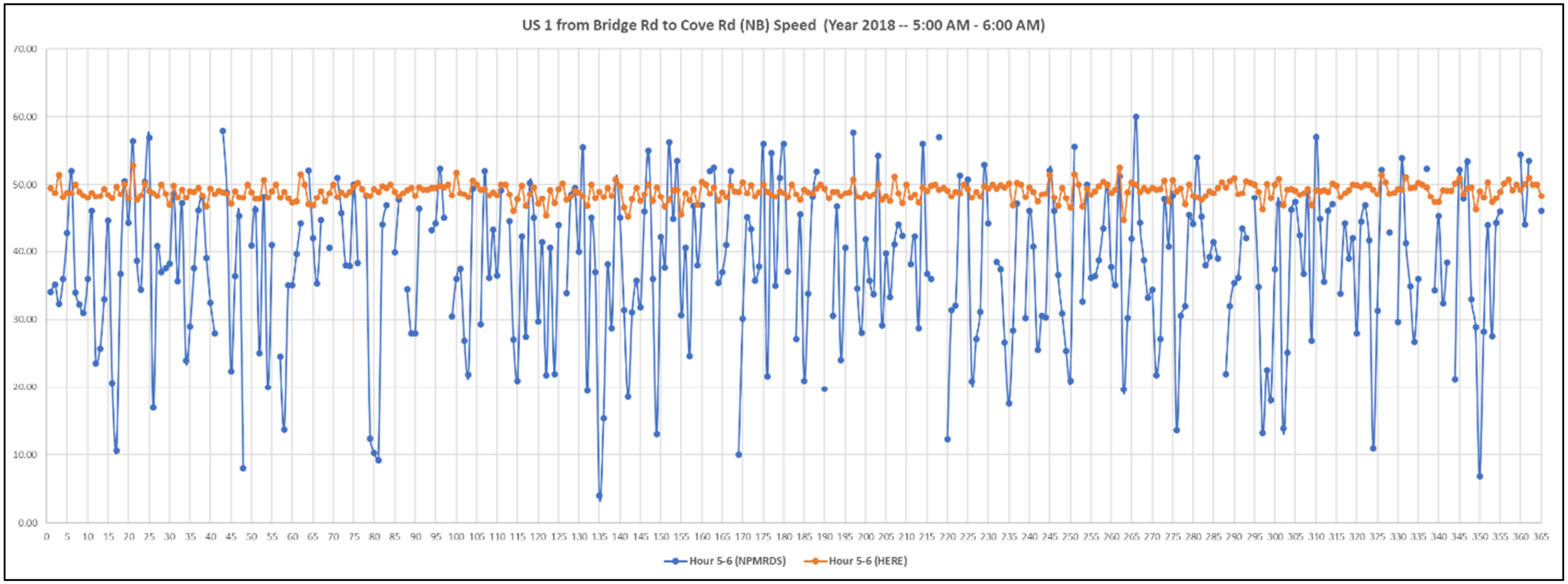
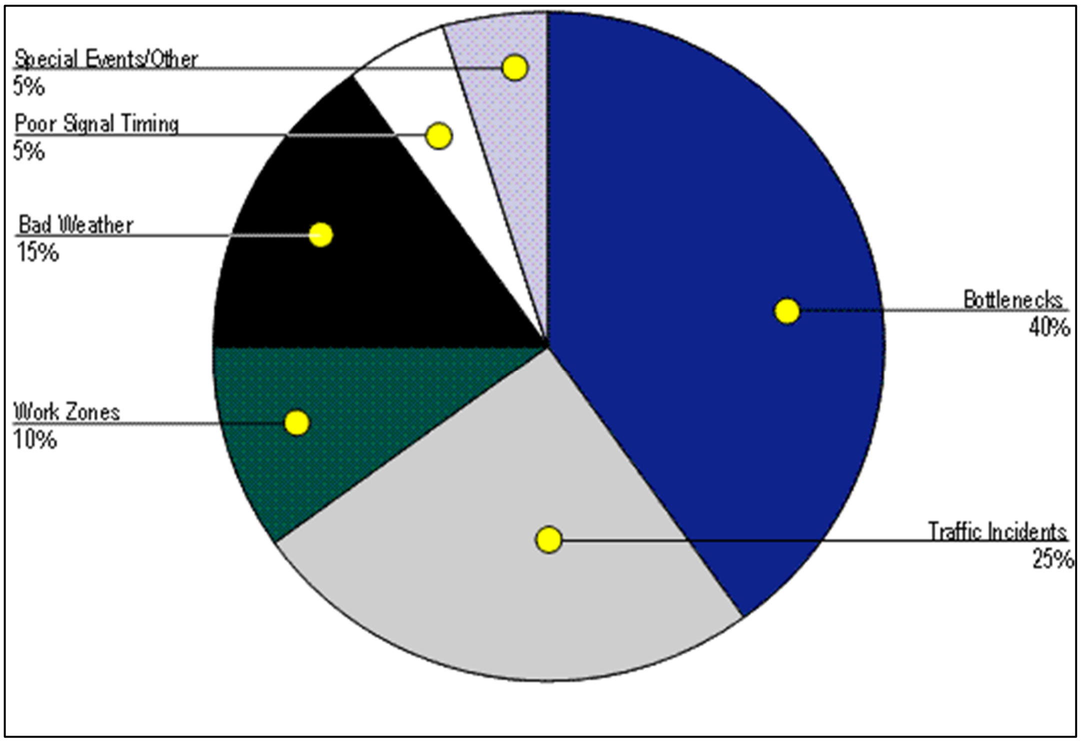


Figure 3 – The Fluctuation Comparison between HERE data and NPMRDS data

2. Phase 1 – Identification of Congested Spots

Causes of Congestion

FHWA conducted a national study on the sources of congestion and the results are presented in **Figure 4**. According to the study, bottlenecks are the largest cause of congestion nationally, followed by traffic incidents and bad weather. These national data are widely used in Congestion Management Process (CMP) updates because there are few comprehensive local studies on the causes of congestion. Based on the study and the unique characteristics in Martin County, the following three (3) major factors were considered to determine the potential congestion spots.



(Source: https://ops.fhwa.dot.gov/congestion_report/executive_summary.htm)

Figure 4 – Sources of Congestion National Summary

- Bottlenecks – Points where the roadways or regular traffic demands (typically at traffic signals) cause traffic to back up. These are the largest source of congestion and typically cause a roadway to operate below its adopted level of service standards.
- Traffic Incidents – Crashes, stalled vehicles, debris on the road. The incidents cause about one quarter of congestion problems.
- Special Events – Cause “spikes” in traffic volumes and changes in traffic patterns. These irregularities either cause or increase delay on days, times, or locations where there usually is none.

Bottlenecks

Two types of factors can be used to display the bottleneck ranking in RITIS, including base impact factor and weighted base impact factor. **Figure 5** presents the relationship between the bottleneck factors.

Basic Impact – the sum of queue lengths over the duration of the bottleneck

Weighted Base Impact — The base impact weighted by speed differential, congestion, or total delay, which provides an additional insight into the effects of bottlenecks on traffic within study area.

- Speed Differential — Base impact weighted by the difference between free-flow speed and observed speed. This metric should be used to identify and rank bottlenecks from the individual vehicle perspective.
- Congestion — Base impact weighted by the measured speed as a percentage of free-flow speed. Similar to the speed differential metric, the congestion metric should be used to identify and rank bottlenecks from the individual vehicle perspective.
- Total Delay — Base impact weighted by the difference between free-flow travel time and observed travel time multiplied by the average daily volume (AADT), adjusted by a day-of-the-week factor. This metric should be used to rank and compare the estimated total delay from all vehicles within the bottleneck.

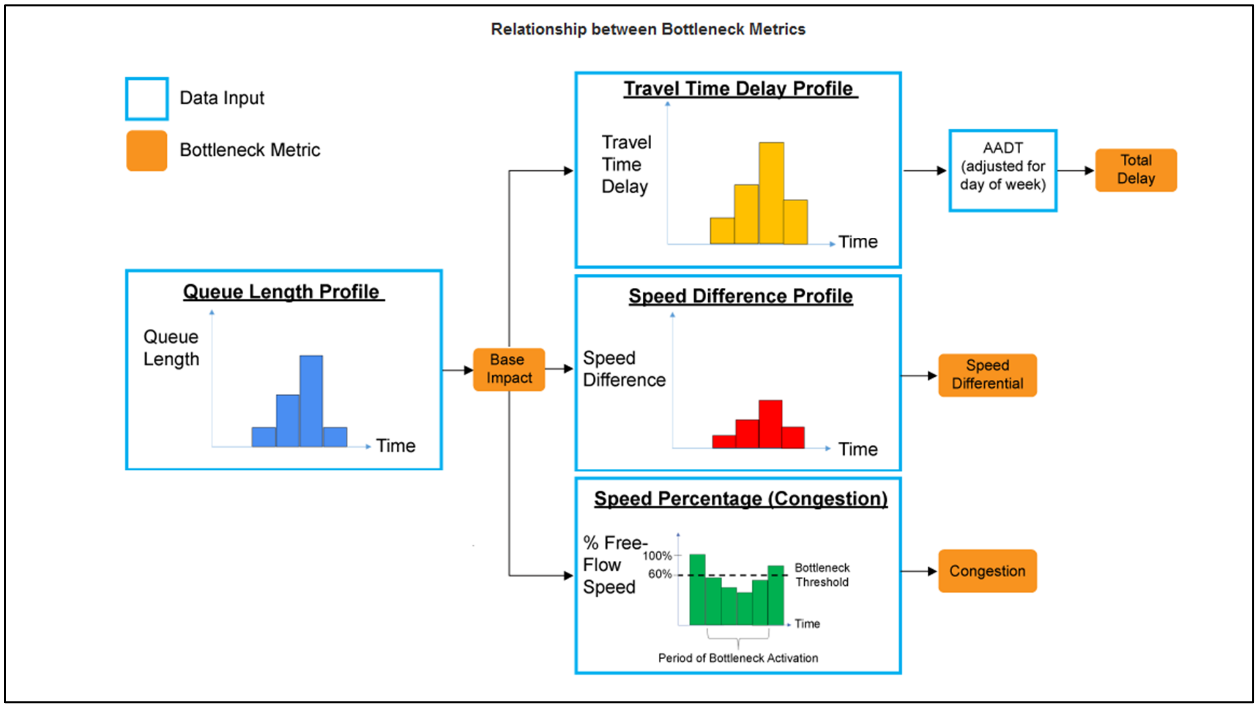


Figure 5 – The Relationship between Bottleneck Factors

Although RITIS recommends using the total delay for the bottleneck ranking, it should be noted that the "free-flow" speed in RITIS represents the 85th percentile of the observed speeds on that segment for all time periods. It is not the actual free-flow speed, which could lead to inaccurate weighted base impact factors Therefore, it was decided to use basic impact factor for bottleneck ranking.

The RITIS HERE data, between March 1st, 2018 and April 30th, 2018, were used to identify the bottlenecks in Martin County. **Table 2** summarizes the result of bottleneck ranking with the basic impact factor over than 1,000. **Figure 6** displays the potential bottlenecks based on the basic impact factor.

Table 2 – The Basic Impact Factors Summary

Location	Starting TMC Code	Average max length (miles)	Average daily duration	Total duration (From March 1st, 2018 to April 30th, 2018)	Base Impact (mile-minutes)
SR-76 W at US-1/SR-5/SW Federal Highway	102N07520	0.46	3 h 24 m	8 d 15 h 48 m	5,329
US-1 S at SR-76/S Kanner Highway /S Colorado Avenue	102N07527	0.71	1 h 43 m	4 d 9 h 23 m	4,154
US-1 S at CR-707A/NW Jensen Beach Boulevard	102N08772	2.13	32 m	1 d 8 h 56 m	3,780
SR-714 W at US-1/SE Federal Highway	102N07493	0.25	4 h 21 m	11 d 1 h 38 m	3,692
CR-707A W at NE Pineapple Drive/NE West End Boulevard	102-17399	0.12	8 h 55 m	22 d 16 h 33 m	3,688
CR-714 W at CR-609/Hale Dairy Road/Allapattah Road	102-11781	5.40	12 m	13 h 1 m	2,888
SR-76 E at SE Cove Road	102+07516	0.52	1 h 18 m	3 d 7 h 32 m	2,168
I-95 N at CR-708/Exit 96	102P05502	9.87	3 m	3 h 29 m	2,141
US-1 N at SR-714/SE Monterey Road	102+07525	0.79	46 m	1 d 22 h 57 m	2,037
CR-714 W at CR-76A/SW 48th Avenue	102-11783	1.04	33 m	1 d 9 h 52 m	1,947
SE Indian Street S at US-1/SE Federal Highway	102-17431	0.34	1 h 43 m	4 d 9 h 11 m	1,936
SR-714 E at CR-A1A/SE Palm Beach Road	102+09799	0.25	2 h 21 m	6 d 14 m	1,887
CR-732 E at SR-A1A/Ocean Boulevard	102+17372	1.89	16 m	16 h 28 m	1,864
SR-714 W at SR-76/S Kanner Highway	102N07492	0.75	43 m	1 d 20 h 30 m	1,852
CR-714 E at I-95/SR-9	102+11782	5.32	9 m	9 h 52 m	1,729
SR-76 W at SE Cove Road	102-07516	3.08	9 m	9 h 24 m	1,721
SR-714 E at SW Mapp Road	102+07491	0.52	58 m	2 d 11 h 47 m	1,683
CR-714 W at SR-91/SR-714/SW Martin Downs Boulevard	102-11784	1.93	14 m	14 h 35 m	1,573
S Dixie Highway at Joan Jefferson Way/Akron Avenue	102N17384	1.19	22 m	22 h 30 m	1,514
SR-710 E at SR-706/W Indiantown Road	102-07776	7.49	3 m	4 h 1 m	1,430
CR-708 E at SR-76/SW Kanner Highway	102P07504	0.04	11 h 5 m	28 d 4 h 22 m	1,423
CR-707A E at SR-707/Indian River Drive	102+17400	0.11	3 h 43 m	9 d 11 h 33 m	1,418
US-1 N at SR-716/Cane Slough Road	102+08773	2.02	12 m	13 h 5 m	1,393
SR-A1A S at US-1/SR-5/SW Federal Highway	102-09699	1.28	18 m	18 h 54 m	1,345
I-95 S at CR-708/Exit 96	102N05502	4.83	4 m	4 h 42 m	1,334
I-95 N at SR-76/Exit 101	102P05503	4.94	3 m	4 h	1,332
US-1 N at SR-76/S Kanner Highway/S Colorado Avenue	102+07527	0.55	43 m	1 d 20 h 15 m	1,329
US-1 S at SR-714/SE Monterey Road	102N07525	1.05	19 m	20 h 16 m	1,184
Florida's Turnpike N at Thomas B Manuel Bridge	102P18580	5.96	4 m	4 h 36 m	1,180
SR-76 E at US-1/SR-5/SW Federal Highway	102P07520	1.11	19 m	19 h 56 m	1,175
US-1 N at SW Joan Jefferson Highway	102+07528	0.86	21 m	22 h 17 m	1,173
I-95 S at CR-713/Exit 102	102N05504	7.88	3 m	3 h 6 m	1,115

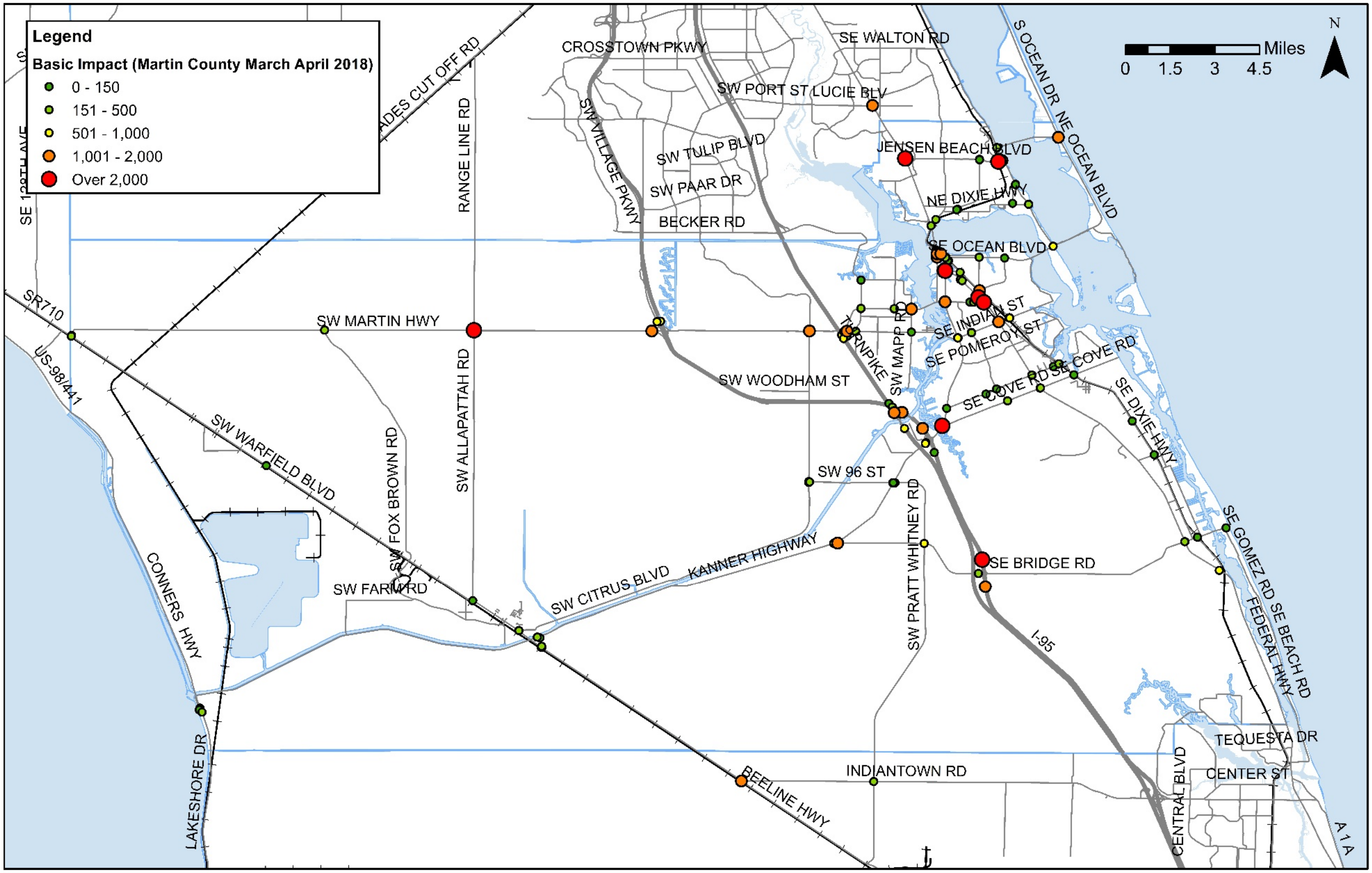


Figure 6 – Bottleneck Ranking Map based on Basic Impact Factors

Crash Density

Congestion correlates to a diminishing of road safety. During times of congestion, when the roadway is at or over capacity, there is usually an increase in crash frequency. The other facet of the relationship between safety and congestion is the occurrence of a crash incident contribution to congestion. Traffic incidents are also a contributor to bottlenecks and cause for congestion.

To identify areas that may be prone to congestion, a crash density map was created by using the historical five years (2012-2016) crashes data obtained from FDOT Crash Analysis Reporting System (CARS). The CARS database is generated generally by merging crash data from Department of Highway Safety and Motor Vehicles (DHSMV) with roadway information from FDOT. The database contains all the information recorded in the long form crash report. All reported crashes with a fatality, an injury, and high property damage that occurred on state roads are included in the database. The several major locations with high frequent crashes during the five-year period were identified in **Table 3** and **Figure 7**. These spots have a higher potential for significant congestion.

Table 3 – Historical Number of Crashes Summary

Location	Number of Crashes (per 0.1 square miles)
Jensen Beach Boulevard at US-1/Federal Highway	144
SW Martin Downs Boulevard at SR-76/Kanner Highway	129
I-95 at SR-76/Kanner Highway	123
US-1/Federal Highway at NW Britt Road/NW Goldenrod Road (South of Jensen Beach Boulevard)	123
NW Goldenrod Road at US-1/Federal Highway (North of Jensen Beach Boulevard)	119
US-1/Federal highway at SE Indian Street	117
US-1/Federal Highway at SR-76/Kanner Highway/Colorado Avenue	115
US-1/Federal Highway at SE Monterey Road	114
US-1/Federal Highway at SE Salerno Road	101
SE Cove Road at SR-76/Kanner Highway	93
US-1/Federal Highway at SE Pomeroy Street/SE Market Place/SE Monroe Street	92
Martin Downs Boulevard at SW Highway Meadow Avenue	84
SE Salerno Road at SR-76/Kanner Highway	79
US-1/Federal Highway south of SE Dixie Highway	78
SW Mapp Road at Martin Downs Boulevard	77
Martin Downs Boulevard at SW Martin Highway	71
US-1/Federal Highway at SE Cove Road	68
SR-76/Kanner Highway at SE Indian Street	67
US-1/Federal Highway at NW Forest Drive (North of NW Dixie Highway)	63
US-1/Federal Highway at SW Dixie Highway	61
SE Ocean Boulevard at N Sewalls Point Road	60
US-1/Federal Highway north of NW Goldenrod Road	59
US-1/Federal Highway at NW Westmoreland Boulevard	59
I-95 South of SE Bridge Road	58
US-1/Federal Highway at NE Baker Road	57
US-1/Federal Highway north of SE Monterey Road	55
US-1/Federal Highway south of SE Indian Street	54
SE Monterey Road at SE Willoughby Boulevard	53
US-1/Federal Highway at SE Bridge Road	52
SE Monterey Road at SE Ocean Boulevard	52
I-95 south of SR-76/Kanner Highway	51

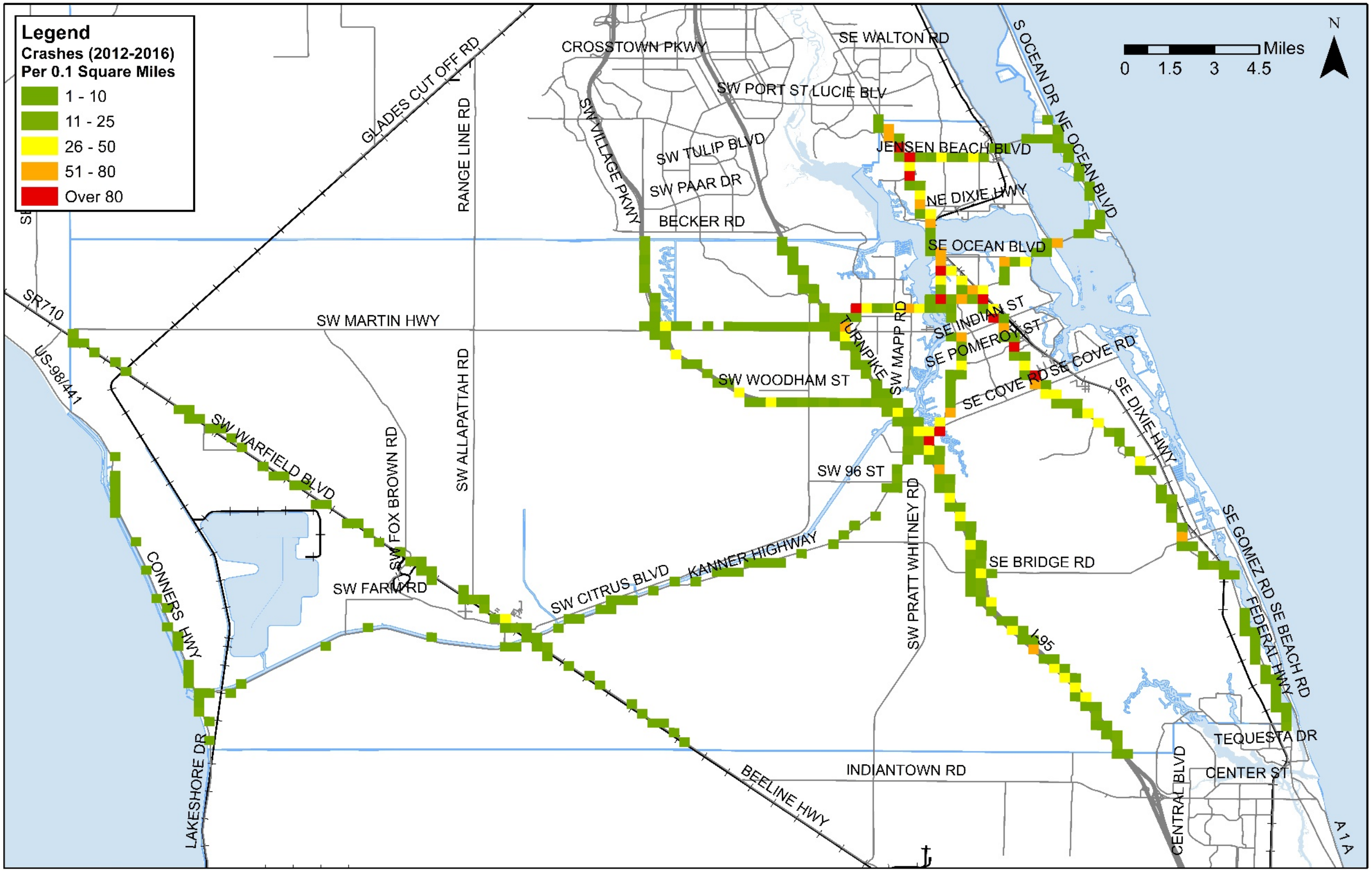


Figure 7 – Crash Density Map

Special Events

Planned special events will lead to the sudden increases in traffic demand, particularly in suburban or rural areas, these sudden increases can temporarily overburden the roadway system. Since these events happened on several fixed days in every year and typically resulted in traffic congestion, therefore it is necessary to evaluate if they would be the potential congested spots. There were eight special events took place in Martin County in 2018. **Figure 8** presents the major roadway segments nearby these special events and the dates of the events.

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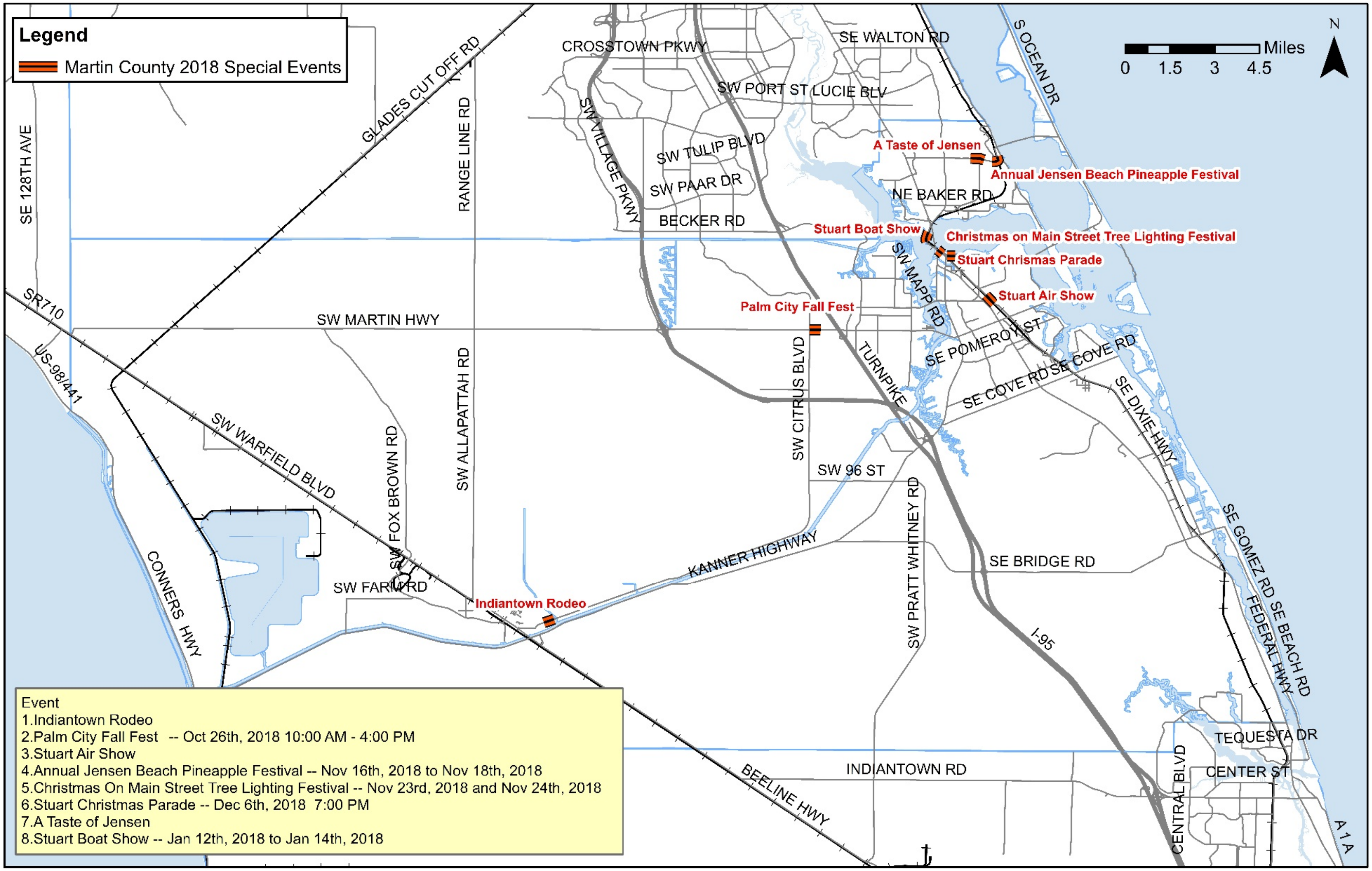

Figure 8 – Special Events Locations Map

By reviewing the performance metrics of each events using RITIS, five of the eight special events significantly resulted in the traffic congestion.

- Palm City Fall Fest

  Palm City Fall Fest occurred on October 26th, 2018 (from 10:00 AM to 4:00 PM), at Citrus Grove Community Park. **Figure 9** below shows the during of congestion for SR-714/SW Martin Highway at the location nearby compared to other days of the year. The color shade represents the severity of congestion and the length represents the time period of the congestion. There was a 1.04-miles queue and it lasted for 16 minutes during that period. The basic impact factor, which is the product of queue length in miles and duration in minutes, is shown as 16.64 at this location.

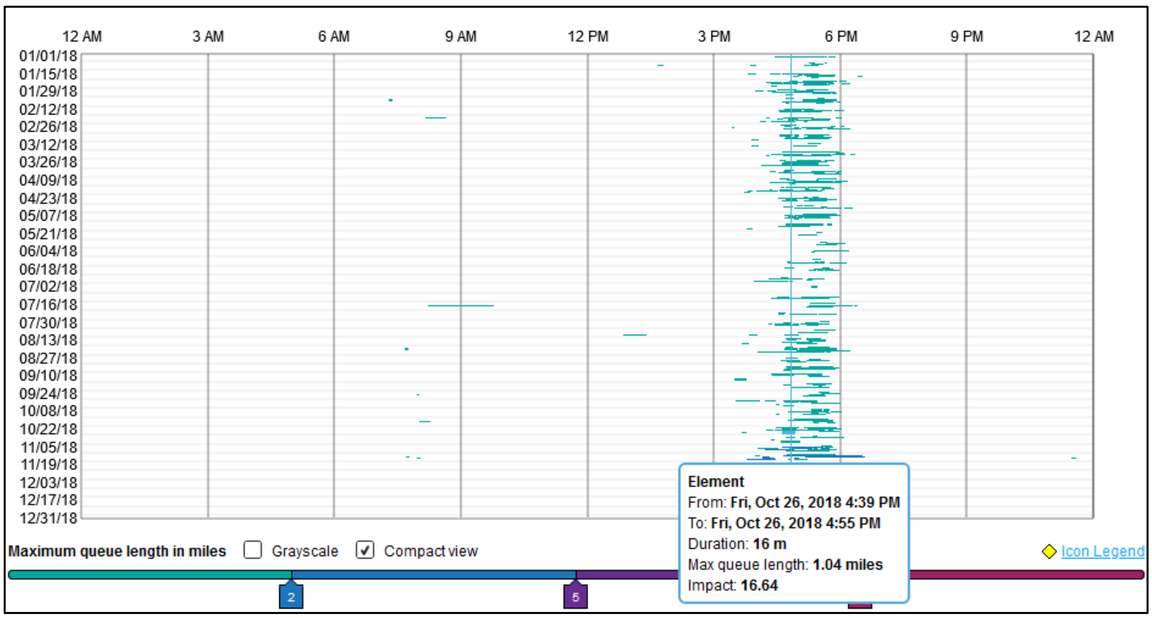

Figure 9 – Bottleneck Performance of Palm City Fall Fest

- Annual Jensen Beach Pineapple Festival

  Annual Jensen Beach Pineapple Festival was held from November 16th, 2018 to November 18th, 2018, at Downtown Jensen Beach. Two major bottlenecks were resulted from this event.

  Figure 10 shows the performance of the first bottleneck, which was located at the intersection of NE Pineapple Avenue and NE Jensen Beach Boulevard. The duration of the queue lasted for thirteen hours, from 8:00 AM to 9:00 PM. It should be noted that this location was a bottleneck even on other regular times, which was consistent with the fifth-highest basic impact factor (3,688) in the bottleneck ranking analysis. **Figure 11** shows the speed changes when this event took place.

  Figure 12 presents the performance of the second bottleneck, which was located at the intersection of NE Indian River Drive and NE Jensen Beach Boulevard. The duration of the queue was six (6) hours, from 10:00 AM to 4:00 PM. Similar to the first bottleneck, this bottleneck was also regular congestion spots with a higher basic impact factor during other regular times. **Figure 13** presents the speed changes when this event happened.

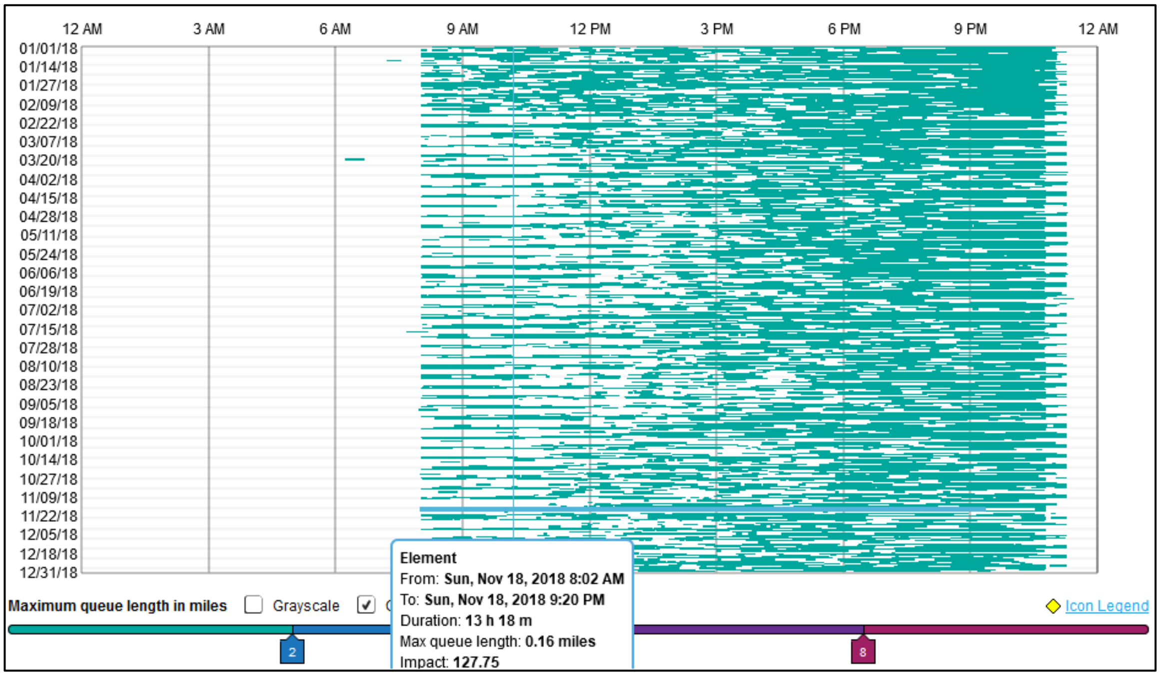

Figure 10 –Performance of Annual Jensen Beach Pineapple Festival for Bottleneck 1

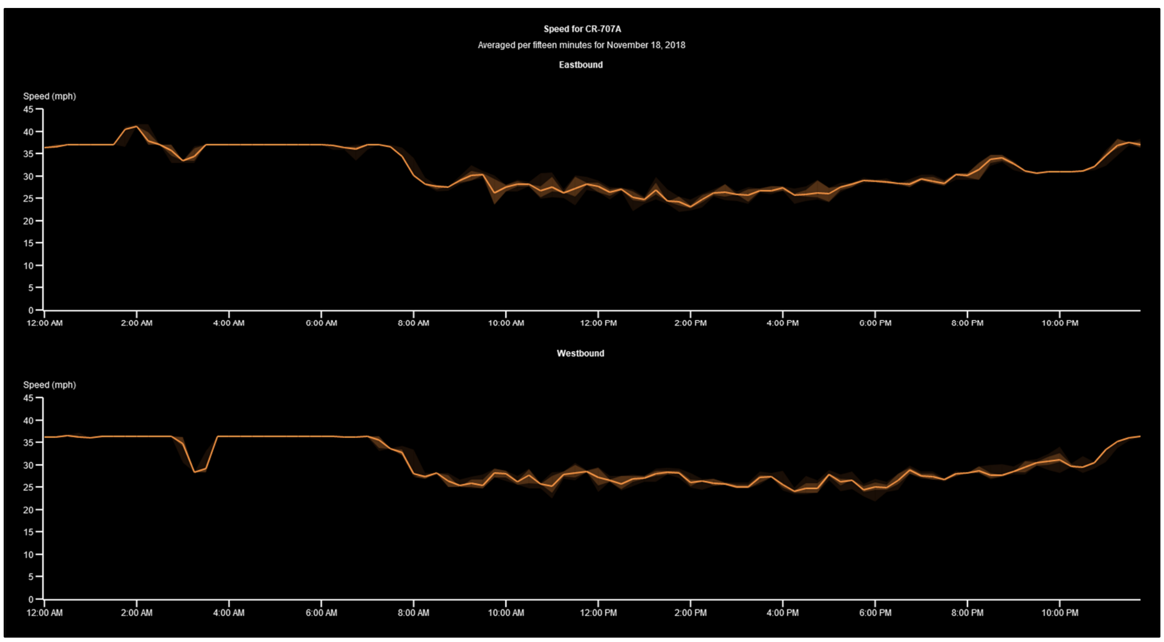

Figure 11 – Speed Changes during the Period of Annual Jensen Beach Pineapple Festival for Bottleneck 1

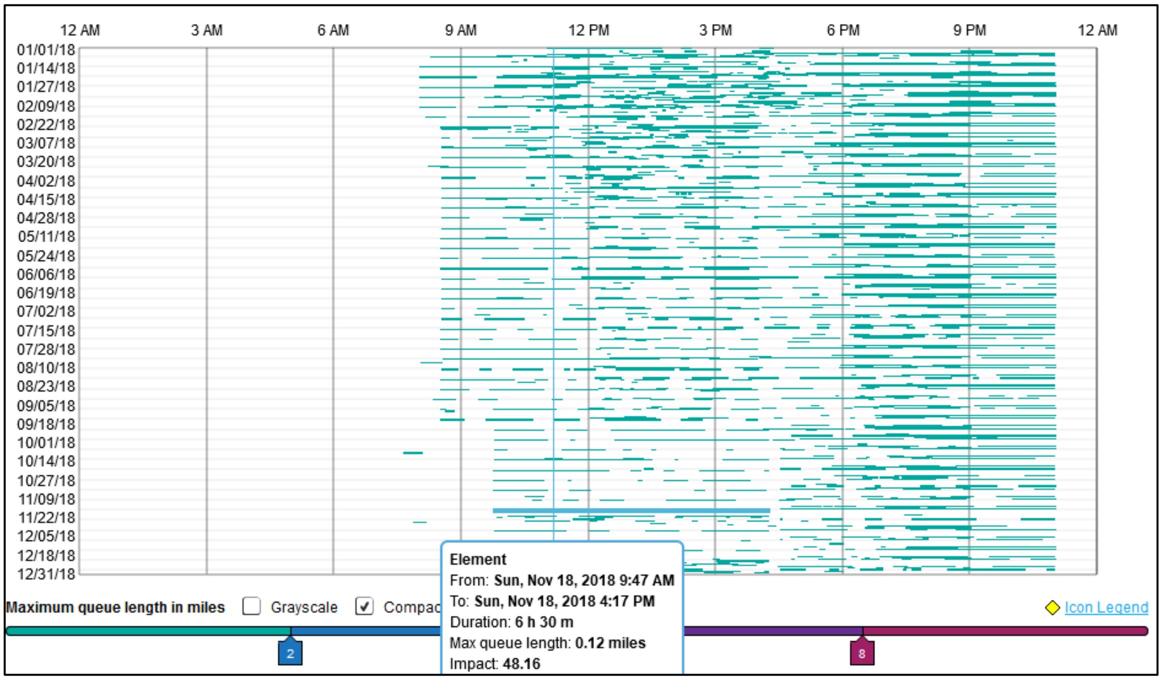

Figure 12 –Performance of Annual Jensen Beach Pineapple Festival for Bottleneck 2

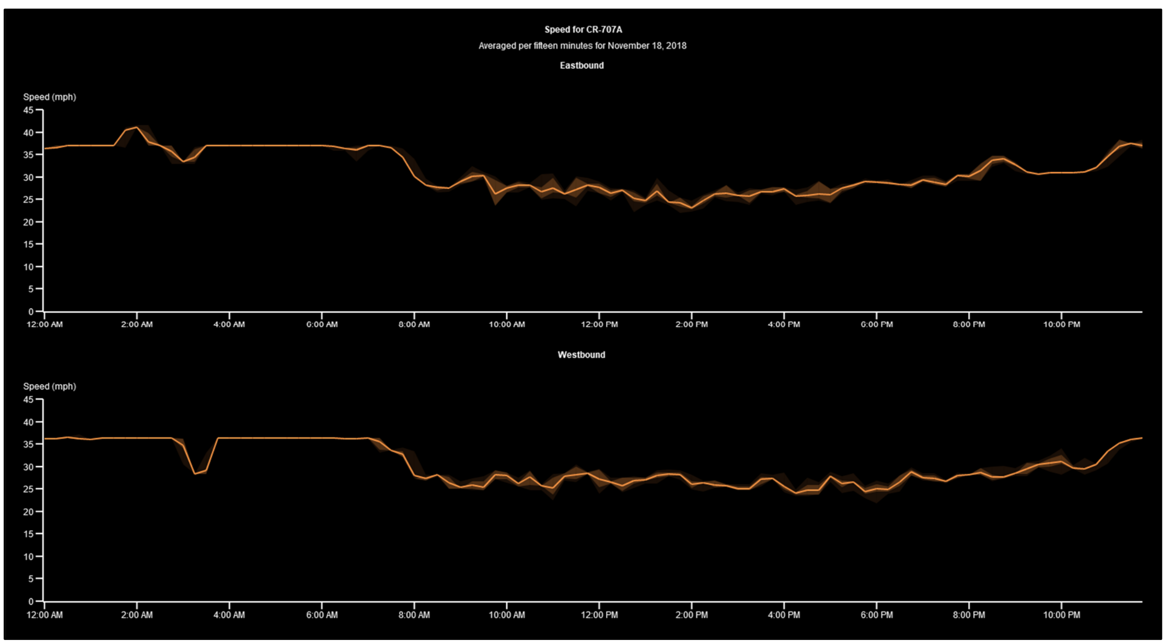

Figure 13 – Speed Changes during the Period of Annual Jensen Beach Pineapple Festival for Bottleneck 2

- Christmas on Main Street Tree Lighting Festival

Christmas on Main Street Tree Lighting Festival was held from November 23rd, 2018 to November 24th, 2018, at Riverwalk Stage in Downtown Stuart. A bottleneck, as the results of this event, was observed at the intersection of SW Joan Jefferson Way and S Dixie Highway. **Figure 14** shows the performance of this bottleneck. The duration of queue was two hours due to this event. Since this location only became a bottleneck in the winter season/holiday season, the performance chart of this bottleneck presents a different pattern from others. The basic impact factor during other times was also considered high. There were many crashes happened during the five-year period from 2012 to 2016, which could be the result of low capacity (one lane in each direction) and high traffic demand.

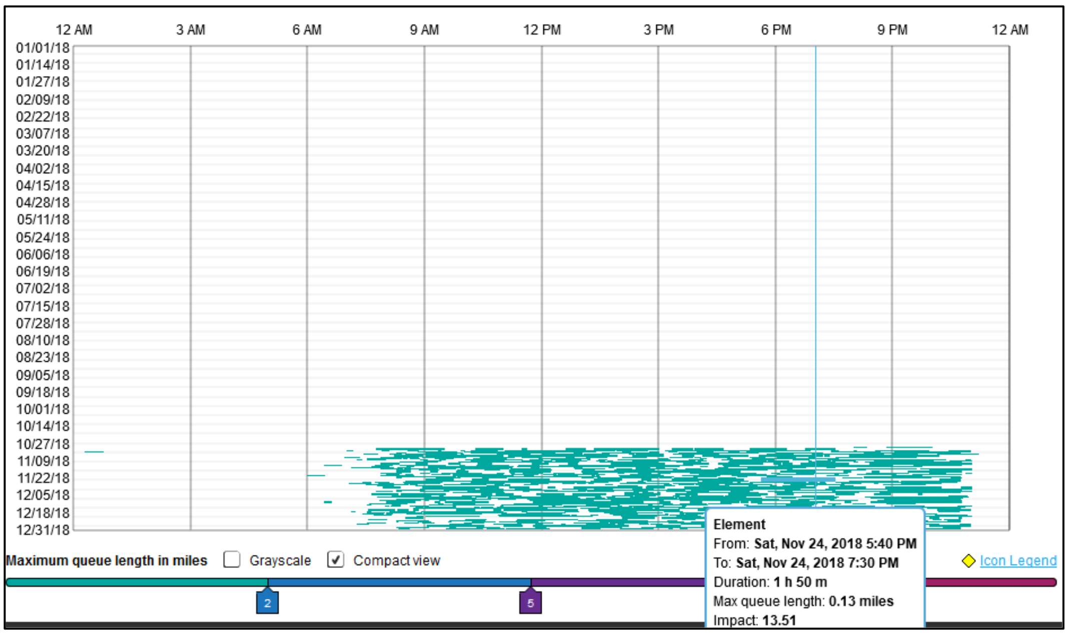

Figure 14 – Bottleneck Performance of Christmas on Main Street Tree Lighting Festival

- Stuart Christmas Parade

Stuart Christmas Parade was held at 7:00 PM, on December 6th, 2018. It took place at E. Ocean Boulevard. **Figure 15** shows the bottleneck performance due to this event. As shown on the chart, there was a 28-minute queue before the starting of this Christmas parade. Although there were several bottlenecks along E Ocean Boulevard during the regular dates, the basic impact factors were low.

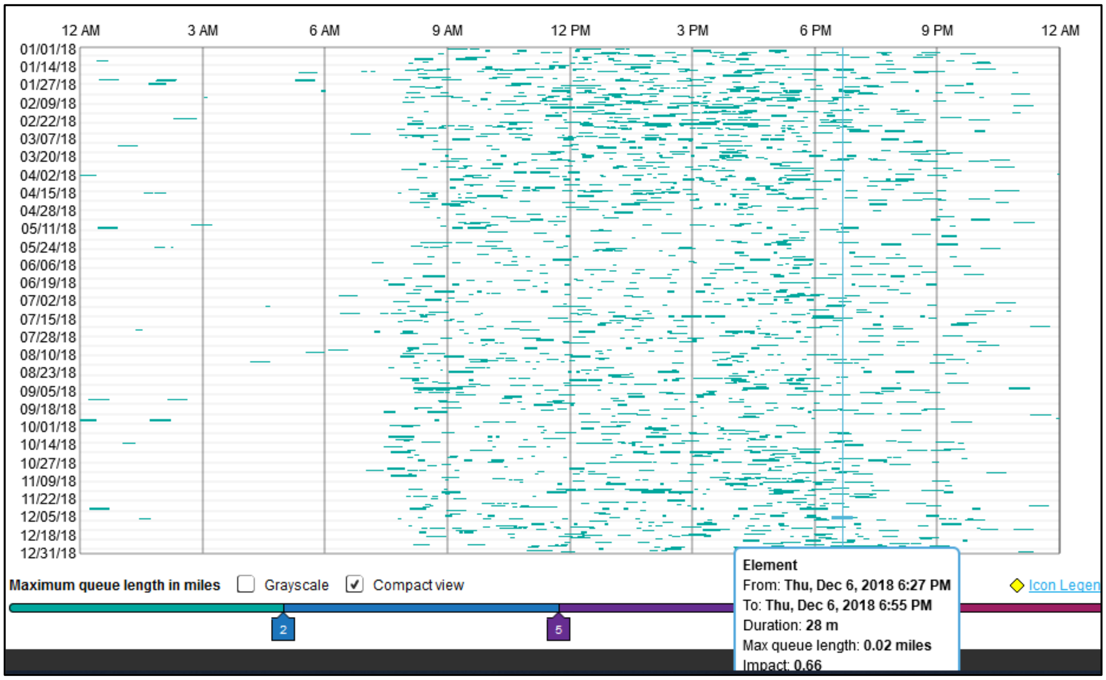

Figure 15 – Bottleneck Performance of Stuart Christmas Parade

- Stuart Boat Show

Stuart Boat Show was held from January 12th to January 14th, 2018, at NW Dixie Highway. **Figure 16** presents the bottleneck performance resulting from this event. As shown on the chart, there were several queues with different durations observed from 11:00 AM to 3:00 PM on January 13th, 2018. Based on the bottleneck ranking analysis during other regular dates, this location was not included in further bottleneck analysis. In addition, the number of crashes in the five-year period along the roadway near this location was low.

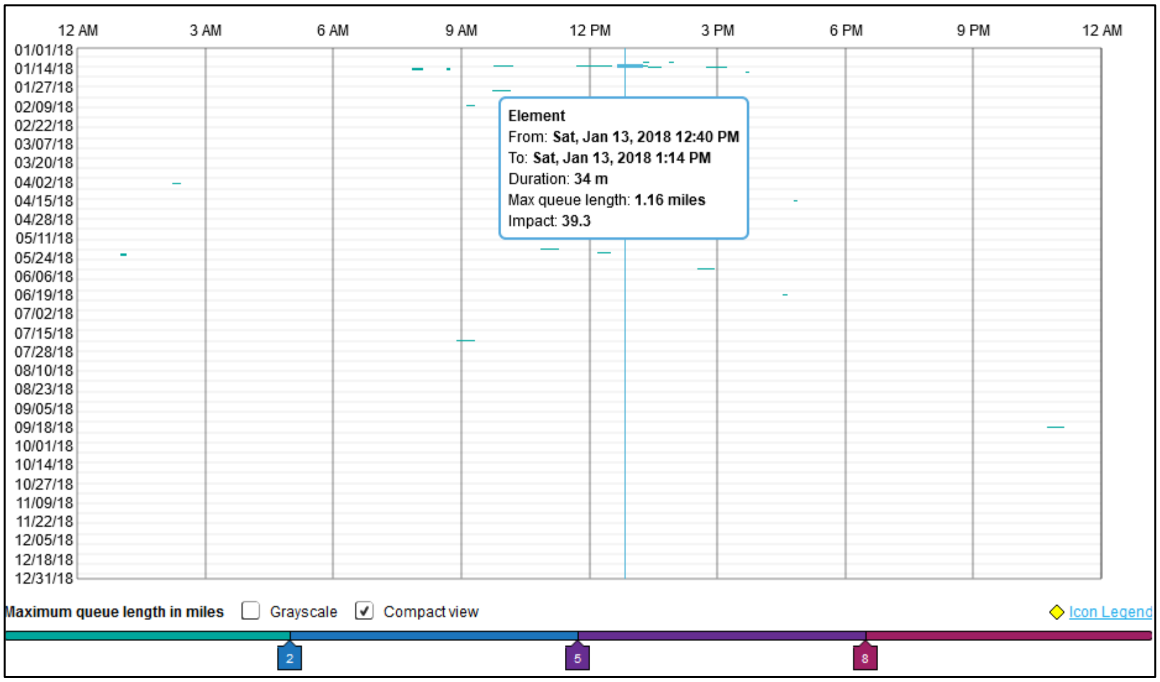

Figure 16 – Bottleneck Performance of Stuart Boat Show

Preliminary Congestion Spots

Based on the analysis above, a total of twenty-seven spots was considered to be the potential congested spots. Those spots would be further evaluated to determine the preliminary congested segments in Phase 2. **Figure 17** identifies the locations of the potential congested spots.

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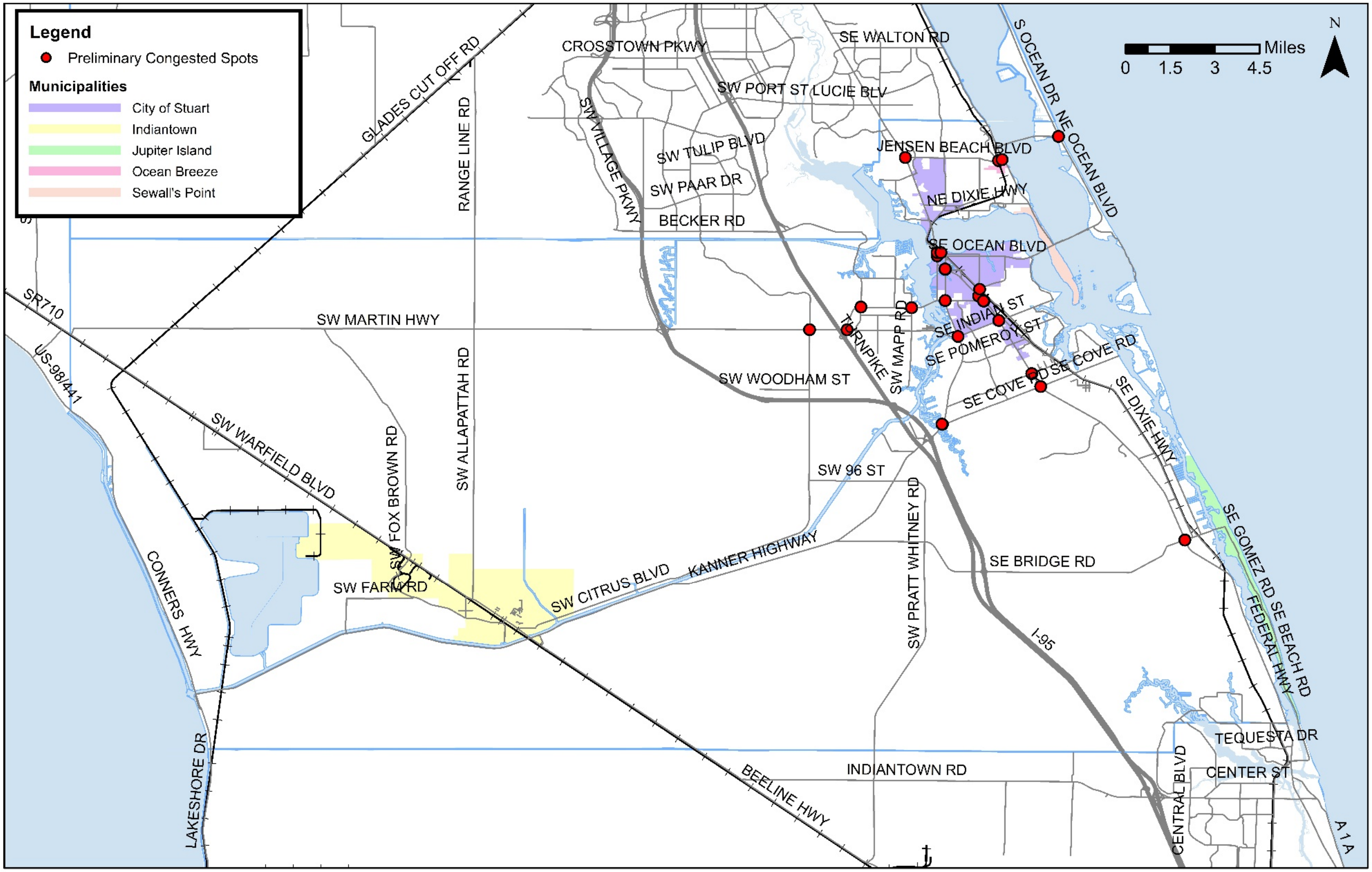

Figure 17 – Potential Congested Spots Locations Map

3. Phase 2 - Preliminary Congestion Segments

Congestion Scan

A third-party vendor RITIS website was utilized to generate congestion scan charts that provided a robust visualization of congestion occurrences along a corridor and allowed for detailed exploration of each corridor. The congestion scan chart, based on average raw speeds along a corridor, provides a consolidated view of the extent of slow traffic specific to each location along a corridor, in each direction over a 24-hour period. Therefore, the preliminary congestion spots obtained from Phase 1 could be further extended to congestion corridors by reviewing their congestion scan charts. **Figure 20Figure 26** presents all the potential congested segments.

As an example, a congestion scan chart for roadway US-1 was prepared to show raw speeds on March 9th, 2018 in **Figure 18**. As shown in the chart, there were two congested segments within Martin County, one was located between SE Indian Street and Roosevelt Bridge, and the other is between Roosevelt Bridge and North County Line (south of SR-716). Combined with the congested spots obtained from Phase 1, those two congested segments were divided into six segments.

- US-1 between SE Indian Street and Monterey Road
- US-1 between Monterey Road and SR-714
- US-1 between SR-714 and SE Dixie Cutoff Road
- US-1 between SE Dixie Cutoff Road and SR-76
- US-1 between SR-76 and Dixie Highway
- US-1 between Dixie Highway and North County Line

Although US-1 south corridor was not presented a congested condition in congestion scan chart, it was still considered as a potential congested segment due to the congested spot located at US-1 and Bridge Road.

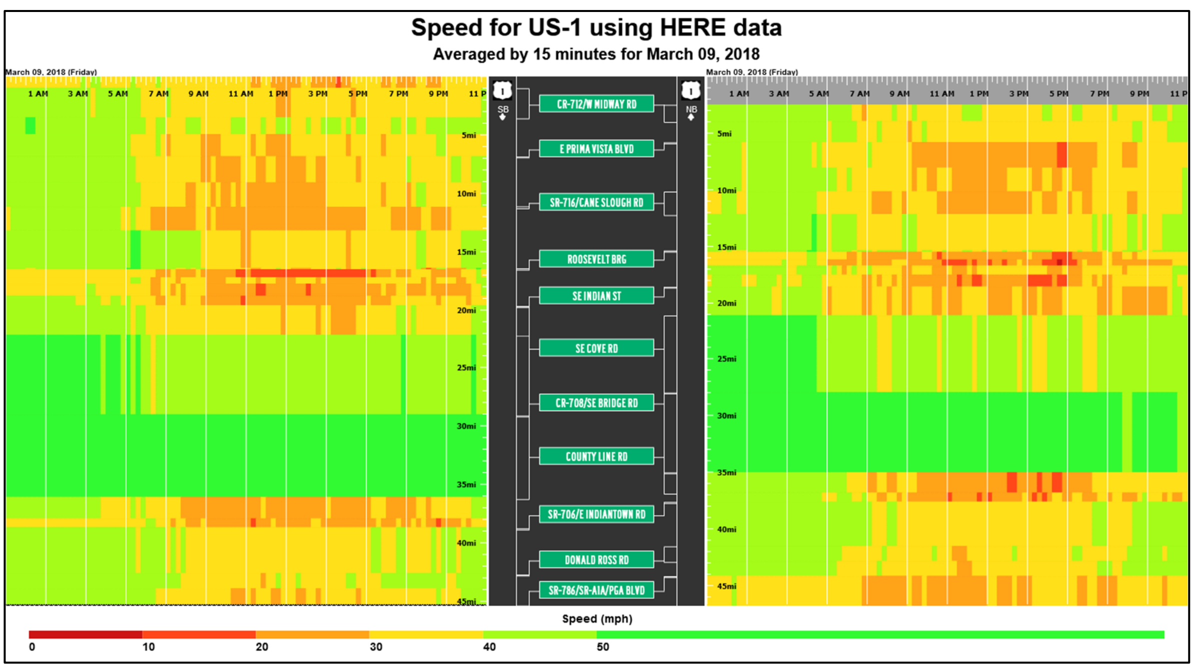

Figure 18 – Congestion Scan Chart for US-1

Figure 19 shows another example. As can be seen in the congestion scan chat, there was a significant congestion along SR-76/Kanner Highway between north of I-95 and SR-714/Monterey Road. Combined with the congested spots from Phase 1, the corridor Kanner Highway/SR-76 between north of I-95 and SR-714/Monterey Road was identified as potential congested segment.

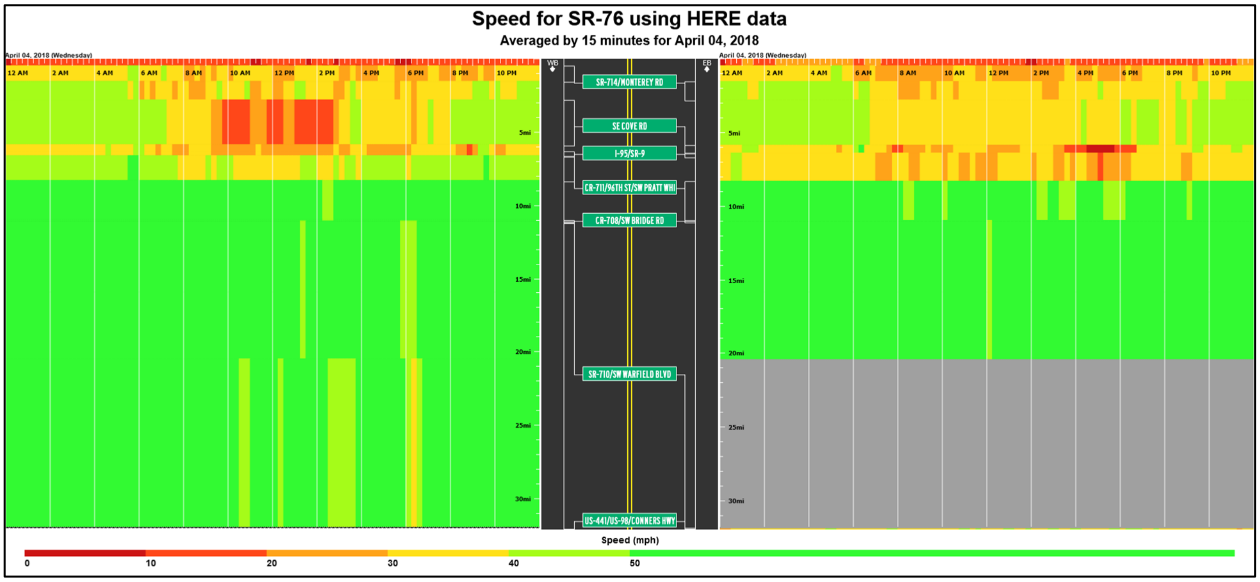

Figure 19 – Congestion Scan Chart for SR-76/Kanner Highway

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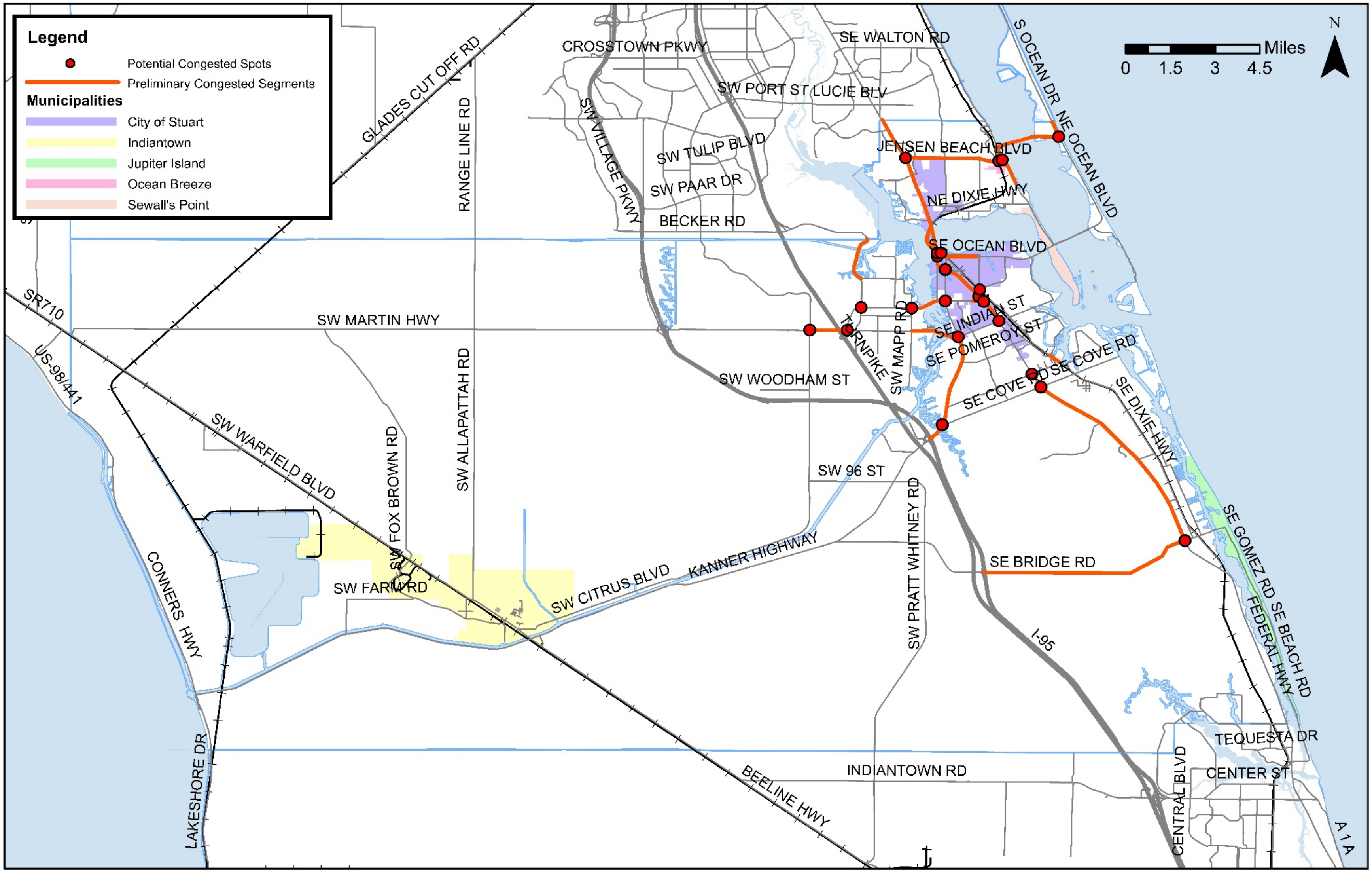

Figure 20 – Potential Congested Spots and Preliminary Congested Segments Locations Map

4. Phase 3 - Potential congestion segments

A variety of congestion performance measures were utilized to determine the potential congestion segments including Travel Time Index (TTI)/Planning Time Index (PTI), Level of Service (LOS), and Volume-to-Capacity (V/C) ratio.

TTI/PTI

Travel time index (TTI) is the travel time represented as a percentage of the ideal travel time. It uses the units of travel rate due to the ease of mathematical calculation. The equation below presents the calculation of the travel time index.

The index can be applied to various system elements with different free-flow speeds. The travel time index compares measured travel rates to free flow conditions for any combination of freeways and streets. Index values can be related to the general public as an indicator of the length of extra time spent in the transportation system during a trip.

$$Travel\ Time\ Index\ (TTI) = \frac{Travel\ Time}{Free - Flow\ Travel\ Time}$$

Planning Time Index (PTI) is the total travel time that should be planned when an adequate buffer time is included (95% Travel Time / Free-flow Travel Time). The planning time index includes typical delay as well as unexpected delay. Thus, the planning time index compares near-worst case travel time to a travel time in light or free-flow traffic. It is used as a supplemental measure for reliability. Because reliability is related to the distribution of travel rates, the 95th percentile indicates an excessively high travel rate, one that only five percent of all travel rates exceed for the time period under consideration.

$$Planning\ Time\ Index\ (PTI) = \frac{95th\ Percentile\ Travel\ Time}{Free - Flow\ Travel\ Time}$$

TTI/PTI provided by RITIS could be found by using the performance summaries function. However, the "free flow" speed in RITIS HERE data is the reference speed, not the real free-flow speed. It is calculated based upon the 85^{th}-percentile point of the observed speeds on that segment for all time periods. Therefore, the TTI/PTI from RITIS HERE data cannot be used directly.

The free-flow speeds were manually calculated for each congested corridor obtained from Phase 2. According to the NCHRP Report 387, two linear equations were recommended for computing the free-flow speed. One equation is for the facilities whose posted speed limits exceed 50 mph. the other equation is for the facilities with lower posted speed limits.

Facilities with posted speed limits greater than 50 mph:

$$Free - Flow\ Speed\ =\ 0.88 \times (Posted\ Speed\ Limit\ in\ mph) + 14$$

Facilities with posted speed limits equal to or less than 50 mph:

$$Free - Flow\ Speed\ =\ 0.79 \times (Posted\ Speed\ Limit\ in\ mph) + 12$$

To calculate the TTIs and PTIs, the posted speeds for all roadway segment were obtained from FDOT Roadway Characteristics Inventory (RCI) data based and verified through Google Maps. The free flow speeds were then calculated based on formulae included in NCHRP Report 387 listed above. The average travel time and 95th percentile travel times were identified using RITIS HERE data and converted to corresponding travel speeds. **Table 4** presents the results for SW Joan Jefferson Way between US-1 and Dixie Highway (Westbound) as an example. The TTIs/PTIs were calculated for 54 roadway segments listed in **Table 6**. **Figure 21** and **Figure 22** present the daily TTI/PTI Changes for all segments. **Figure 23** shows the segments color coded based on their TTI values. In the example above, since the TTI value for each hour was higher than 1.25, the corridor SW Joan Jefferson Way between US-1 and Dixie Highway (Westbound) was shown in red color in **Figure 23**.

Table *5* explains the classification of TTIs shown in **Figure 23**. TTI Code was defined based on the number of hours with TTI greater than 1.25.

- None of 24 hours with TTI greater than 1.25 was defined as “TTIs <1.25”
- A few hours (less than 12 hours) with TTI greater than 1.25 was defined as “Some of TTIs >=1.25”
- Majority hours (greater than 12 hours) with TTI greater than 1.25 was defined as “Most of TTIs >=1.25”
- All 24 hours with TTI greater than 1.25 was defined as “TTIs >=1.25”

Table 4 – Calculated TTI/PTI along SW Joan Jefferson Way

ID-41	SW Joan Jefferson Way between US-1 and Dixie Hwy (Westbound)										102-22436
TTI											
Hour 0-1	Hour 1-2	Hour 2-3	Hour 3-4	Hour 4-5	Hour 5-6	Hour 6-7	Hour 7-8	Hour 8-9	Hour 9-10	Hour 10-11	Hour 11-12
1.99	2.04	2.03	2.02	2.02	2.09	2.13	2.51	3.32	3.35	3.37	3.41
Hour 12-13	Hour 13-14	Hour 14-15	Hour 15-16	Hour 16-17	Hour 17-18	Hour 18-19	Hour 19-20	Hour 20-21	Hour 21-22	Hour 22-23	Hour 23-24
3.33	3.38	3.37	3.37	3.35	3.35	3.48	3.52	3.43	3.36	3.16	2.30
PTI											
Hour 0-1	Hour 1-2	Hour 2-3	Hour 3-4	Hour 4-5	Hour 5-6	Hour 6-7	Hour 7-8	Hour 8-9	Hour 9-10	Hour 10-11	Hour 11-12
2.36	2.36	2.36	2.36	2.36	2.36	2.36	3.01	4.37	4.39	4.39	4.42
Hour 12-13	Hour 13-14	Hour 14-15	Hour 15-16	Hour 16-17	Hour 17-18	Hour 18-19	Hour 19-20	Hour 20-21	Hour 21-22	Hour 22-23	Hour 23-24
4.39	4.39	4.45	4.42	4.60	4.53	5.10	4.63	4.39	4.39	4.27	2.77

Table 5 – TTI Classification for all Segments

Name	TTI Code	Number of Hours (TTI>=1.25) 24 Hours per Day
Bridge Road between I-95 and US-1	TTIs <1.25	0%
Jensen Beach Boulevard between US-1 and Savannah Road	Most of TTIs >=1.25	67%
Jensen Beach Boulevard between Savannah Road and Indian River Drive	TTIs >=1.25	100%
Kanner Highway between I-95 and SE Cove Road	TTIs >=1.25	100%
Kanner Highway between SE Cove Road and SE Indian Street	Most of TTIs >=1.25	58%
SW Martin Highway between SW Citrus Boulevard and SW Martin Downs Boulevard	Most of TTIs >=1.25	67%
SW Martin Highway between SW Mapp Road and Kanner Highway	TTIs <1.25	0%
SE Monterey Road between US-1 and SE Dixie Highway	TTIs >=1.25	100%
SE Monterey Road (EXT) at US-1	TTIs >=1.25	100%
US-1 South Corridor	Most of TTIs >=1.25	85%
US-1 North Corridor between North County Line and Dixie Highway	Some of TTIs >=1.25	40%
US-1 North Corridor between Dixie Highway and SR-76	Most of TTIs >=1.25	56%
US-1 North Corridor between SR-76 and Dixie Cutoff Road	Most of TTIs >=1.25	69%
US-1 North Corridor between Dixie Cutoff Road and SR-714	Most of TTIs >=1.25	69%
US-1 North Corridor between SR-714 and SE Monterey Road (Ext)	Most of TTIs >=1.25	73%
US-1 North Corridor between SE Monterey Road (EXT) and SE Indian Street	Most of TTIs >=1.25	71%
SW Murphy Road between High Meadow Avenue and North County Line	Some of TTIs >=1.25	44%
SR-714 between Mapp Road and SR-76	Some of TTIs >=1.25	33%
Dixie Highway between Salerno Road and St. Lucie Boulevard	Most of TTIs >=1.25	52%
SW Ocean Boulevard between US-1 and SR-A1A	TTIs >=1.25	100%
SW Joan Jefferson Way between US-1 and Dixie Highway	TTIs >=1.25	100%
Dixie Highway between South US-1 and North US-1	TTIs >=1.25	100%
Dixie Highway between US-1 and SW Ocean Blvd	TTIs >=1.25	100%
Indian River Drive between NE Dixie Highway and Jensen Beach Boulevard	TTIs >=1.25	100%
Indian River Drive between Jensen Beach Boulevard and CR-732	TTIs >=1.25	100%
CR-732 between Indian River Drive and SR-A1A	Some of TTIs >=1.25	8%
SR-A1A between CR-732 and North County Line	TTIs <1.25	0%

Table 6 – Description of all Calculated TTI/PTI Segments

ID	Segment	From	To	Direction	TMC Code (HERE Data)
1	Bridge Road	I-95	US-1	Eastbound	102+09806
2	Bridge Road	I-95	US-1	Westbound	102-07506
3	Jensen Beach Blvd	US-1	Savannah Road	Eastbound	102+17398
4	Jensen Beach Blvd	US-1	Savannah Road	Westbound	102-17397
5	Jensen Beach Blvd	Savannah Road	Indian River Drive	Eastbound	102+17399,102P17399,102+17400
6	Jensen Beach Blvd	Savannah Road	Indian River Drive	Westbound	102-17399,102N17399,102-17398
7	SW Kanner Highway	at I-95		Northbound	102+07516, 102P07501
8	SW Kanner Highway	at I-95		Southbound	102-07501, 102N07501
9	SW Kanner Highway	I-95	SR-714	Northbound	102+07518
10	SW Kanner Highway	I-95	SR-714	Southbound	102-07516
11	SW Martin Highway (Turnpike)	SW Citrus Blvd	SW Martin Downs Blvd	Westbound	102-11783, 112N11784
12	SW Martin Highway (Turnpike)	SW Citrus Blvd	SW Martin Downs Blvd	Eastbound	102+11784, 112P11784
13	SW Martin Highway	SW Mapp Rd	S Kanner Hwy	Westbound	102-11785
14	SW Martin Highway	SW Mapp Rd	S Kanner Hwy	Eastbound	102+50062
15	SE Monterey Road	US-1	SE Dixie Hwy	Eastbound	102+07493, 102P07493, 102+09799
16	SE Monterey Road	US-1	SE Dixie Hwy	Westbound	102-07493, 102N07493, 102-09798
17	SE Monterey Road (Ext)	US-1	SE Dixie Hwy	Eastbound	102P11442, 102+11443, 102P11443
18	SE Monterey Road (Ext)	US-1	SE Dixie Hwy	Westbound	102N11443, 102-11442, 102N11442
19	US-1 (South)			Northbound	102+08771
20	US-1 (South)			Southbound	102-07523
21	US-1 (North)	North County Line	Dixie Hwy	Southbound	102-07529
22	US-1 (North)	North County Line	Dixie Hwy	Northbound	102+08772
23	US-1 (North)	Dixie Hwy	SR-76	Southbound	102N07529, 102-07528, 102-07527
24	US-1 (North)	Dixie Hwy	SR-76	Northbound	102P07529, 102+07528, 102+07529
25	US-1 (North)	SR-76	SE Dixie Cutoff Rd	Southbound	102-07526
26	US-1 (North)	SR-76	SE Dixie Cutoff Rd	Northbound	102+07527, 102P07526
27	US-1 (North)	SE Dixie Cutoff Rd	SR-714	Southbound	102-07525
28	US-1 (North)	SE Dixie Cutoff Rd	SR-714	Northbound	102+07526
29	US-1 (North)	SR-714	Monterey Rd	Southbound	102N07525
30	US-1 (North)	SR-714	Monterey Rd	Northbound	102P07525
31	US-1 (North)	Monterey Rd	SE Indian Street	Southbound	102-07524
32	US-1 (North)	Monterey Rd	SE Indian Street	Northbound	102+07525
33	SW Murphy Road	High Meadow Ave	St. Lucie County Line	Northbound	102+56918
34	SW Murphy Road	High Meadow Ave	St. Lucie County Line	Southbound	102-56917
35	SR-714	Mapp Rd	SR-76	Eastbound	102+07492
36	SR-714	Mapp Rd	SR-76	Westbound	102-07491
37	Dixie Highway	Salerno Rd	St. Lucie Blvd	Northbound	102+17351
38	Dixie Highway	Salerno Rd	St. Lucie Blvd	Southbound	102-17350
39	SW Ocean Blvd	US-1	SR-A1A	Westbound	102-09699

ID	Segment	From	To	Direction	TMC Code (HERE Data)
40	SW Ocean Blvd	US-1	SR-A1A	Eastbound	102+09700
41	SW Joan Jefferson Way	US-1	Dixie Hwy	Westbound	102-22436
42	SW Joan Jefferson Way	US-1	Dixie Hwy	Eastbound	102+22437
43	Dixie Highway	US-1	US-1	Northbound	102+17385
44	Dixie Highway	US-1	US-1	Southbound	102-17384
45	Dixie Highway	US-1	SW Ocean Blvd	Northbound	102+17384
46	Dixie Highway	US-1	SW Ocean Blvd	Southbound	102-17383
47	Indian River Drive	NE Dixie Hwy	Jensen Beach Blvd	Northbound	102+17413
48	Indian River Drive	NE Dixie Hwy	Jensen Beach Blvd	Southbound	102-17412
49	Indian River Drive	Jensen Beach Blvd	CR-732	Northbound	102+17414
50	Indian River Drive	Jensen Beach Blvd	CR-732	Southbound	102-17413
51	CR-732	Indian River Drive	SR-A1A	Eastbound	102+17372
52	CR-732	Indian River Drive	SR-A1A	Westbound	102-17371
53	SR-A1A	CR-732	North County Line	Northbound	102+09703
54	SR-A1A	CR-732	North County Line	Southbound	102-09702

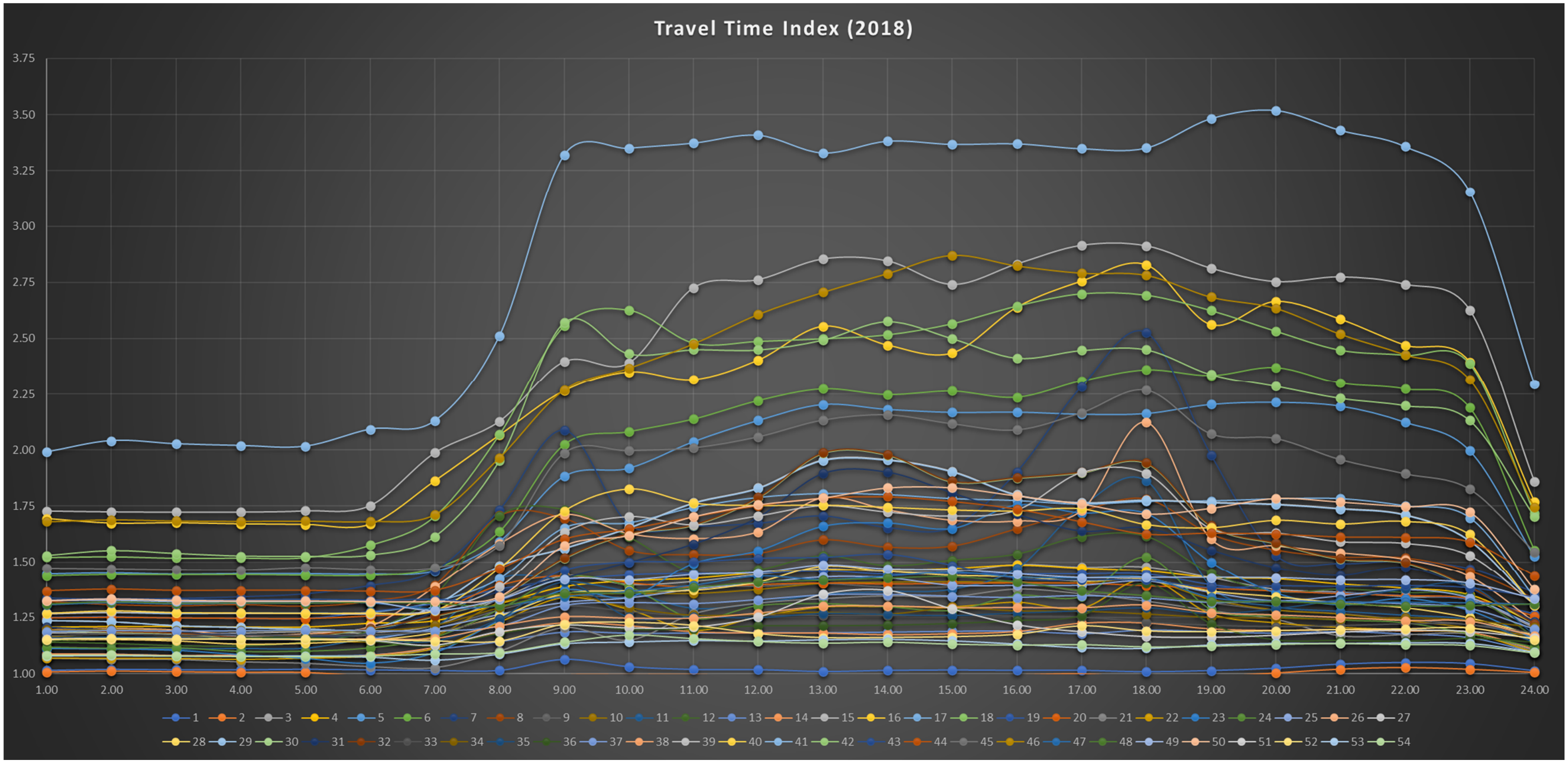

Figure 21 – Calculated Travel Time Index for All Segments

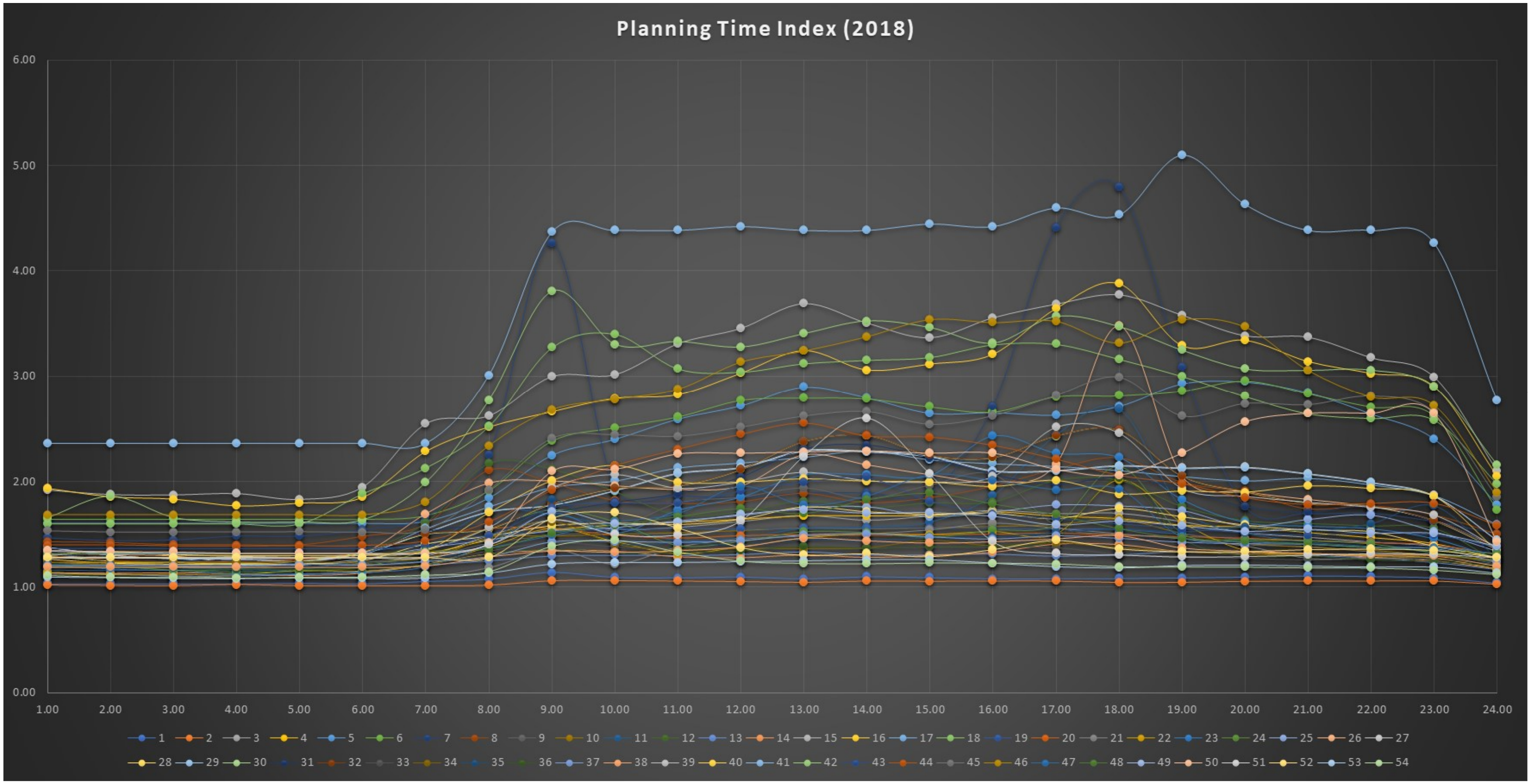

Figure 22 – Calculated Planning Time Index for All Segments

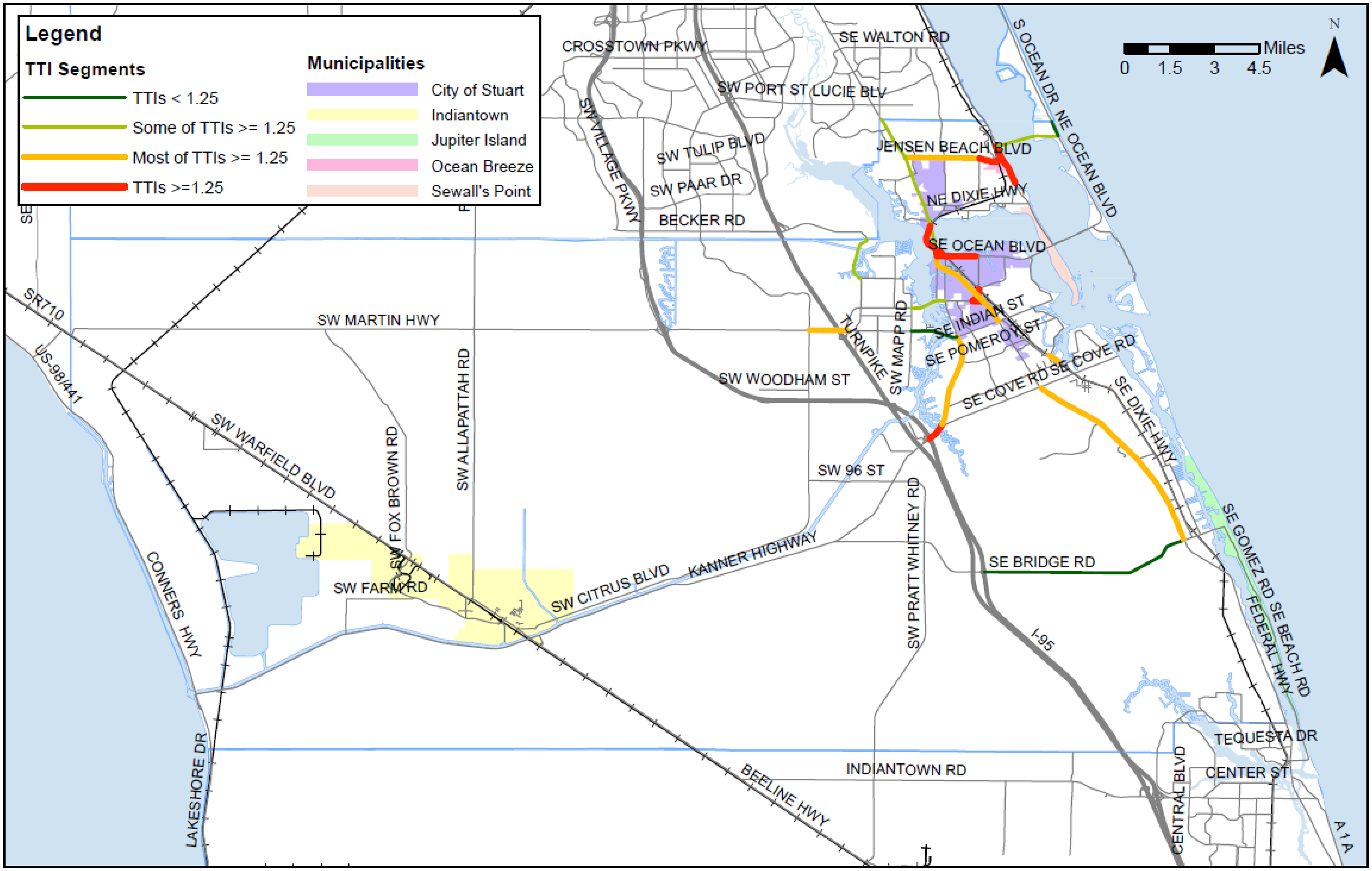

Figure 23 – Calculated Travel Time Index Ranking Map

2018 Martin County LOS Inventory

Level of Service (LOS) is a quantitative stratification of the quality of service of a roadway into six letter grade levels, "A" through "F", with "A" being the best and "F" being the worst. LOS provides a planning and preliminary engineering technique to address quality of service. With the "A" through "F" LOS scheme, traffic professionals have a tool to explain to the public and elected officials operating and design concepts of roadways.

To further evaluate the congestion conditions, 2018 Martin County LOS Inventory data were obtained from the county. The LOS inventory indicated that there were four segments with LOS E or LOS F. The four segments are listed in **Table 7**. **Figure 24** shows their locations graphically.

Table 7 – 2018 Martin County LOS E or LOS F Segments

Road Name	From	To	Generalized Service Capacity	2018 Average Annual Daily Traffic	Peak Hour Factor	Directional Distribution	2018 Peak Hour Directional Volume	2018 Generalized LOS	Average Annual Growth Rate
CR-A1A (Dixie Hwy)	Salerno Rd	St. Lucie Blvd	750	16,587	0.09	0.51	753	E	3.10%
Murphy Rd	High Meadow Ave	St Lucie County	750	9,699	0.13	0.72	887	F	4.50%
SR-5 (US-1)	Palm City Rd	Joan Jefferson Way	2,520	55,868	0.08	0.64	2,860	F	0.80%
SR-714 (Palm City Bridge)	Mapp Rd	SR-76	2,000	34,965	0.10	0.59	2,022	F	0.90%

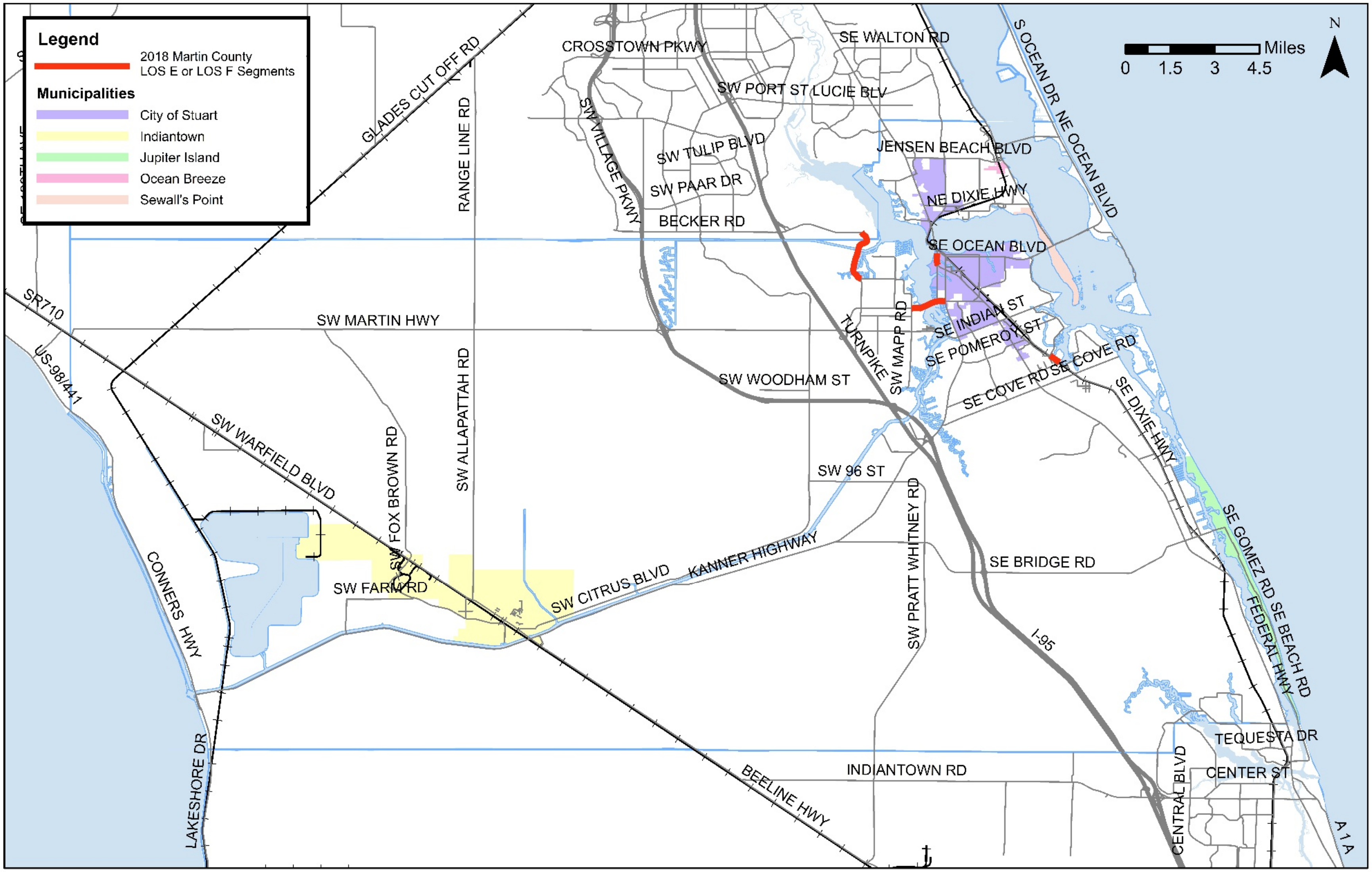

Figure 24 – 2018 Martin County LOS E or LOS F Segments Locations Map

Volume-to-Capacity Ratio (TCRPM 5 –2015 Base Network)

Volume-to-capacity (V/C) ratio is a measure of the traffic volume on a road compared to the capacity of the road. The capacity of a road depends on its physical and operational characteristics and varies by functional class. A higher V/C ratio indicates that the traffic volume of the road is nearing its capacity and is becoming congested.

The Treasure Coast Regional Planning Model (TCRPM 5) developed by FDOT provides V/C ratios for roadway segments. **Figure 25** shows the V/C ratios for the 2015 roadway network for Martin County. Roadway segments with V/C ratio over 1.0 indicate that traffic demand is over capacity and the roadway is congested. These roadway segments are highlighted in red and are considered potential candidates for CMP.

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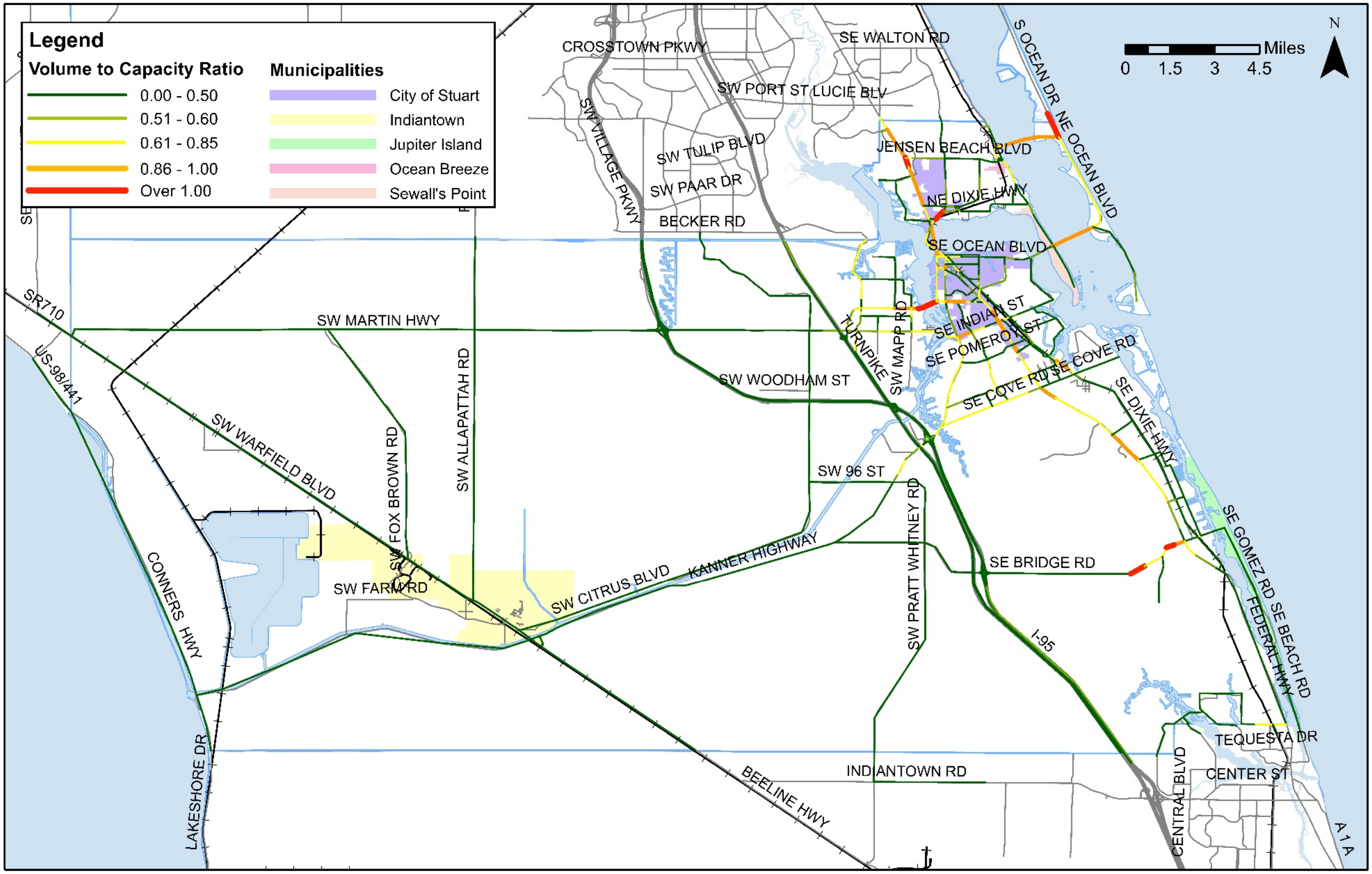

Figure 25 – TCRPM 5 2015 Volume-to-Capacity Ratio Map

Summary of Potential Congested Segments

Based on the analysis above, there were a total of twenty-six corridors that were determined as the potential congested segments. These segments are listed below and are shown in **Figure 26**.

- Bridge Road between I-95 and US-1
- Jensen Beach Blvd between US-1 and Savannah Road
- Jensen Beach Blvd between Savannah Road and Indian River Drive
- SW Kanner Highway between I-95 and SR-714
- SW Martin Highway (Turnpike) between SW Citrus Blvd and SW Martin Downs Blvd
- SW Martin Highway between SW Mapp Rd and S Kanner Hwy
- SE Monterey Road between US-1 and SE Dixie Hwy
- SE Monterey Road (Ext) between US-1 and SE Dixie Hwy
- US-1 (South) between SE Cove Road and SE Bridge Road
- US-1 (North) between North County Line and Dixie Hwy
- US-1 (North) between Dixie Hwy and SR-76
- US-1 (North) between SR-76 and SE Dixie Cutoff Rd
- US-1 (North) between SE Dixie Cutoff Rd and SR-714
- US-1 (North) between SR-714 and Monterey Rd
- US-1 (North) between Monterey Rd and SE Indian Street
- SW Murphy Road between High Meadow Ave and St. Lucie County Line
- SR-714 between Mapp Rd and SR-76
- Dixie Highway between Salerno Rd and St. Lucie Blvd
- SW Ocean Blvd between US-1 and SR-A1A
- SW Joan Jefferson Way between US-1 and Dixie Hwy
- Dixie Highway between US-1 and US-1
- Dixie Highway between US-1 and SW Ocean Blvd
- Indian River Drive between NE Dixie Hwy and Jensen Beach Blvd
- Indian River Drive between Jensen Beach Blvd and CR-732
- CR-732 between Indian River Drive and SR-A1A
- SR-A1A between CR-732 and North County Line

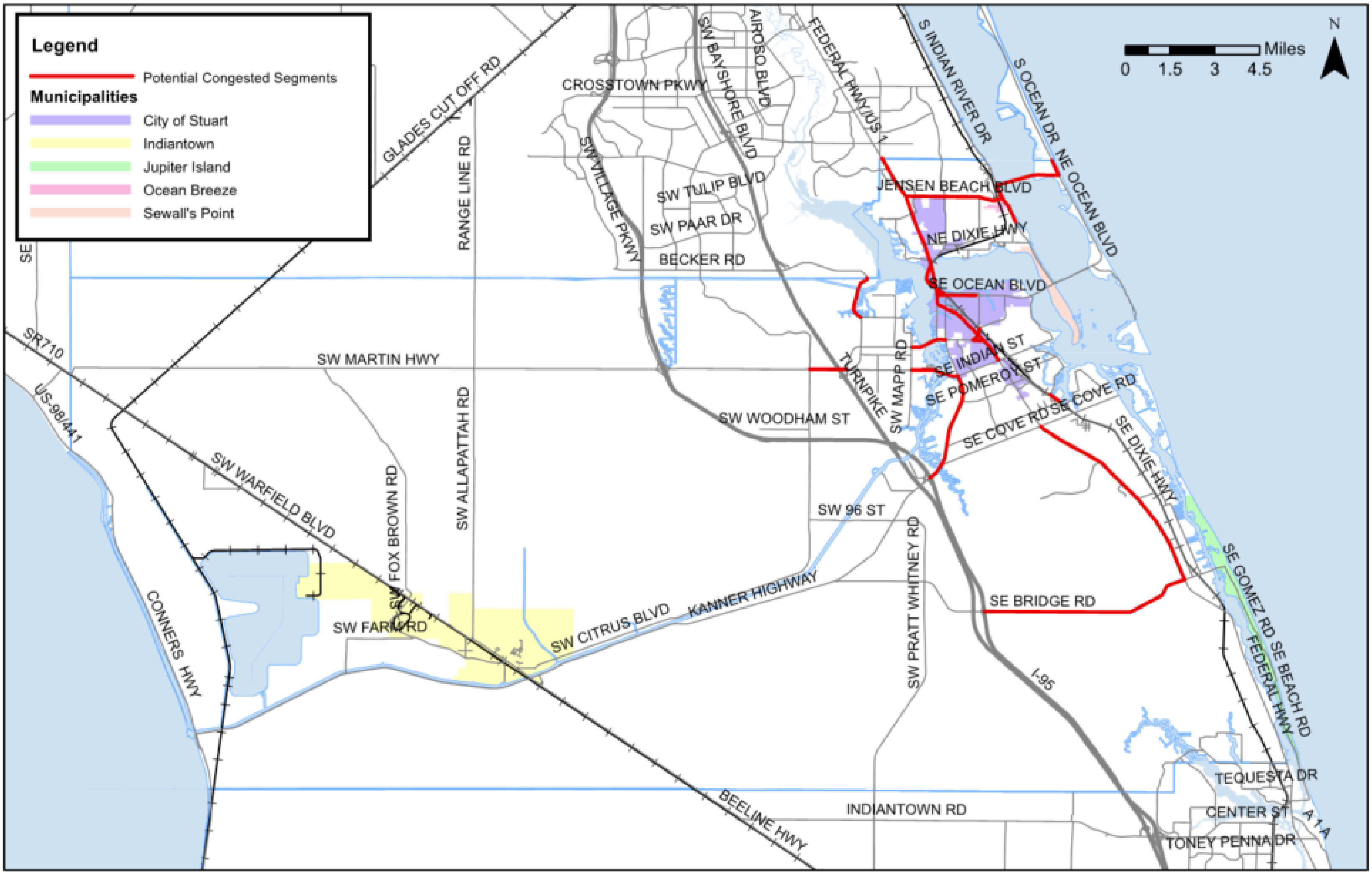

Figure 26 – Potential Congested Segments Map

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