LEE COUNTY MPO
TSM&O MASTER PLAN

AUGUST 2019

LEE COUNTY MPO
METROPOLITAN PLANNING ORGANIZATION

FDOT TSM&O
Transportation Systems Management & Operations

T

Table of Contents

Contents

LIST OF FIGURES

LIST OF TABLES

APPENDIX

1

Introduction

1.1 Introduction

Transportation System Management and Operations (TSM&O) is a program that views the transportation network from a system wide perspective, allowing expansion beyond a project, corridor or single strategy. TSM&O's system wide approach provides a clear set of strategies and performance measures designed to maintain, restore and enhance the transportation network across various modes of use and optimize performance outcomes. These strategies present opportunities to implement improvements that offer solutions beyond traditional capacity enhancements. The Federal Highway Administration (FHWA) defines TSM&O as:

> "An integrated program to optimize the performance of existing multimodal infrastructure through implementation of systems, services, and projects to preserve capacity and improve the security, safety, and reliability of our transportation system."

The system wide approach of a TSM&O program enables strategies to work across multiple jurisdictions, agencies, and modes—ultimately delivering unified solutions that, if implemented successfully, can enhance the overall performance of the entire transportation network. TSM&O provides benefits that can improve the reliability of traffic flow, reduce congestion, improve safety, increase mobility and help strengthen economic vitality. As roadway congestion and traffic needs continue to increase through the State, TSM&O Strategies and solutions are needed to implement proactive solutions on corridors that are constrained or unable to undergo traditional improvements. Many TSM&O strategies are designed to take advantages of technology innovations and can be used to provide alternatives when funds are limited and as near-term/mid-term improvements leading up to a traditional capacity project.

The purpose of the Lee County TSM&O Master Plan is to identify corridors, develop TSM&O strategies and promote the inclusion of the TSM&O process in all project development phases (mainstream TSM&O). Identifying corridors based on their performance across a variety of traffic and safety metrics will indicate the facilities in need of immediate attention. By understanding the performance of these facilities, as well as their constraints, specific TSM&O strategies can be identified that are context-driven to meet those facility needs. Data driven principles are used throughout this document to establish how using the TSM&O process can provide justification to local agencies on the value of TSM&O strategies and solutions in the identification of corridors that would benefit from TSM&O improvements and the project prioritization process. The following sections provide a road map for describing how the TSM&O process functions and identifies corridors on both state and local maintained roadways that could benefit from TSM&O strategies and solutions.

1.2 TSM&O Process

The TSM&O process serves as a guide, designed to assist agencies in operating and proactively managing the transportation system. The process is meant to remain dynamic, allowing agencies to incorporate solutions and strategies that best fit the needs of a project, corridor, or system. This process encompasses the overall transportation system and expands across different modes of travel to deliver a complete solution that can benefit all users of the transportation system.

Once agencies have successfully implemented the TSM&O process, they may decide to formalize the process into a TSM&O program. With a TSM&O program in place, agencies an ensure TSM&O strategies are appropriately considered alongside typical improvement strategies, such as major widening projects or new facilities.

While the TSM&O process is meant to remain dynamic, the following outline is generally recommended for incorporating TSM&O.

Evaluate the TSM&O Strategic Network
In this step the overall transportation system is evaluated using a data-driven approach. Examining a variety of data sources provides a holistic view of the network, allowing different performance measures to be utilized in the analysis and present a comprehensive view of the system.

Determine and Identify Priority Corridors
Using the output of the TSM&O Strategic Network evaluation, corridors within the transportation system are identified for prioritization based on needs across both state and locally maintained facilities. A review of existing conditions and a gap analysis is performed to further evaluate the priority corridors. This review also references existing state and local funding plans to understand desired priorities and opportunities which may already be planned.

Identify TSM&O Strategies and Opportunities

As priority corridors are identified, TSM&O strategies are reviewed to identify where opportunities exist for implementation that can assist in providing innovative solutions that benefit all system users. Upon review of TSM&O strategies, appropriate strategies and solutions can be further assessed for their compatibility and effectiveness in the context of the priority corridors.

Implement TSM&O Strategies

Implementation of strategies on priority corridors should be considered beyond the specific limits of the project and should adhere to the regional architecture. Following the funding and programming protocols and applying them to TSM&O strategies may present opportunities for additional resources and funds that otherwise might have been unavailable. During this stage, performance measures should be put in place to provide monitoring and updates of the implementation of the chosen TSM&O solutions and strategies.

Engage Stakeholders

Throughout the TSM&O process, stakeholder engagement serves an important role to a successful TSM&O program. Involving stakeholders early and continually throughout the process is critical to create synergy and efficient collaboration as many TSM&O solutions are most effective when implemented across a corridor that may extend through multiple jurisdictions and impact both short- and long-term planning efforts.

Each of these steps are fully explored throughout the remainder of this Master Plan to provide a clear and concise roadmap to successfully implement the TSM&O Process.

2

Why Prepare a TSM&O Master Plan?

2.1 Why Prepare a TSM&O Master Plan?

As mobility challenges continue to arise, a TSM&O program offers proactive solutions to growing travel demands, expanding constraints, and limited resources. The TSM&O Master Plan serves as the foundation of a successful TSM&O program, providing guidance on the steps required to evaluate corridors, establish priorities, identify needs and opportunities, and implement effective solutions. This document establishes the TSM&O process for the MPO region and provides the County an opportunity to identify and prioritize project overlaps where resources can be leveraged for the greatest benefit.

The TSM&O Master Plan establishes the following goal and objectives:

Goal:
Incorporate TSM&O Process and considerations into all project development phases (mainstream TSM&O)

Objectives:
1. Increase safety across all modes
2. Increase travel reliability, reduce congestion and establish clear performance metrics
3. Maximize efficiency and Return on Investment (ROI) across the transportation network
4. Incorporate the TSM&O Process into project prioritization

The use of this Master Plan and the TSM&O process will assist in achieving the goal and objectives while establishing a pathway to include TSM&O into prioritization of corridors, identification of opportunities for TSM&O solutions, and providing guidance on successfully implementing TSM&O strategy implementation.

Along with the TSM&O Master Plan, additional documents including the statewide TSM&O Strategic Plan[1] and TSM&O Guidebook[2] are available to compliment the Master Plan and provide additional resources to facilitate a successful TSMO program. Published in 2017, Florida Department of Transportation's 2017 TSM&O Strategic Plan was developed in conjunction with collaboration from the District, local agencies, and other stakeholders. The Strategic Plan outlines a three- to five-year horizon for goals, objectives, and priority focus areas across the State of Florida.

The Planning for TSM&O Guidebook is a comprehensive document used by the USDOT that explores the various functional areas of the TSM&O practice. It provides transportation professionals with a systematic methodology with resources to implement a long-term program, from the planning level to construction and maintenance/operations, that can be applied to all projects/strategies. The Guidebook focuses on a collaborative approach between all transportation professionals (internal and external to the organization) through a cyclical, iterative process that evaluates the system and implements improvements where appropriate.

[1] https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/content/traffic/doc_library/pdf/2017-tsm-and-o-strat-plan-aug-24-2017-final.pdf?sfvrsn=d38c3054_0
[2] http://www.cflsmartroads.com/docs/Planning%20for%20TSMO%20Guidebook%20-%20FINAL.pdf

3

Prioritization Methodology

The development of the Lee County MPO TSM&O Master Plan is comprised of four components, outlined in the following sections: Data Review and Needs Assessment, Priority Scoring Methodology, Methodology Calibration and Validation, and Prioritization and Issue Identification.

3.1 Data Review and Needs Assessment

The *initial data review and needs assessment* was conducted by the FDOT to determine existing datasets available for development of the TSM&O Master Plan.

Each dataset was reviewed and validated for its accuracy and relevance. This included examining each dataset for potential outliers, false data values, and erroneous geospatial data.

Once the datasets were validated for accuracy and deemed relevant for the TSM&O Master Plan, the range of values were identified for inclusion in the Priority Scoring process (see Section 3.2).

3.2 Priority Scoring Methodology

A priority scoring system was created for measuring corridor segments within the Lee County MPO region. One cumulative priority score was given to each segment of roadway.

3.2.1 Scoring Parameters

Scoring is comprised of seven (7) primary categories, which is detailed in Table 1, on the following page, with a brief explanation of its relevance to the Corridor Needs Assessment.

Table 1 – Scoring Parameters

Category	Measure	Relationship
Safety	Bicycle and Pedestrian Involved Incidents	This category includes crash data gathered from the University of Florida's Signal Four Analytics tool, from 2013 to 2017, and will help identify potential conflict points within the study area based on historic incident information. The identification of these conflict points may assist the District in identifying segments or locations which have safety concerns that can mitigated or addressed.
	Incidents Involving a Fatality	
	Crash Rate of the Corridor	
Capacity	Volume to Capacity (V/C)	Datasets under this category provide the remaining capacity values for a roadway segment, along with the volume/capacity (v/c) ratio. The data assists in identifying the saturation of a roadway and / or segment and whether adequate capacity is available.
Performance	AM & PM Planning Time Index (PTI)	Datasets under this category are obtained utilizing the HERE.com data, which provides information relating to traffic volumes along the roadway during AM and PM Peak Hour period. These datasets assist with determining travel patterns and congestion along the roadway, which represents the expected quality of travel.
	AM & PM Indicator of Congestion	
	AM & PM Reported Speed Difference	
Trucks/Freight	Percentage of Truck & Freight Volume on Network	This dataset provides the daily truck percentage, obtained from the FDOT Traffic Online[3].
Design/Geometry	Presence of Medians	These datasets provide physical characteristics of the roadway, including the presence of medians, number of lanes, and whether a facility was constrained. This data was collected to explain how freight traffic might interact with and be affected by the physical roadway.
	Number of Lanes on Roadway	
	If Roadway is Identified as Constrained	
Transit	Presence of Transit on the Corridor	This dataset indicates the presence of ridership and the number of riders utilizing transit, via LeeTran.
Volume/Growth	Historical Growth Rate	Datasets under this category provide information regarding the volume and growth rate of the roadway. The Annual Average Daily Traffic (AADT) dataset provides general traffic volumes along a roadway, gathered from the FDOT Traffic Online and FDOT D1 LOS_ALL spreadsheet.
	Average Annual Daily Traffic (AADT) volumes	

Each of the categories contain different performance measures and include a variety of available datasets that were individually used to evaluate the transportation network. These individual performance measures were then given weights with guidance from FDOT and stakeholders to provide a combined overall Preference Score across the seven groups, with the lowest preference score being identified as the worst preforming, therefore the top priority. The use of a weighted value allowed flexibility to emphasize the importance of specific metrics or areas without removing other measures that provide valuable details. For example, in the analysis, Performance and Safety were given a larger impact on the range of the score than the availability of Transit. This doesn't diminish the value of the Transit information on the corridor or remove it from the analysis but allows the performance measures related to Performance and Safety to be given additional emphasis. Note, the logical beginning and ending points do not entirely correspond to the segments' score preferences within. Reviewing the network, the top 10 state and local roads were identified as priorities.

As part of the data driven process, a variety of data sources were used to provide the data used in the above performance measures. This data includes:

- Probe Roadway Performance Data from HERE.com
- Crash Data from Signal4 Analytics

[3] https://tdaappsprod.dot.state.fl.us/fto/

- SunGuide sensor data
- FDOT Roadway Characteristics Inventory (RCI) data layers
- Locally available Bluetooth, BlueToad, and WaveTronics data (where available)

This methodology was applied to roadways throughout the county to provide a comprehensive view of the overall transportation system and identify a Performance Score on the roadways in the county.

3.2.2 Corridor Priority Analysis

A *Corridor Priority Analysis* was developed to provide FDOT with an ability to identify roadway segments which may require further analysis to identify potential improvements. The Corridor Priority Analysis utilized a series of automated spatial and tabular parameterized calculations to assist in the identification of high priority corridors which may exhibit declining conditions. Each roadway segment was scored according to each parameter. The scoring of each parameter was based on comparable values. For example, parameters determined to be more influential in affecting corridor conditions have been given stronger values than parameters whose impacts may be less influential.

During the data collection phase, the range of values for each parameter within the transportation network was identified. Using the range of values, the FDOT developed a base line scoring rubric for each parameter.

These individual weighted scores are then cumulated to provide a single output value, allowing for an "apples-to-apples" comparison of each roadway segment's overall condition.

3.3 Methodology Calibration and Validation

Methodology calibration and validation was conducted to ensure the project approach could be applied across the entire District One transportation network. Due to the wide range of datasets collected for the TSM&O Master Plan, appropriate segmentation was a key issue in validating the prioritization process.

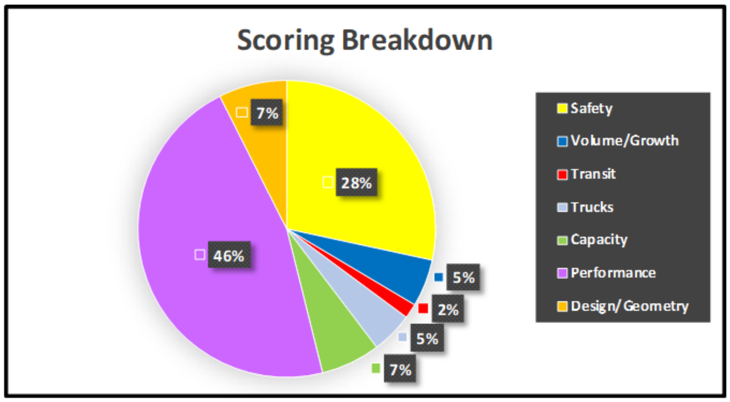
To identify priority corridors of an appropriate length (one mile or more) for additional study and analysis, an initial preference score was collected for each smaller segment. In certain cases, what might be expected to be logical ending points do not entirely correspond to the segments' score preferences within each smaller section. This segmentation process was reviewed, calibrated and validated across the District One transportation network.

In addition, known issues with capacity and bottlenecks helped provide context to how the preference tool reported the issues, and helped determine in which manner the segments were combined.

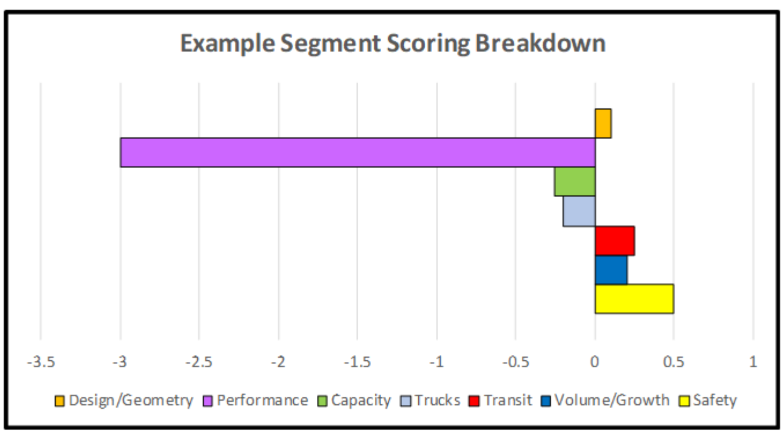
3.4 Prioritization and Issue Identification

In addition to the preference score, the analysis of each roadway segment also provided a breakdown of how the score was affected by each parameter considered for the roadway segment. For example, the pie chart below illustrates how each of the seven primary categories impacted the segment's preference score. Safety also contributed significantly to the segment's preference score. While the pie chart shows an overall effect on the preference score, the bar graph below illustrates the negative or positive impact each category had on the preference score.

Example Scoring Breakdown Pie Chart



Example Scoring Breakdown Bar Graph



4

TSM&O Strategic Network Needs

Using the data and information gained through the evaluation of the transportation network, TSM&O strategies can be identified to assist in increasing safety, improving reliability, and maximizing efficiency. This section explores the details of the network analysis and identifies the top state and local priorities.

4.1 Needs

Lee County is located in southwest Florida and is home to over 700,000 residents. It is also a prominent destination for tourists and seasonal residents, who visit the County to access its beautiful beaches and great weather. These attributes allow for countless outdoor activities and active lifestyles, and the warm weather provides year-round opportunities for walking and cycling. However, consistent with the Lee County MPO Bike-Ped Master Plan, walking and bicycling remain marginal modes of transportation in Lee County. Florida's road system has not kept up and will continue to fall short with anticipated population growth[4] unless alternative modes of transportation are provided.

The TSM&O Strategic Network was identified using the validated datasets collected, in addition to the capacity analysis dataset developed by the FDOT. Geospatial datasets relating to crash rates, congestion, capacity, and other metrics were used to identify the TSM&O Strategic Network Corridors. This network included both state and local corridors, as shown in Figure 1.

[4] According to the Bureau of Economic and Business Research (BEBR) 2019 *Medium* Population Projections for Horizon Year 2030, the Lee County population is estimated to increase by approximately 25%. The State of Florida's population is projected to increase by 17%.

\\vhb\gbl\proj\Orlando\62868.06 FDOT D1 TSMO Lee MP\graphics\FIGURES\AI

Source: Google Maps

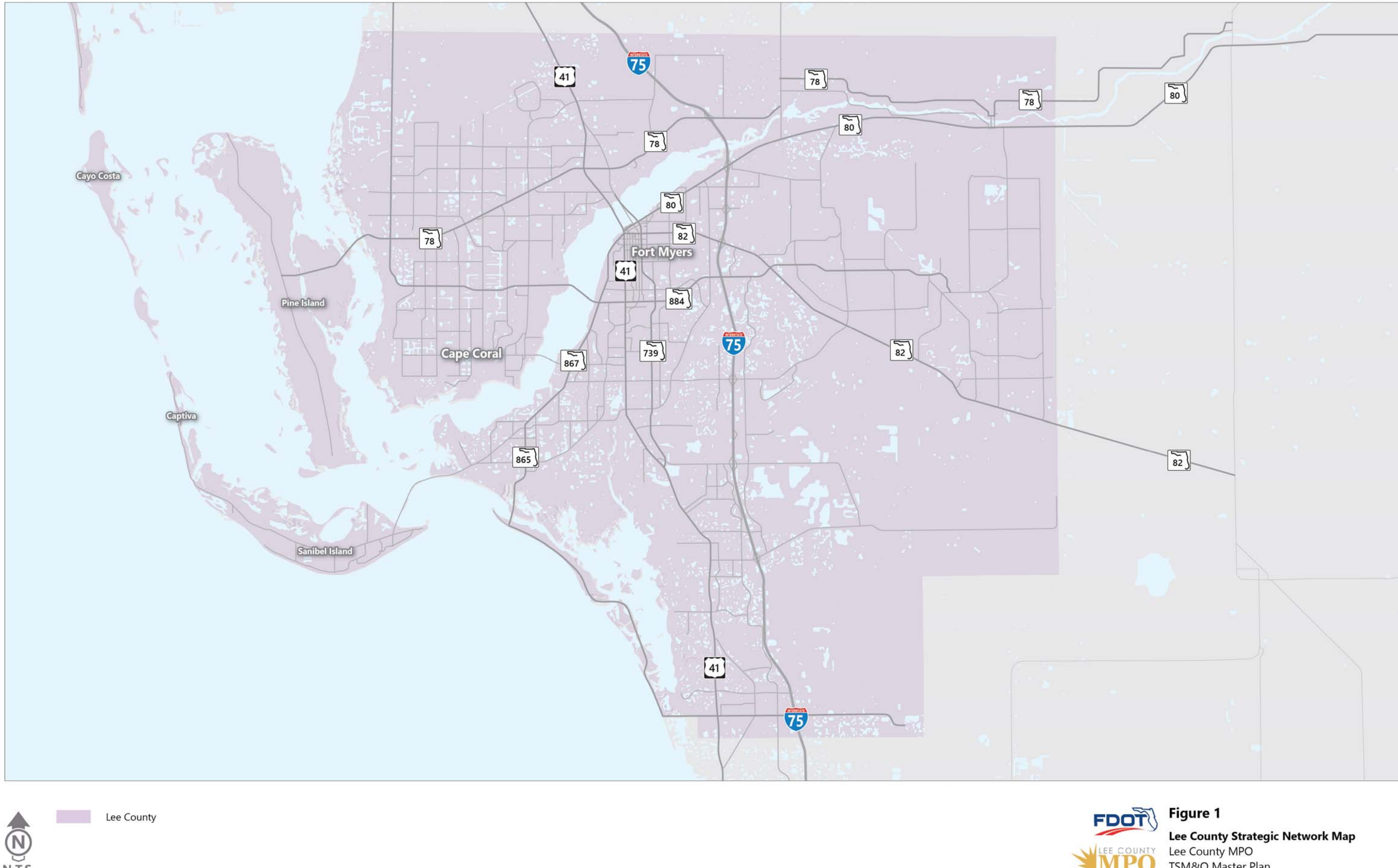


Figure 1

Lee County Strategic Network Map
Lee County MPO
TSM&O Master Plan

4.1.1 Overall Network Evaluation

Table 2 – Census Data

Census	Total
Population (2017)	700,165
Households (5-year 2013-2017)	264,325
Percent Population with a Disability (65 or under)	6.1%
Percent of Population in Poverty	14.8%
Median Household Income (2017 inflation-adjusted dollars)	$52,052
Total Employment (16 and older)	309,173

Source: 2017 American Community Survey (ACS) 2013-2017 Five-Year Estimates

Lee County covers over 1,212 square miles in southwest Florida. There are several major roadways and corridors serving as connectors between the counties to the north and south, as well as significant traffic flowing to the beachside communities along the Gulf of Mexico. Several bridges span the Caloosahatchee River as it flows through the central area of the County, providing a unique challenge to identify solutions and strategies for these locations.

Preference Scores were calculated for each of the roadways within the TSM&O Strategic Network. This data-driven preference score allows for a highly detailed view of the network and the individual segments along a corridor. To assist in the assignment of top 10 state and local maintained priorities, the preference scores along individual segments were considered on a corridor level allowing segments with similar scores along the same roadway to be combined. Figure 2 below represents an output of that process, with red representing those with low preference scores and green those with high preference scores. The methodology employed to determine the preference scores is summarized within Chapter 3 of this document.

Source: Google Maps

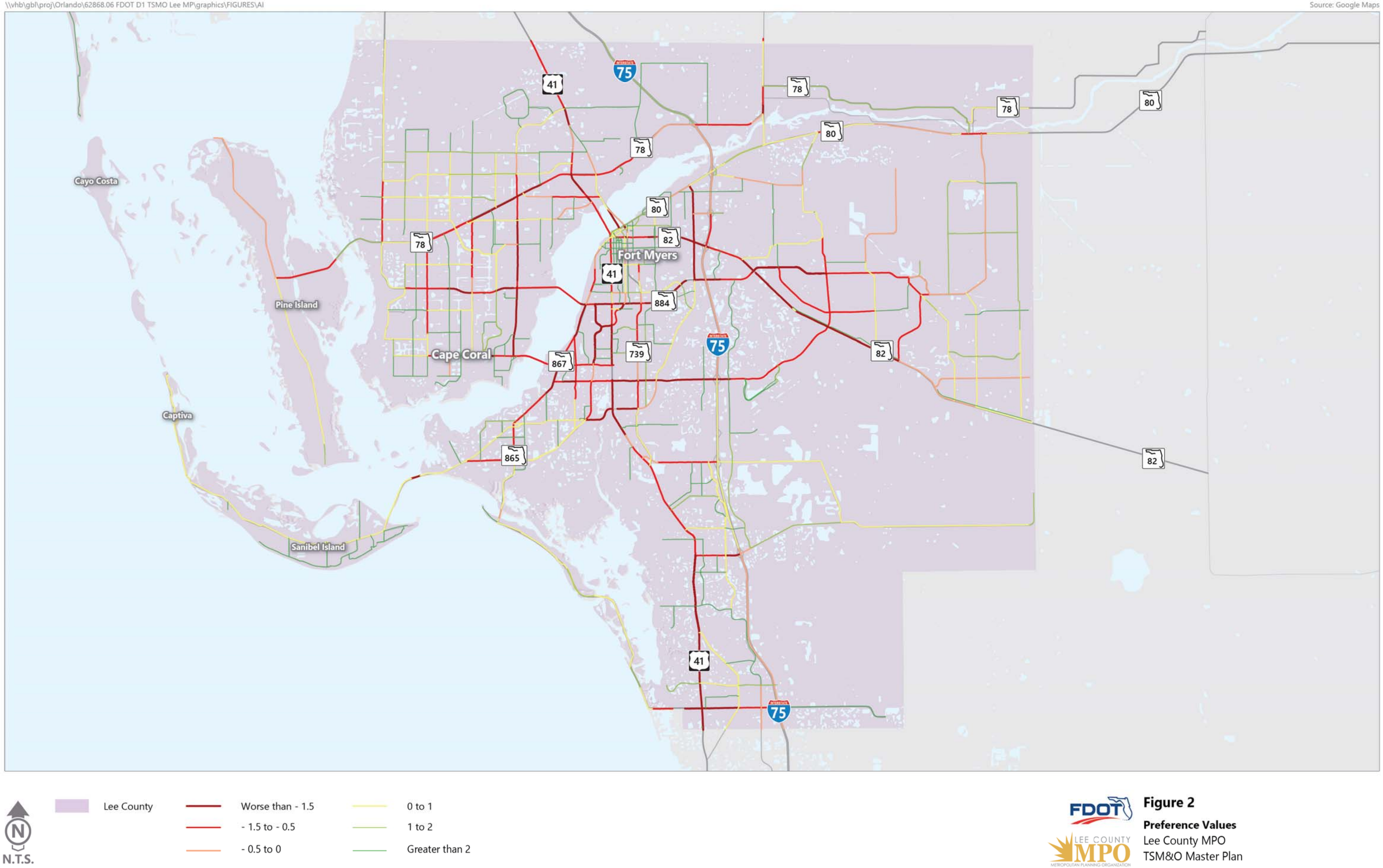


Figure 2

Preference Values

Lee County MPO

TSM&O Master Plan

4.1.2 Top 10 State Road Priorities

Table 3 shows the top ten (10) on-system corridors within Lee County, sorted by score preference. The top state roadways are graphically represented on Figure 3.

Table 3 – State Road Priorities

Priority Rank	Road Name	Local Street Name	From	To	Segment Length (mi.)	Preference Score
1	SR 884	Colonial Blvd.	US 41/Cleveland Ave.	Colonial Country Club Blvd.	5.289	-4.30
2	SR 82	Dr. Martin Luther King Jr. Blvd.	Colonial Blvd.	Alabama Rd.	7.835	-3.86
3	SR 45	US 41/ Cleveland Ave.	SR 865 (6 Mile Cypress Pkwy.)	SR 884 (Colonial Blvd.)	4.75	-3.65
4	SR 865	6 Mile Cypress Pkwy.	Summerlin Rd.	Metro Pkwy.	2.712	-3.59
5	SR 876	Daniels Pkwy.	US 41/Cleveland Ave.	Treeline Ave.	5.329	-3.27
6	SR 867	McGregor Blvd.	Colonial Blvd.	College Pkwy.	3.814	-3.26
7	SR 78	Pine Island Rd.	Santa Barbara Blvd.	Hancock Creek Blvd.	3.491	-3.08
8	SR 82	Dr. Martin Luther King Jr. Blvd.	Michigan Ave.	I-75 NB on-ramps	1.541	-2.91
9	US 41 Business (SB)	Edison Bridge / Fowler St. (SB)	SR 80 (Palm Beach Blvd.)	MP 1.017	1.017	-2.80
10	US 41 Business (NB)	Park Ave.	Second St.	First St.	0.143	-2.79

Source: Google Maps

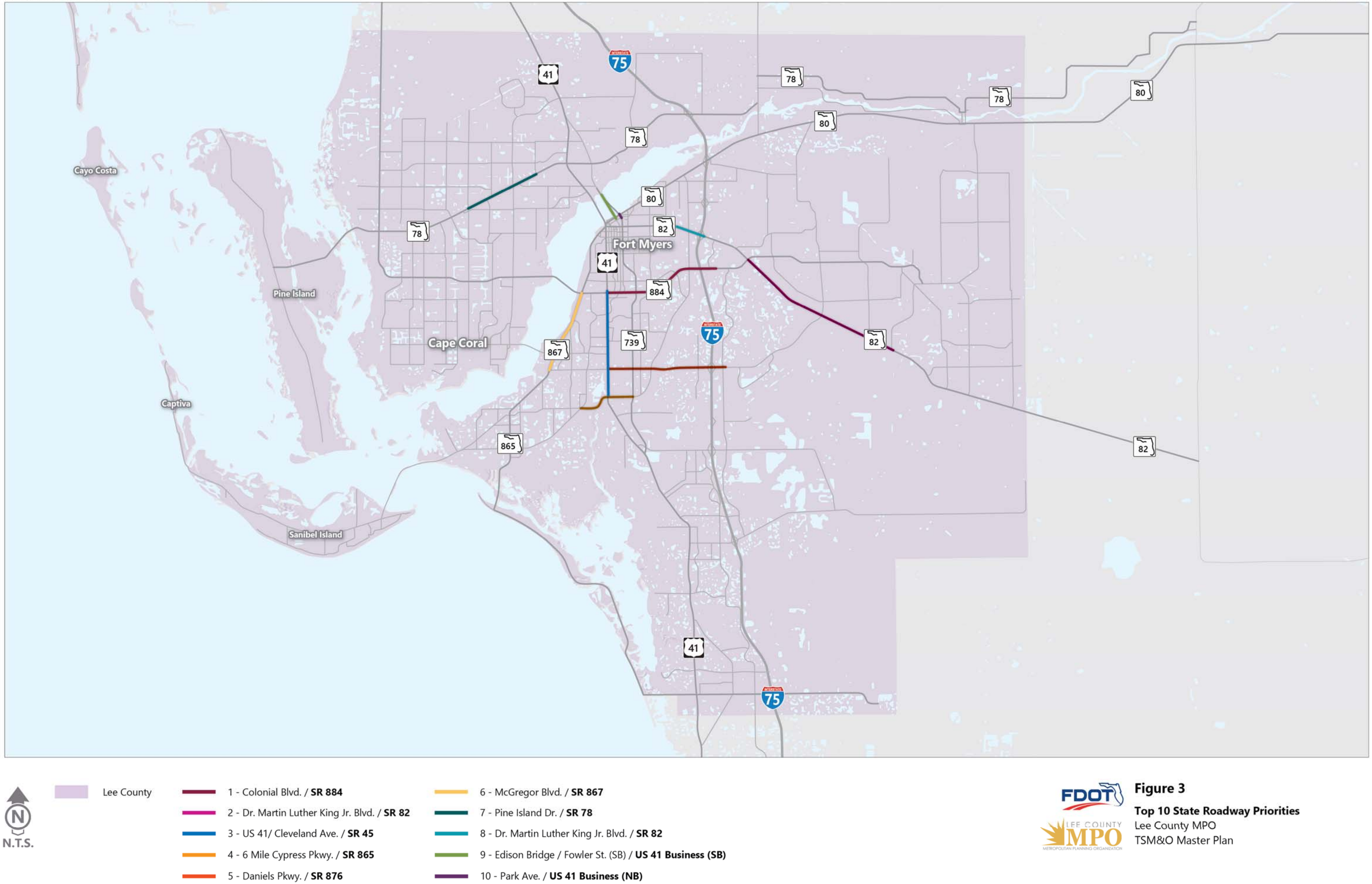


Figure 3

Top 10 State Roadway Priorities
Lee County MPO
TSM&O Master Plan

4.1.3 Top 10 Local Road Priorities

In addition to the top on-system corridors, the top off-system corridors were identified. Table 4 shows the top ten (10) off-system corridors, sorted by score preference. The top local roadways are graphically represented on Figure 4.

Table 4 – Local Road Priorities

Priority Rank	Local Street Name	From	To	Segment Length (mi.)	Preference Score
1	Del Prado Blvd.	SE 21st Lane	Hancock Bridge Pkwy.	2.745	-2.38
2	Boy Scout Dr. / Fowler St	Summerlin Rd.	Colonial Blvd	1.779	-2.34
3	Bonita Beach Rd.	Vanderbilt Dr.	Old 41 Rd.	1.431	-2.06
4	Del Prado Blvd.	Cape Coral Pkwy	Veterans Pkwy Ramps	3.111	-2.03
5	Ortiz Ave.	SR884 / Colonial Blvd.	SR 80 / Palm Beach Blvd	4.406	-1.88
6	Cape Coral Pkwy.	Coronado Pkwy	Santa Barbara Blvd.	0.978	-1.79
7	Corkscrew Rd.	US 41	I-75	2.053	-1.74
8	Veterans Pkwy.	West of Skyline Blvd.	SR 867 / McGregor Blvd.	5.43	-1.67
9	Summerlin Rd.	SR 884 (Colonial Blvd.)	College Pkwy.	2.953	-1.51
10	Leonard Blvd. S.	Lee Blvd	Sunshine Blvd.	5.391	-1.44

Source: Google Maps

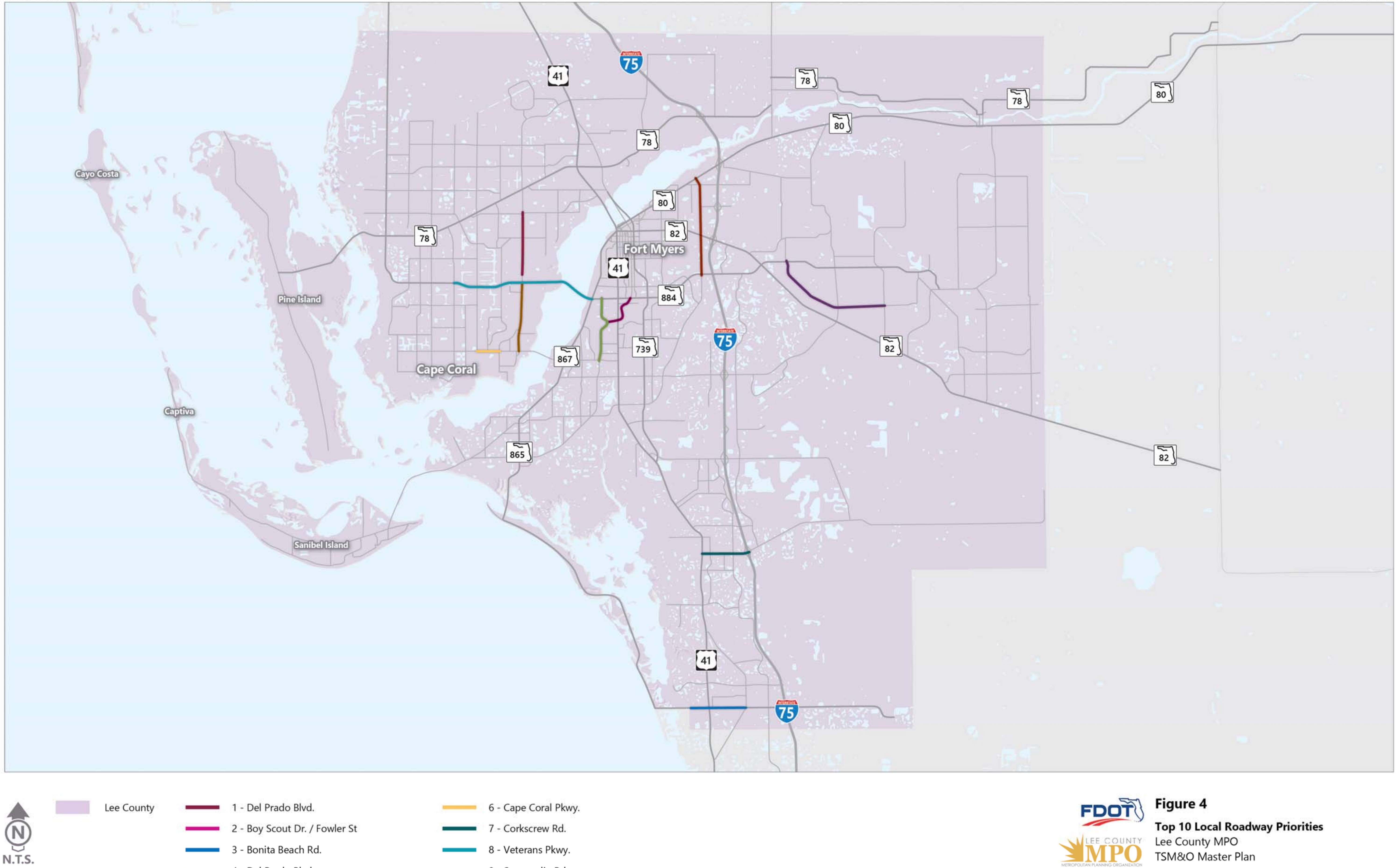


Figure 4

Top 10 Local Roadway Priorities
Lee County MPO
TSM&O Master Plan

5

TSM&O Strategies and Gaps

5.1 Existing Conditions

This section of the Master Plan begins with an evaluation of the physical conditions and existing operational characteristics of the TSM&O Strategic Network. This evaluation was utilized within the prioritization model to determine the top corridors identified in the previous section. The physical conditions collected included number of lanes, area type, speed limit, roadway classification, and existing infrastructure (such as transit route/stops, sidewalks, and bike lanes, if applicable). The existing operational characteristics calculated included daily traffic count data, level of service evaluation, volume-capacity ratio, travel time, and speed differential.

To help understand specific time periods where congestion occurs, an average travel speed was calculated to represent a 'typical' weekday for both directions during the quarter using available real-time probe data (HERE data retrieved in one-minute increments every hour). This was further broken down to show a 24-hour speed profile along each corridor segment and compare to the maximum speed limit. The maximum speed limit was utilized for visual understanding, as the range in speed limits within a specific corridor is typically no more than 10 mph. The range of speed limits was considered when accounting for the speed differential and identification of congestion time periods.

5.1.1 Capacity

Understanding the relationship between the supply and demand on a corridor segment is a fundamental consideration in evaluating how well a transportation facility safely and efficiently accommodates the traveling public. Utilizing the latest Generalized Peak Hour Directional Service Volumes Tables from the 2012 FDOT Quality/Level of Service (Q/LOS) Handbook, an arterial level of service (LOS) and volume to capacity ratio was calculated for each corridor within the TSM&O Strategic Network. The tables from the Q/LOS Handbook utilized the data collected, such as the number of lanes, area type, and LOS standard. The results of this capacity analysis and the corresponding LOS for each corridor within the network can be found in Figure 5.

Source: Google Maps

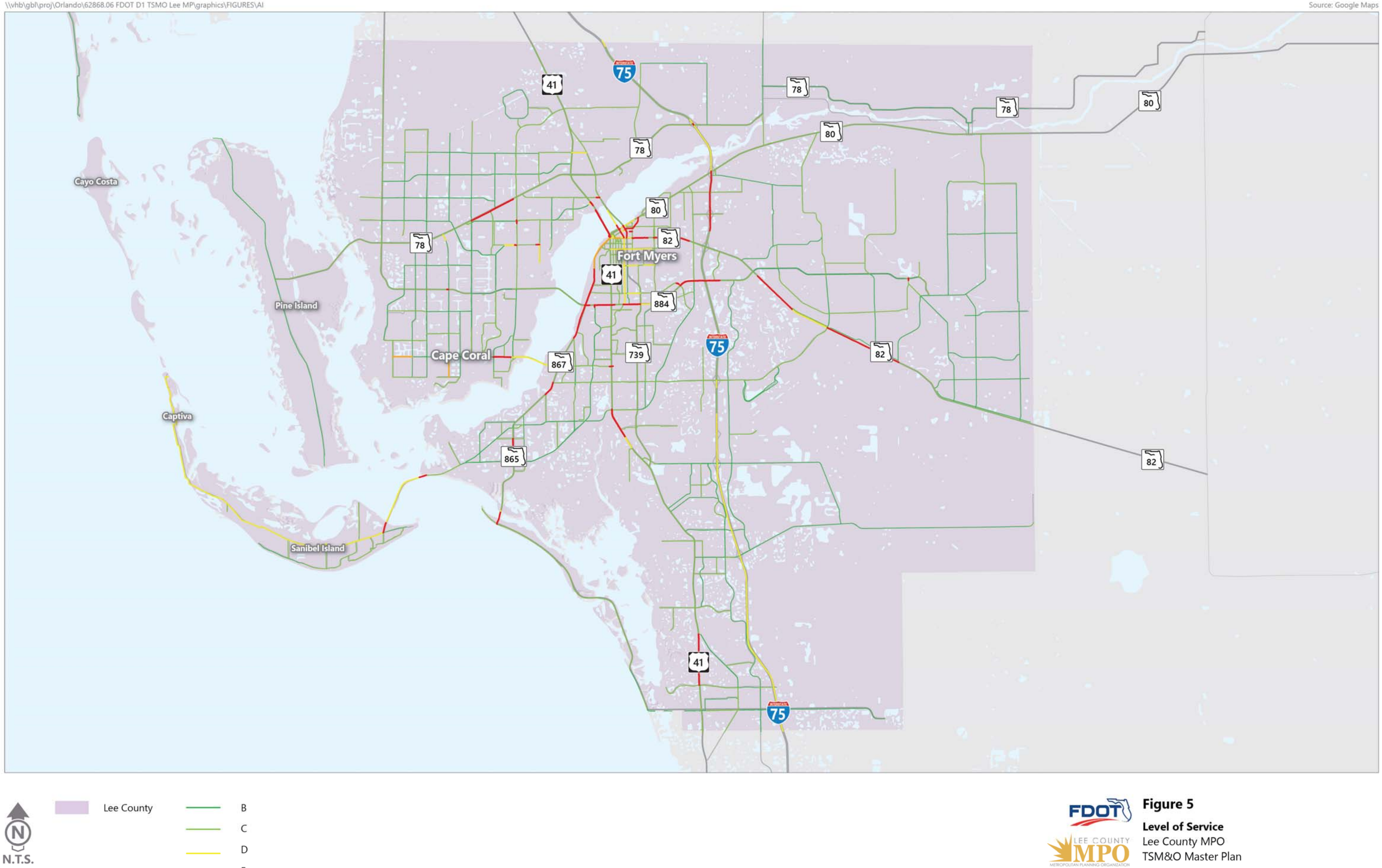


Figure 5

Level of Service

Lee County MPO

TSM&O Master Plan

5.1.2 Safety

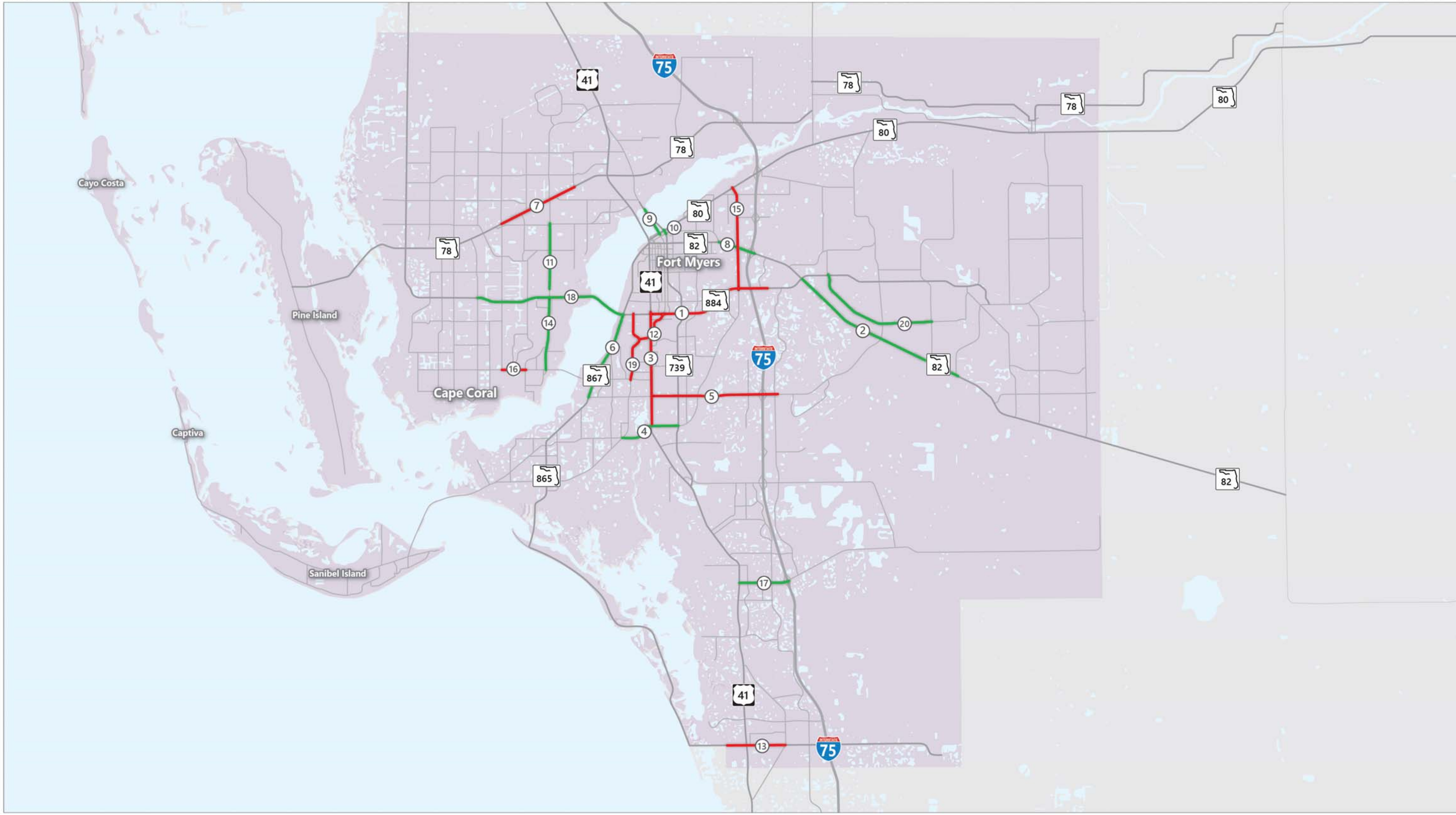
As part of the data-driven model created by FDOT for the TSM&O Strategic Network, a multimodal safety analysis was completed to determine if the traffic demands combined with geometric conditions pose potential safety issues. To identify crash patterns along the corridor, crash data was obtained from the Signal 4 analytics and confirmed within the FDOT's Crash Analysis Reporting System (CARS) for the previous five years (2012-2016).

Segment crash rates in crashes per million vehicle-miles traveled were calculated for each corridor to compare the actual crash rate of the corridor to the statewide average crash rate for similar facilities during the study period. The crash rates for the state and local priority corridors, as compared to the FDOT statewide average crash rate, are illustrated in Figure 6. A total of 71,666 crashes were reported within Lee County (2013-2017), resulting in an average of 14,333 crashes per year.

Crashes involving one or more bicycles or pedestrians were also reviewed and illustrated on Figure 7. A total of 1,282 pedestrian crashes (average of 256 pedestrian crashes per year) and 1,230 bicycle crashes (average of 246 bicycle crashes per year) occurred in Lee County from 2012 to 2016. In addition, the number of fatalities to occur over the same period along the network corridors resulted in 479 fatalities (average of 96 fatalities per year), as illustrated on Figure 8.

Preliminary review of bike-ped crash data suggests a large majority of crashes are located along a few roadways with similar characteristics. These roadways tend to be multi-lane, undivided roadways with bi-directional turn lanes, such as U.S. 41 (Cleveland Avenue) in Fort Myers and Old 41 in Bonita Springs. Further study of these high bike-ped crash corridors is recommended and physical improvements such as raised medians and mid-block crosswalks should be evaluated.

Source: Google Maps



1 - Colonial Blvd. / **SR 884**
2 - Dr. Martin Luther King Jr. Blvd. / **SR 82**
3 - US 41/ Cleveland Ave. / **SR 45**
4 - 6 Mile Cypress Pkwy. / **SR 865**
5 - Daniels Pkwy. / **SR 876**
6 - McGregor Blvd. / **SR 867**
7 - Pine Island Dr. / **SR 78**
8 - Dr. Martin Luther King Jr. Blvd. / **SR 82**
9 - Edison Bridge / Fowler St. (SB) / **US 41 Business (SB)**
10 - Park Ave. / **US 41 Business (NB)**
11 - Del Prado Blvd.
12 - Boy Scout Dr. / Fowler St
13 - Bonita Beach Rd.
14 - Del Prado Blvd.
15 - Ortiz Ave.
16 - Cape Coral Pkwy.
17 - Corkscrew Rd.
18 - Veterans Pkwy.
19 - Summerlin Rd.
20 - Leonard Blvd. S

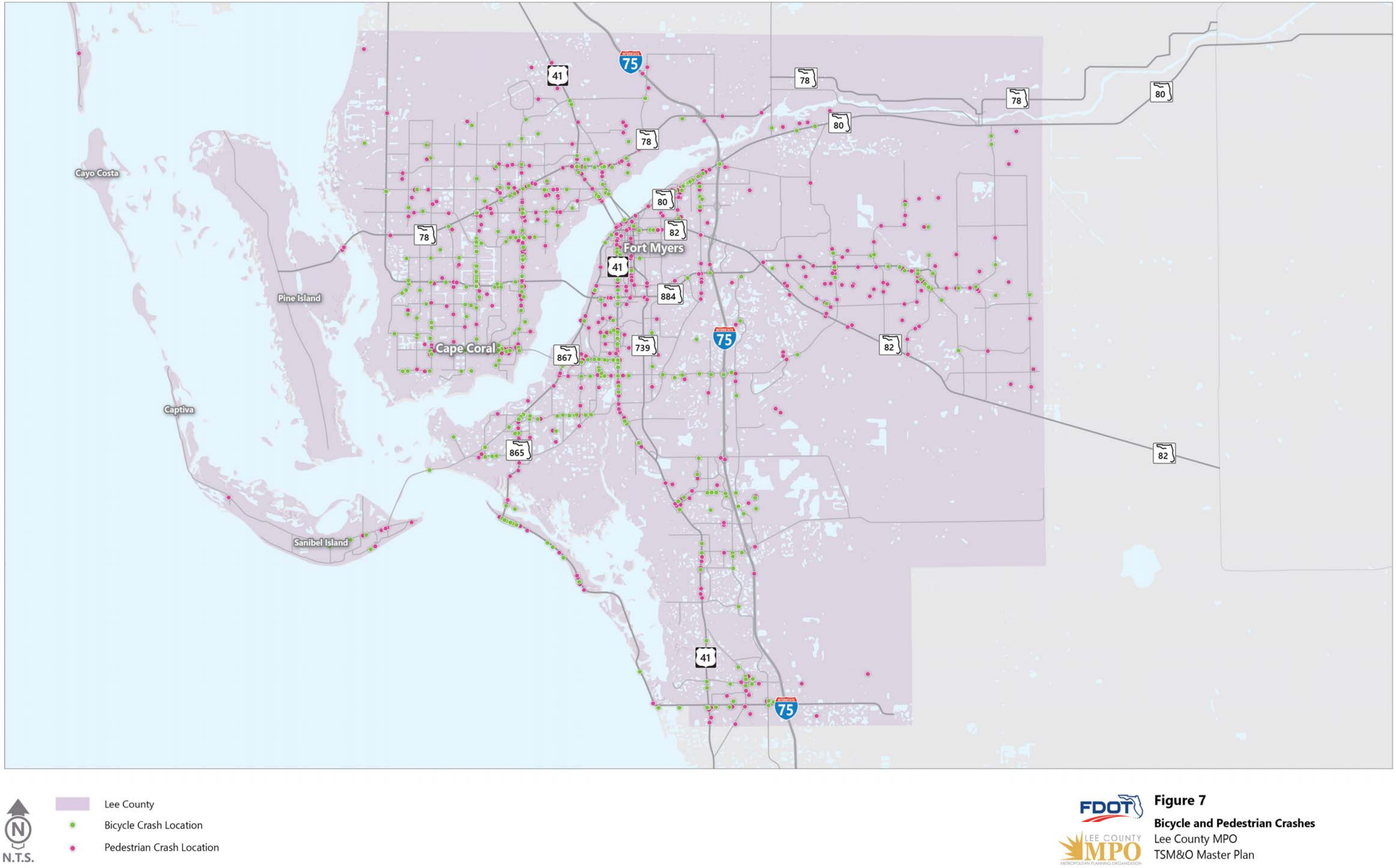
FDOT
LEE COUNTY MPO METROPOLITAN PLANNING ORGANIZATION

Figure 6

Crash Rate Comparison
Lee County MPO
TSM&O Master Plan

\\vhb\gbl\proj\Orlando\62868.06 FDOT D1 TSMO Lee MP\graphics\FIGURES\AI

Source: Google Maps



FDOT

LEE COUNTY MPO METROPOLITAN PLANNING ORGANIZATION

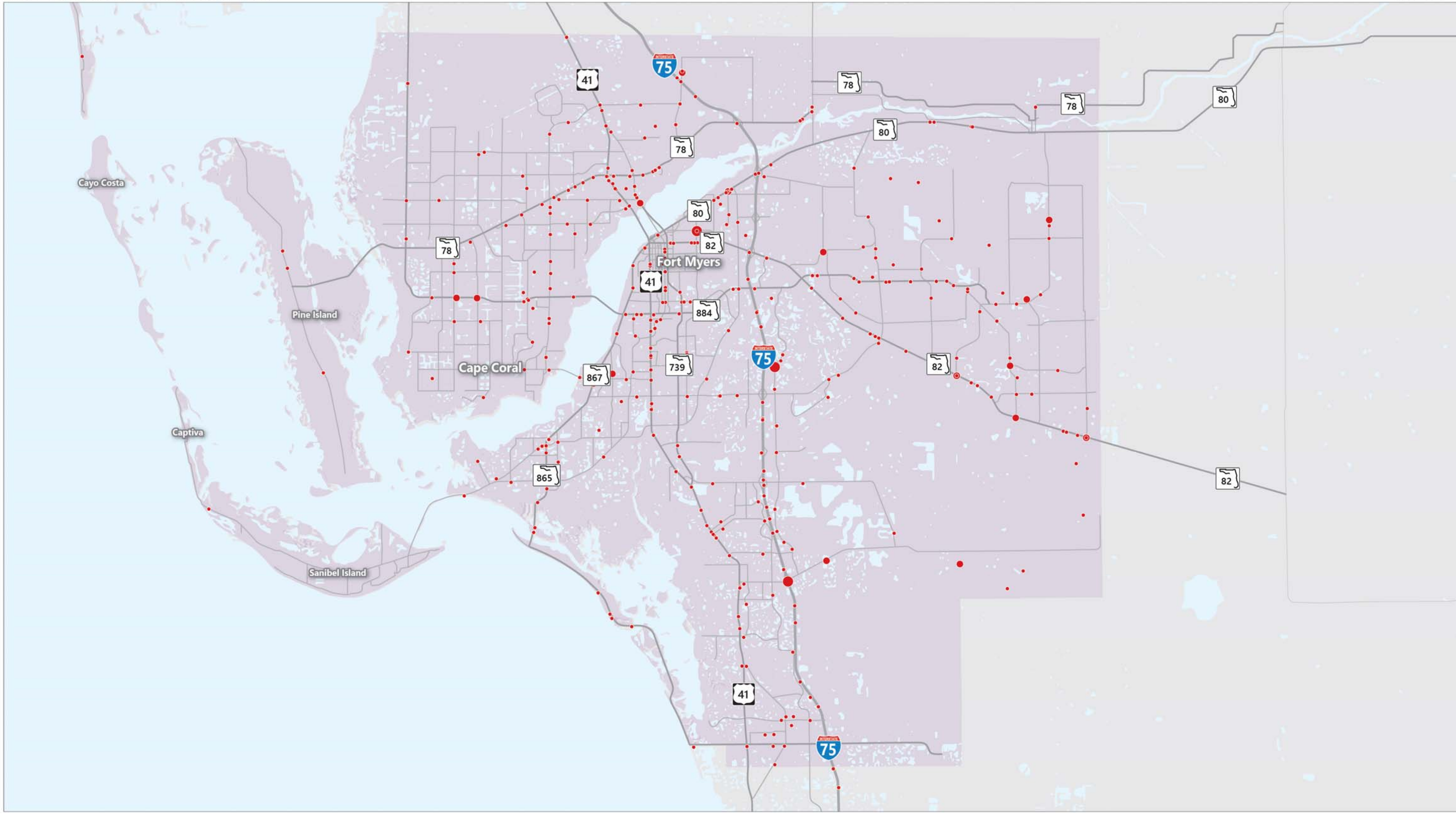
Figure 7

Bicycle and Pedestrian Crashes

Lee County MPO

TSM&O Master Plan

Source: Google Maps



N.T.S.

- Lee County
- Fatal Crash Location (3 Fatalities)
- Fatal Crash Location (2 Fatalities)
- Fatal Crash Location (1 Fatality)

Figure 8

Fatal Crashes
Lee County MPO
TSM&O Master Plan

5.1.3 Infrastructure

An evaluation of the physical multi-modal conditions of the corridor is intended to identify the existing infrastructure and potential issues with providing a safe multi-modal network for non-vehicular travel, as well as aid in identifying network corridors requiring closer examination as part of future recommendations.

Bicycle and pedestrian connectivity play an important role in meeting the goals of providing the first and last-mile connection. The "last-mile" or "first- and last-mile" connection describes the beginning or end of an individual trip made primarily by public transportation. In many cases, people will walk to transit if it is close enough. However, on either end of a public transit trip, the origin or destination may be difficult or impossible to access by a short walk. This gap from public transit to destination is termed a last-mile connection. This subsection details the existing bicycle and pedestrian network.

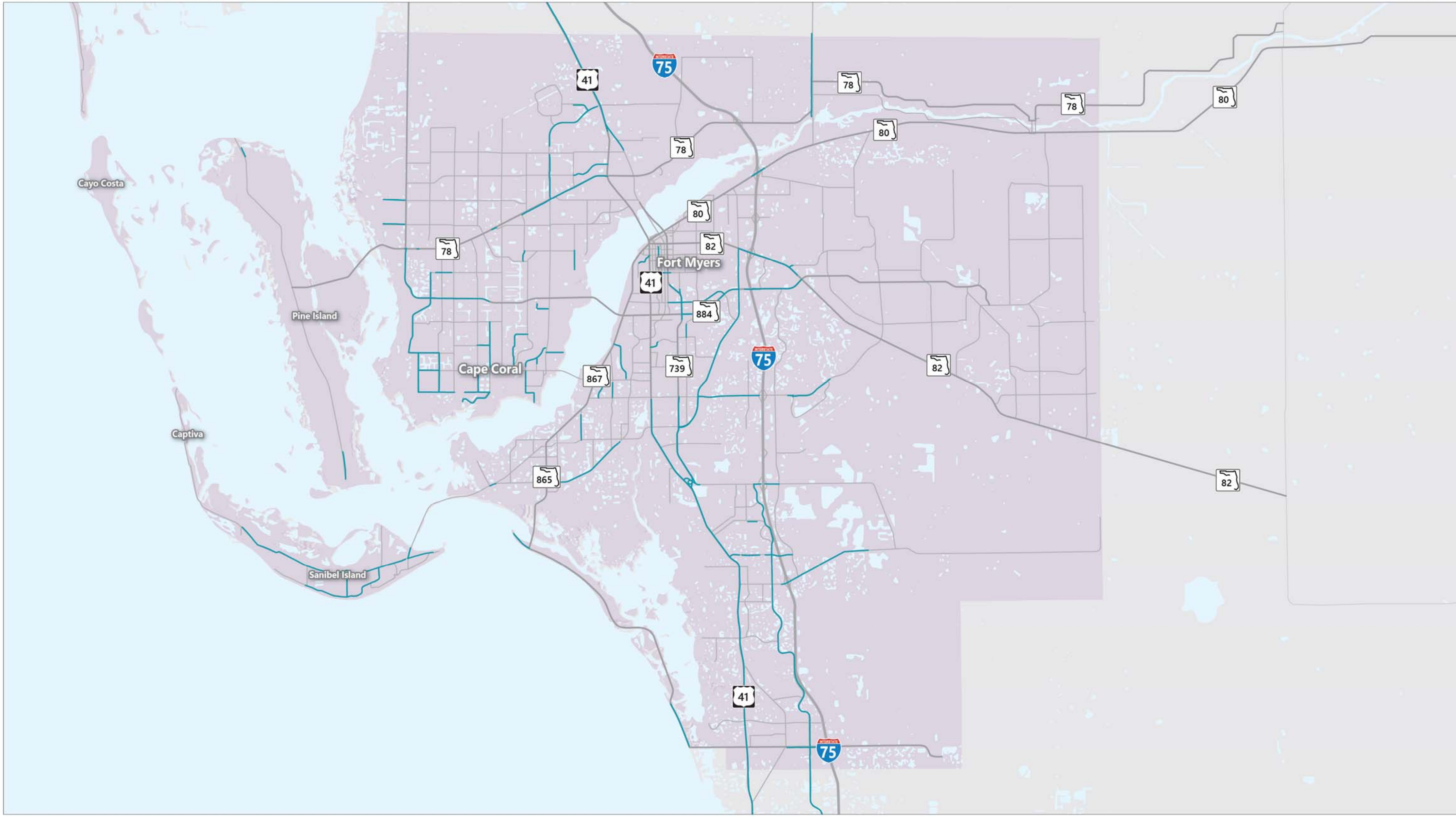
Bicycle Lanes and Shared-Use Paths

A desktop inventory of the bicycle lanes and shared-use paths was completed for the TSM&O strategic network utilizing the latest available GIS data from the FDOT RCI Database (FY 18/19). Per definition, shared-use paths are wider sidewalks where bicycles and pedestrians can use the available path for traveling, when bicycle lanes are not available. The locations where bicycle lanes and shared-use paths exist is depicted in Figure 9.

Sidewalks

Similar to the bicycle lane inventory, a desktop inventory of sidewalk facilities was completed for the TSM&O strategic network, utilizing the latest available GIS data from the FDOT RCI Database (accessed August 2018). In general, the County has a robust and connected sidewalk network. This robust network can be seen graphically in Figure 10.

Source: Google Maps



N
N.T.S.

Lee County

Bike Lanes/Shared Use Path

Figure 9

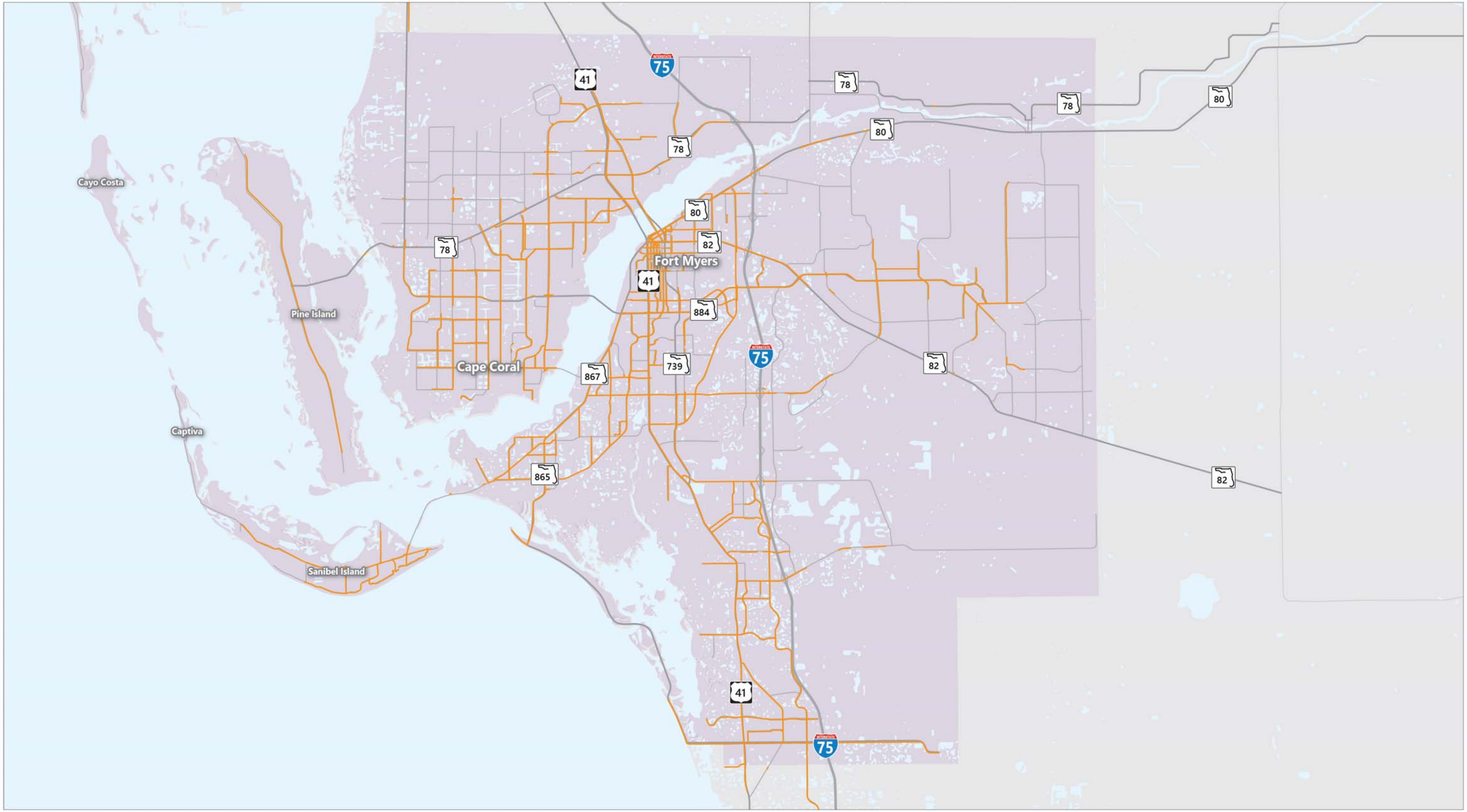
Bike Lanes and Shared Use Path Network

Lee County MPO

TSM&O Master Plan

\\vhb\gbl\proj\Orlando\62868.06 FDOT D1 TSMO Lee MP\graphics\FIGURES\AI

Source: Google Maps



Lee County

Sidewalk/Shared Use Path

Figure 10

Sidewalk Network

Lee County MPO

TSM&O Master Plan

5.1.4 Fiber

Many TSM&O strategies include different traffic management equipment, such as signals and the connecting fiber optics / communications networks. As the County is progressing towards future technology deployments, such as connected/autonomous vehicle (CAV) solutions, the need to understand the location of existing fiber optics / communication systems and correlating gaps becomes increasingly important.

The purpose of this section is to identify the existing locations for ITS infrastructure and understand potential infrastructure gaps within Lee County. Locations where the conduit was identified, but no fiber optic cable exists are also noted on Figure 11. The fiber facilities noted are categorized as being maintained by:

- Lee County
- FDOT
- ITG (Information Technology Group)
- Shared
- Other agency

All information regarding fiber was sourced from the FDOT and the Lee County Fiber Viewer (March 2019), available at:

https://leegis.maps.arcgis.com/apps/webappviewer/index.html?id=533318340ec54b53a964997cf952fbd1.

The coordination and management of the fiber optics and communication systems are essential to the success of future TSM&O investments. The status of the Fiber Optics along the top 10 priority state and local corridors, respectively, throughout Lee County can be found within Table 5 and Table 6, as well as shown graphically on Figure 11.

Table 5 – Fiber / Communication Identification for State Road Priorities

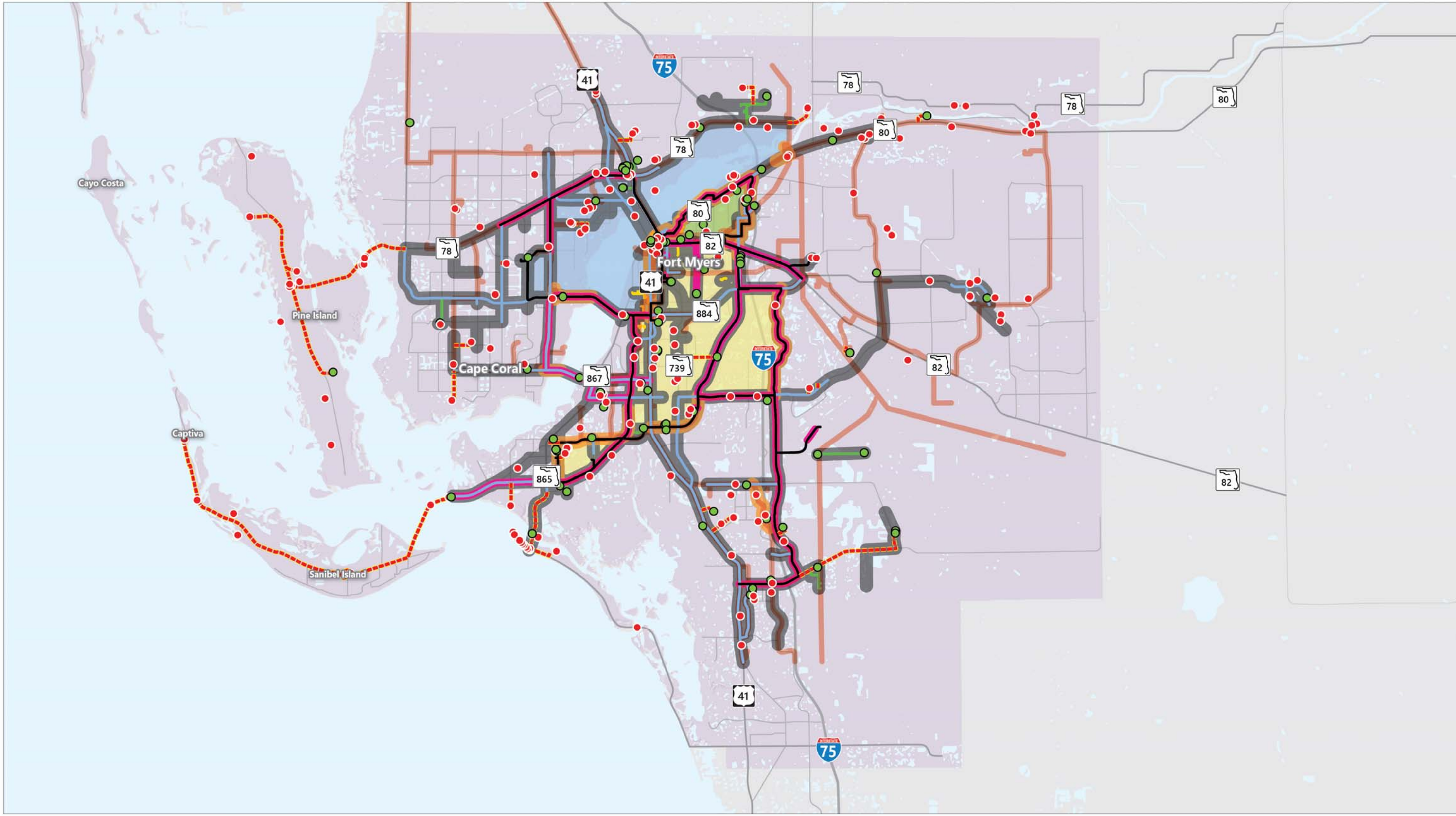
Road Name	From	To	Segment Length (mi.)	Notes
SR 884	US 41/Cleveland Ave.	Colonial Country Club Blvd.	5.289	**FDOT Fiber** along entire segment – 144 Fiber Count
SR 82	Colonial Blvd.	Alabama Rd.	7.835	**No Fiber along entire segment**
SR 45	SR 865 (6 Mile Cypress Pkwy.)	SR 884 (Colonial Blvd.)	4.75	**FDOT Fiber** along entire segment – 96 count
SR 865	Summerlin Rd.	Metro Pkwy.	2.712	**FDOT Fiber** – 96 count from Summerlin Rd. to Nancy View Ln. (east of US 41) **ITG Underground** – 48 count – for entire length of segment **FPL Fibernet** from Summerlin Rd. to Nancy View Ln. (east of US 41)
SR 876	US 41/Cleveland Ave.	Treeline Ave.	5.329	**FDOT/ITG Fiber** from 6 Mile Cypress Pkwy. to Treeline Ave. – 96 count - DOT 1-84, ITG 85-96 **FDOT Fiber** from US 41 to Brynwood Ln. and from Metro Parkway, east to the beginning of shared fiber from 6 Mile Cypress Pkwy to Treeline Ave. – 96 count **FPL Fibernet** from 6 Mile Cypress Pkwy to Treeline Ave.
SR 867	Colonial Blvd.	College Pkwy.	3.814	**No fiber along entire segment**, conduit from Colonial Blvd. from Royal Palm Square Blvd.
SR 78	Santa Barbara Blvd.	Hancock Creek Blvd.	3.491	**FDOT/ITG Fiber** along entire segment – 216 count (1-96 DOT, 97-144 ITG, 145-216 DOT)
SR 82	Michigan Ave.	I-75 NB on-ramps	1.541	**FDOT/ITG Fiber** along entire segment – 216 count, west of I-75 and 96 count, east of I-75
US 41 Business (SB)	SR 80 (Palm Beach Blvd.)	MP 1.017	1.017	**FDOT Fiber** – 96 count **ITG aerial Fiber** – 144 count **FPL Fibernet** along corridor
US 41 Business (NB)	Second St.	First St.	0.143	**FDOT Fiber** – 36 count **ITG Fiber** – 144 count **FPL Fibernet** along corridor

Table 6 – Fiber / Communication Identification for Local Road Priorities

Road Name	From	To	Segment Length (mi.)	Notes
Del Prado Blvd.	SE 21st Lane	Hancock Bridge Pkwy.	2.745	**FDOT Fiber** (96 count) from SE 21st Lane to Viscaya Pkwy. **Shared Fiber** from Viscaya Pkwy to Hancock Bridge Pkwy.
Boy Scout Dr. / Fowler St	Summerlin Rd.	Colonial Blvd	1.779	**FDOT Fiber** (96 Count) from Summerlin Rd. to US 41 and from US 41 to Colonial Blvd. *Fiber does not connect across the US 41 intersection.*
Bonita Beach Rd.	Vanderbilt Dr.	Old 41 Rd.	1.431	**Fiber** from Vanderbilt Dr. to Spanish Wells Blvd. (96 Count) There is **FDOT fiber** east of Old 41 along Bonita Beach Rd. There is also **conduit** from Spanish Wells Blvd. to Old 41 Rd.
Del Prado Blvd.	Cape Coral Pkwy	Veterans Pkwy Ramps	3.111	**Shared Fiber** along entire segment – (DOT 1 to 24, TOLLS 25 to 72, DOT 73 to 84, ITG 85 to 96, DOT remainder) – 216 Count
Ortiz Ave.	SR884 / Colonial Blvd.	SR 80 / Palm Beach Blvd	4.406	**FDOT Shared Fiber** from Colonial Blvd. to SR 82 (144 Count) **FDOT Fiber** (12 and 48 count) from SR 82 to Luckett Rd. **Conduit** from Tice St. to SR 80.
Cape Coral Pkwy.	Coronado Pkwy	Santa Barbara Blvd.	0.978	**FDOT Fiber** along entire segment – 216 count on north side of Cape Coral Pkwy. and 96 count on south side
Corkscrew Rd.	US 41	I-75	2.053	**FDOT/ITG Fiber** along entire segment – 96 count (1-84 DOT, 85-96 ITG. DOT agrees to provide ITG with 12 strands of fiber) – 288 count (DOT 1-144, ITG 145-288)
Veterans Pkwy.	West of Skyline Blvd.	SR 867 / McGregor Blvd.	5.43	Fiber along entire segment **FDOT** – 96 count from West of Skyline Blvd. to Del Prado Blvd. **ITG** – 48 count from Country Club Blvd. to Del Prado Blvd. **FDOT/ITG Fiber** from Del Prado Blvd. to SR 867 – 216 Count (1-24 DOT, 25-72 TOLLS, 73-96 DOT, 97-144 ITG, 145-216 Undefined)
Summerlin Rd.	SR 884 (Colonial Blvd.)	College Pkwy.	2.953	Fiber along entire segment **FDOT** – 96 count (DOT - 1 to 24, TOLLS 25 to 72, DOT 73 to 96) **ITG** – 48 Count
Leonard Blvd. S.	Lee Blvd	Sunshine Blvd.	5.391	**FPL Fibernet** along entire segment

\\vhb\gbl\proj\Orlando\62868.06 FDOT D1 TSMO Lee MP\graphics\FIGURES\AI

Source: Google Maps



N.T.S.

Lee County
Possible Fiber Connection Path
ITG FOC
DOT FOC

Lee County FOC
Other Agency FOC
Shared Fiber
FPL Fibernet Fiber

Fiber Zones
Zone 1
Zone 2
Zone 3

Fiber Conduit
DOT - ITG - County - City
Other Agencies

County Facilities
Networked
Not Networked

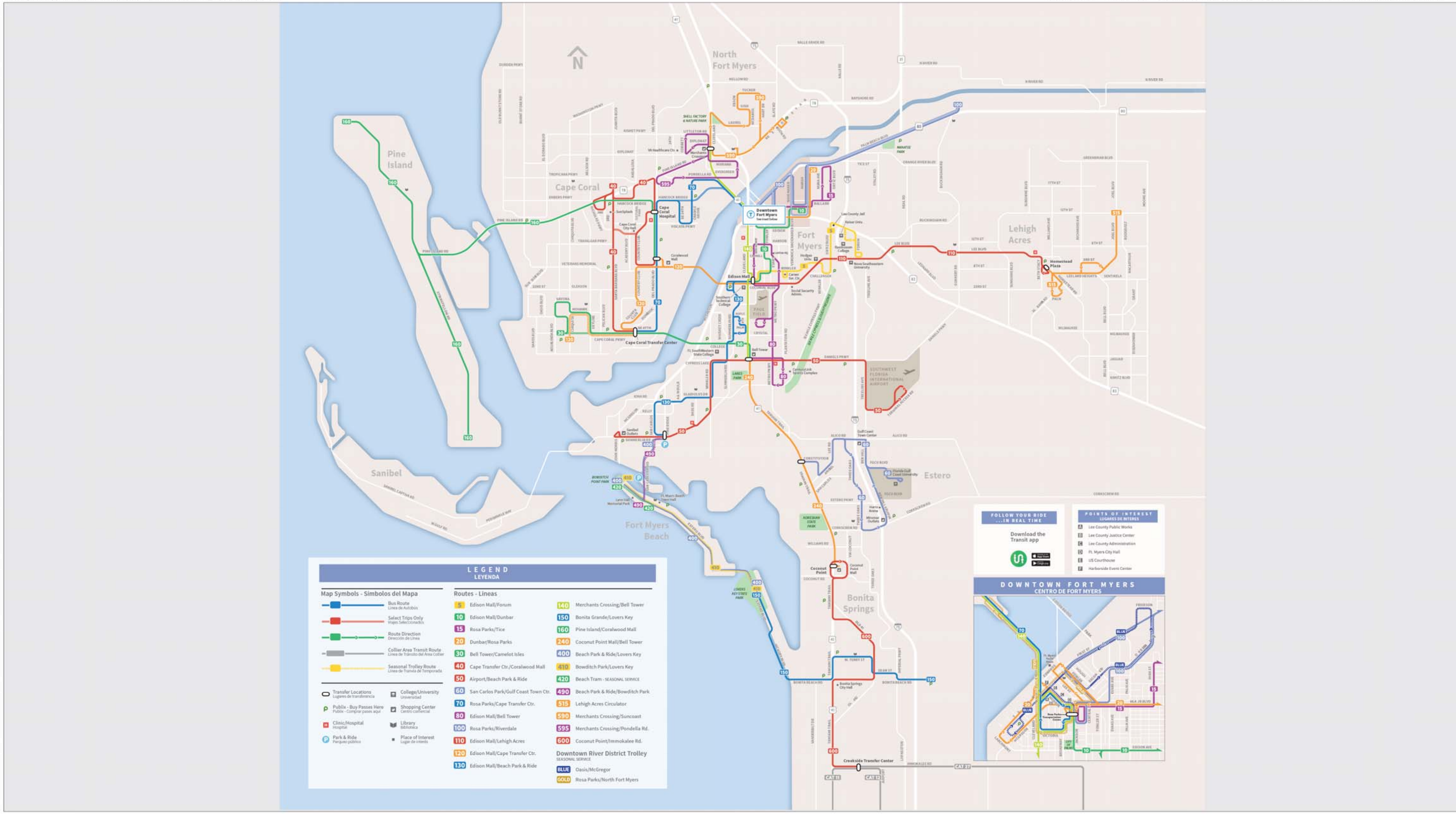
Figure 11

Fiber Map
Lee County MPO
TSM&O Master Plan

5.1.5 Transit

LeeTran is a department of Lee County government, responsible for operating the public transit system serving the County. Per the LeeTran website, the transit agency operates 24 bus routes, a paratransit service for the disabled called Passport, and an employer vanpool program. Many TSM&O strategies include transit-oriented improvements. The purpose of this section is to identify the current bus routes and understand the existing bus stop locations. The existing bus routes were obtained from the LeeTran website (https://www.leegov.com/leetran/how-to-ride/maps-schedules) and are illustrated on Figure 12.

Source: LeeTran https://www.leegov.com/leetran/PublishingImages/Lee%20Tran%20System%20Map%202019%20web.pdf



N.T.S.

Figure 12

LeeTran Transit Routes

Lee County MPO

TSM&O Master Plan

5.2 Summary of Transportation Plans

A review of the various transportation plans was performed to identify any planned improvements throughout Lee County and connected to the TSM&O strategic network, particularly those projects affecting the prioritized on- and off-system corridors. During this exercise, the following documents were reviewed:

FDOT Five Year Work Program (FY 2018/19-FY 2022/23)
Each year, FDOT develops the Five-Year Work Program in accordance with Section 339.135, Florida Statutes. The Five-Year Work Program is an ongoing process used to forecast the funds needed for upcoming transportation system improvements scheduled for the next five years. The development of this Work Program involves extensive coordination with local governments, including Metropolitan Planning Organizations and other city and county officials.

FDOT SIS Adopted 1st and 2nd 5-year Improvement Plan
Per the FDOT Systems Planning Office, FDOT produces a document set known as the SIS Funding Strategy, identifying potential Strategic Intermodal System (SIS) Capacity Improvement projects in various stages of development. All of the projects identified within the SIS Funding Strategy are considered financially feasible for implementation. The system encompasses transportation facilities of statewide and interregional significance and is focused on the efficient movement of passengers and freight. The document set identifies projects that are funded (Year 1), programmed for proposed funding (Years 2 through 5), and planned to be funded (Years 6 through 10).

FDOTs SIS Long-Range Cost Feasible Plan (FY 2029-2045)
The Long-Range Cost Feasible Plan is provided within the same document set of the SIS Funding Strategy as the plan identifies projects considered financially feasible based on projected State revenues (Years 11 through 25).

Lee County MPO 2040 Long Range Transportation Plan (LRTP)
The Lee County MPO 2040 LRTP identifies a multimodal range of improvements for Lee County through 2040. The MPO is currently developing the 2045 LRTP, which was not available for review at the time of this publication.

Lee County MPO Transportation Improvement Plan (TIP) FY 2018/19-FY 2022/23
The TIP is a priority list of federal and state funded projects that have been scheduled for implementation by the Lee County MPO. The TIP includes financially feasible multimodal projects that were previously adopted by state and local officials, and transportation agencies funded through FY 2023.

LeeTran 2017-2026 Transit Development Plan (TDP)
The LeeTran 2017-2026 TDP documents future transit improvements throughout Lee County for the next 10 years. Transit improvements can include new routes, expanded hours of operation, or increased frequencies.

Tables 7 and 8 details the projects found within the aforementioned documents, itemized for each of the prioritized state and local corridors, respectively.

Table 7 – Programmed Projects for State Road Priority Corridors

Road Name	From	To	Notes
SR 884	US 41/Cleveland Ave.	Colonial Country Club Blvd.	• **FDOT Work Program – Adopted FY 18** o Intersection Improvements at SR 884 (Colonial Blvd.) and Fowler St. (FPID #436955-1) for $2,634,204 – Begin MP 0.495, End MP 0.7 - .208 miles total o I-75 at SR 884 Interchange – Add Lanes 19/20 (FPID #413065-1) - $58,910,161 project total • **Lee MPO TIP – FY 18/19 – 22/23** o Intersection Improvements at SR 884 (Colonial Blvd.) and Fowler St. (FPID #436955-1) – Deferred to 2023 - $2,959,204 o I-75 at SR 884 Interchange – Add Lanes 19/20 (FPID #413065-1) - $54,140,599 project total ($63,366,773 including FY 18/19) • **LeeTran TDP** o Express service on Colonial Blvd. from Homestead Plaza to Edison Mall Transfer Center – Weekdays with 30-minute headways- $239,823 annual operating costs o BRT from Metro Parkway to Edison Mall Transfer Center - $809,404 annual operating cost • **2040 LRTP** o Colonial Boulevard at I-75 Interchange Improvement (FPID #413065-1) – 2021-2025
SR 82	Colonial Blvd.	Alabama Rd.	**None** o Note: Widening from 2 lanes to 6 lane divided highway is already in progress
SR 45	SR 865 (6 Mile Cypress Pkwy.)	SR 884 (Colonial Blvd.)	• **Lee MPO TIP – FY 18/19 – 22/23** o Transit Bus Queue jumps from College Parkway to Daniels Parkway– FY 20/21 - $398,000 o Intersection Improvement at US 41 and College Pkwy. /Woodland Blvd. (FPID #436547-1) FY 18/19 - $354, 662 total (Total project cost $510,684 including prior work) o Urban Corridor Improvements – Transit Operating Assistance- from FY18/19 to FY 22/23 - $3,418,508 annual operating expenses • **LeeTran TDP** o Transit Bus Queue jumps along US 41 – FY 2021
SR 865	Summerlin Rd.	Metro Pkwy.	**None**
SR 876	US 41/Cleveland Ave.	Treeline Ave.	• **LeeTran TDP** o Bell Tower Transfer Hub Park and Ride at US 41 and Daniels Pkwy.
SR 867	Colonial Blvd.	College Pkwy.	**None**
SR 78	Santa Barbara Blvd.	Hancock Creek Blvd.	• **2040 LRTP** o Widen SR 78 from Santa Barbara Boulevard to east of Pondella Rd. from 4 lanes to 6 lanes – 2031-2040 - $61.1 million • **TIP** o SR 78 at Santa Barbara Blvd - Add left turn lane (FPID #433222-1) – total $31,153 – FDOT annual obligations report
SR 82	Michigan Ave.	I-75 NB on-ramps	• **LeeTran TDP** o Lehigh Express Route from Lee Blvd to Homestead – unfunded - $726,257 annual operating costs
US 41 Business (SB)	SR 80 (Palm Beach Blvd.)	MP 1.017	**None** o Related project on TIP at Fowler St. and SR 82 (Dr. Martin Luther King Jr. Blvd.) - Intersection Improvements Managed by FDOT (FPID #433370-1)
US 41 Business (NB)	Second St.	First St.	**None** o Related project on TIP at Fowler St. and SR 82 (Dr. Martin Luther King Jr. Blvd.) - Intersection Improvements Managed by FDOT (FPID #433370-1)

Table 8 – Programmed Projects for Local Road Priority Corridors

Road Name	From	To	Notes
Del Prado Blvd.	SE 21st Lane	Hancock Bridge Pkwy.	• **TDP** o Cape Coral Express Route from Chiquita Blvd. to Rosa Parks- unfunded - $680,866 annual operating costs – scheduled for 2021
Boy Scout Dr. / Fowler St	Summerlin Rd.	Colonial Blvd	• **FDOT Work Program – Adopted FY 18** o Intersection Improvements at SR 884 (Colonial Blvd.) and Fowler St. (FPID #436955-1) for $2,634,204 – Begin MP 0.495, End MP 0.7 - .208 miles total • **Lee MPO TIP – FY 18/19 – 22/23** o Intersection Improvements at SR 884 (Colonial Blvd.) and Fowler St. (FPID #436955-1) – Deferred to 2023 - $2,959,204
Bonita Beach Rd.	Vanderbilt Dr.	Old 41 Rd.	• **None on this segment – Related:** o **LRTP** ▪ Old US 41 from Collier County Line to Bonita Beach Road, widen from 2 lanes to 4 lanes $17.73 million cost of construction – 2026-2030
Del Prado Blvd.	Cape Coral Pkwy	Veterans Pkwy Ramps	• **TDP** o Cape Coral Express Route from Chiquita Blvd. to Rosa Parks- unfunded - $680,866 annual operating costs – scheduled for 2021
Ortiz Ave.	SR884 / Colonial Blvd.	SR 80 / Palm Beach Blvd	• **2040 LRTP** o From Colonial Blvd. to Dr. Martin Luther King Jr. Blvd. and Dr. Martin Luther King Jr. Blvd. to Luckett Rd – Widen from 2 lanes to 4 lanes – total cost $28,690,000
Cape Coral Pkwy.	Coronado Pkwy	Santa Barbara Blvd.	• **TDP** o Cape Coral Express Route from Chiquita Blvd. to Rosa Parks- unfunded - $680,866 annual operating costs – scheduled for 2021
Corkscrew Rd.	US 41	I-75	• **SIS First 5 Year Plan FY 18/19 to 22/23** o I-75 at Corkscrew Rd. Interchange improvement funded for 2019 Construction (FPID #406225-6)
Veterans Pkwy.	West of Skyline Blvd.	SR 867 / McGregor Blvd.	• **2040 LRTP** o Veterans Parkway at Santa Barbara Boulevard Intersection Improvements – 2026-2030 - $39.7 million • **FDOT Workplan – Adopted FY 2018** o SW 3rd Place to SW 2nd Court. Sidewalk (FPID #442507-1) funded for FY 2023 - $167,739
Summerlin Rd.	SR 884 (Colonial Blvd.)	College Pkwy.	**None**
Leonard Blvd. S.	Lee Blvd	Sunshine Blvd.	**None**

5.3 Gaps Analysis

The existing infrastructure was found to have "gaps" along the prioritized corridors. Filling in these "gaps" has the potential to enhance the connectivity of operations (i.e., fiber and communication), as well as create a continuous sidewalk network that will encourage and enable travel to be completed by foot between the surrounding land uses and provide safe access to complete the first-mile, last-mile connection.

This section identifies the existing "gaps" and documents where strategies could be utilized to promote a safe and efficient multi-modal system.

5.3.1 Fiber Gaps

Table 9 and Table 10 identify those corridors within the top 10 on- and off-system corridors, identified in Section 3.1, where fiber gaps exist today, based on the FDOT and Lee County data.

Table 9 – Fiber Gaps for State Road Priority Corridors

Priority Rank	Road Name	From	To	Segment Length (mi.)	Gap
2	SR 82 (Dr. Martin Luther King Jr. Blvd.)	Colonial Blvd.	Alabama Rd.	7.835	No fiber along entire segment
5	Daniels Pkwy. (SR 876)	US 41/Cleveland Ave.	Treeline Ave.	5.329	No fiber from Brynwood Ln. to Metro Pkwy, approximately .67 miles
6	McGregor Blvd. (SR 867)	Colonial Blvd.	College Pkwy.	3.814	No fiber along entire segment

Table 10 – Fiber Gaps for Local Road Priority Corridors

Priority Rank	Road Name	From	To	Segment Length (mi.)	Gap
2	Boy Scout Dr. / Fowler St.	Summerlin Rd.	Colonial Blvd.	1.779	Fiber does not connect across the US 41 intersection.
3	Bonita Beach Rd.	Vanderbilt Dr.	Old 41 Rd.	1.431	No fiber from Spanish Wells Blvd. to Old 41 Rd. (1.19 miles)
5	Ortiz Ave.	SR884 / Colonial Blvd.	SR 80 / Palm Beach Blvd.	4.406	No fiber from Luckett Rd to SR 80 (1.33 miles)
10	Leonard Blvd. S.	Lee Blvd.	Sunshine Blvd.	5.391	No fiber along entire segment

In addition to the prioritized state corridors, other major state arterials were reviewed for significant fiber optics / communication gaps (where no fiber is present).

Table 11 describes the major gaps in other major state facilities.

Table 11 – Fiber / Communication Identification for State Road Priorities

Road Name	From	To	Segment Length (mi.)	Notes
SR 867 / McGregor Blvd.	Summerlin Rd.	Cypress Lake Dr.	2.745	No fiber, conduit along entire segment
SR 867 / McGregor Blvd.	College Pkwy.	US 41	6.39	No Fiber, no conduit throughout most of segment

SR 78 / Pine Island Rd.	Veterans Memorial Pkwy.	Santa Barbara Blvd.	1.779	No fiber, conduit along entire segment
US 41	Across Caloosahatchee River		1.431	No fiber, conduit extends across bridge
SR 884 / Colonial Blvd.	SR 82 / Dr. Martin Luther King Jr. Blvd.	Bella Ct.	3.111	No fiber, conduit from Gunnery Rd. to Bella Ct.

5.3.2 Other Gaps

The County currently has a robust sidewalk system, including several corridors that have a bicycle land and / or shared-use path constructed. However, this section will highlight those locations where gaps currently exist and could be connected via future projects and /or prioritized to complete the first mile / last mile connection.

Table 12 – Sidewalk Gaps for State Road Priorities

Priority	Corridor	Sidewalk Gap	Side Missing
2	S.R. 82	Colonial Blvd. to S of River Trent Ct.	South or West Side
4	S.R. 865	Michael G. Rippe Pkwy. to Canal	South Side
		Over the Canal	North/South Sides
		S Tamiami Trail to Billboard east of Riverchase Dermatology	South Side
		Old Galdiolus Dr. to East of Shannon Blvd.	South Side
		Coca Sabal Ln. to Maida Ln.	South Side
6	S.R. 867	Keenan Ave. to Val Mar Dr.	North or West Side
		Winkler Rd to Brentwood Pkwy.	East Side
		George Town to End of Frontage Rd.	West Side
7	S.R. 78	NE 24th Ave. to Pondella Rd.	North/South Sides
		Pondella Rd. to Del Prado Blvd.	North/South Sides
		Del Prado Blvd. to Andalusia Blvd.	North/South Sides
		Andalusia Blvd. to Cultural Park Blvd.	North Side
		Cultural Park Blvd. to Santa Barbara Blvd.	North/South Sides
8	S.R. 82	Ortiz Ave. to Michigan Ave Link	North Side
9	U.S. 41 Business (SB)	Bridge Split to N. of Edwards Dr.	East Side

Table 13 – Bicycle / Shared-Use Path Gaps for State Road Priorities

Priority	Corridor	From	To	Segment Length (mi.)	Bike Lane Need (% of Corridor)
1	S.R. 884	US 41/Cleveland Ave.	Colonial Country Club Blvd.	5.289	>50%
2	S.R. 82	Colonial Blvd.	Alabama Rd.	7.835	>80%
3	S.R. 45	SR 865 (6 Mile Cypress Pkwy.)	SR 884 (Colonial Blvd.)	4.75	0%
4	S.R. 865	Summerlin Rd.	Metro Pkwy.	2.712	>70%
5	S.R. 876	US 41/Cleveland Ave.	Treeline Ave.	5.329	100%
6	S.R. 867	Colonial Blvd.	College Pkwy.	3.814	>50%
7	S.R. 78	Santa Barbara Blvd.	Hancock Creek Blvd.	3.491	100%
8	S.R. 82	Michigan Ave.	I-75 NB on-ramps	1.541	0%
9	U.S. 41 Business (SB)	SR 80 (Palm Beach Blvd.)	MP 1.017	1.017	>50%
10	U.S. 41 Business (NB)	Second St.	First St.	0.143	100%

Table 14 – Sidewalk Gaps for Local Road Priorities

Priority Rank	Local Street Name	Sidewalk Gap	Side Missing
5	Ortiz Ave.	Colonial Center Dr. to S. of SR 82	East Side
		SR 82 to Garcia Ave. *(occasional parcel has sidewalks)*	West Side
7	Corkscrew Rd.	East of Design Parc Ln. to Three Oaks Pkwy.	North Side
8	Veterans Pkwy.	Santa Barbara Blvd. to SR 867	North Side
		West of Skyline Blvd. to SR 867 *(occasional parcel has sidewalks)*	South Side
9	Summerlin Rd.	N. of Matthew Dr. to Colonial Blvd.	East Side
		N. of Cedarbend Dr. to Boy Scout Dr.	West Side

Table 15 – Bicycle / Shared-Use Path Gaps for Local Road Priorities

Priority Rank	Local Street Name	From	To	Segment Length (mi.)	Bike Lane Need (% of Corridor)
1	Del Prado Blvd.	SE 21st Lane	Hancock Bridge Pkwy.	2.745	100%
2	Boy Scout Dr. / Fowler St	Summerlin Rd.	Colonial Blvd	1.779	100%
3	Bonita Beach Rd.	Vanderbilt Dr.	Old 41 Rd.	1.431	100%
4	Del Prado Blvd.	Cape Coral Pkwy	Veterans Pkwy Ramps	3.111*	100%
5	Ortiz Ave.	SR884 / Colonial Blvd.	SR 82	4.406	100% (East)
		SR 82	SR 80 / Palm Beach Blvd		100%
6	Cape Coral Pkwy.	Coronado Pkwy	Santa Barbara Blvd.	0.978*	100%
7	Corkscrew Rd.	US 41	I-75	2.053	>30% (north)
8	Veterans Pkwy.	West of Skyline Blvd.	SR 867 / McGregor Blvd.	5.43*	100%
9	Summerlin Rd.	SR 884 (Colonial Blvd.)	College Pkwy.	2.953	100%
10	Leonard Blvd. S.	Lee Blvd	Sunshine Blvd.	5.391*	100%

Note: *Corridors have available shoulder to accommodate bicycles; however, no bicycle lane designation exists.*

In addition to evaluating the sidewalk and bike lane gaps, the existing transit service was reviewed to identify which of the prioritized corridors have an existing transit line and which does not. When a transit line is available, it is recommended that the on-time performance be reviewed and evaluated by LeeTran, as it will be affected by the corridor operations and infrastructure needs.

Table 16 – Transit Service for State Road Priorities

Priority	Corridor	From	To	Service Available?	Existing Transit Line
1	S.R. 884	US 41/Cleveland Ave.	Colonial Country Club Blvd.	Yes	110
2	S.R. 82	Colonial Blvd.	Alabama Rd.	No	---
3	S.R. 45	SR 865 (6 Mile Cypress Pkwy.)	SR 884 (Colonial Blvd.)	Yes	30, 50, 140, 240
4	S.R. 865	Summerlin Rd.	Metro Pkwy.	No	---
5	S.R. 876	US 41/Cleveland Ave.	Treeline Ave.	Yes	50
6	S.R. 867	Colonial Blvd.	College Pkwy.	No	---
7	S.R. 78	Santa Barbara Blvd.	Hancock Creek Blvd.	Yes	40 (590 and 595 - Partial)
8	S.R. 82	Michigan Ave.	I-75 NB on-ramps	No *	---
9	U.S. 41 Business (SB)	SR 80 (Palm Beach Blvd.)	MP 1.017	No *	---
10	U.S. 41 Business (NB)	Second St.	First St.	No *	---

**** Note:*** *Corridor limits abut existing transit route; however, do not contain bus stops and / or transit service.*

Table 17 – Transit Service for Local Road Priorities

Priority Rank	Local Street Name	From	To	Service Available?	Existing Transit Line
1	Del Prado Blvd.	SE 21st Lane	Hancock Bridge Pkwy.	Yes	70, 160
2	Boy Scout Dr. / Fowler St	Summerlin Rd.	Colonial Blvd	No	---
3	Bonita Beach Rd.	Vanderbilt Dr.	Old 41 Rd.	Yes	150 / 600
4	Del Prado Blvd.	Cape Coral Pkwy	Veterans Pkwy Ramps	Yes	70
5	Ortiz Ave.	SR884 / Colonial Blvd.	SR 80 / Palm Beach Blvd	Partial	15
6	Cape Coral Pkwy.	Coronado Pkwy	Santa Barbara Blvd.	Yes	30 / 120
7	Corkscrew Rd.	US 41	I-75	Partial	60E (1 stop)
8	Veterans Pkwy.	West of Skyline Blvd.	SR 867 / McGregor Blvd.	No **	---
9	Summerlin Rd.	SR 884 (Colonial Blvd.)	College Pkwy.	Partial	130
10	Leonard Blvd. S.	Lee Blvd	Sunshine Blvd.	No	---

***** Note:*** *Multiple transit routes progress along corridor; however, no bus stops are present along prioritized corridor.*

6

Opportunities and Priorities

After completing the assessment of the overall network, including identifying existing conditions and gaps, specific TSM&O strategies can be considered for implementation. These strategies are evaluated against priorities to identify opportunities to provide the greatest benefit. As described in previous sections, the TSM&O process is meant to remain flexible to allow strategies to be implemented at the TSM&O strategic network locations, where the greatest opportunity for benefit can be achieved for all users.

6.1 TSM&O Strategies

The strategies outlined in this chapter were selected as being most applicable to Lee County MPO based on the identified needs of the region. These strategies consider both general and specific TSM&O approaches that can be implemented across the region or on specific corridors. These strategies are not meant to represent all available strategies and will continue to evolve with technologic innovations.

General TSM&O Strategies were formulated based on National ITS Architecture, the Florida Statewide ITS Architecture (SITSA) and the District 1 Regional ITS Architecture (RITSA), which were created to promote and integrate ITS solutions into the statewide and regional transportation system. The statewide TSM&O Strategy Guide served as a source of cost estimates and strategy categories.

While many of these TSM&O strategies can be applied to multiple locations across the transportation network, these strategies should be evaluated and implemented at locations where the need matches the strategy. For example, safety strategies will be most effective on corridors with high crash densities, those with high transit use can identify transit strategies, etc.

6.1.1 Strategies Considered

Four (4) TSM&O strategy categories were used that best fit the needs of the priority corridors within the Lee County MPO.

Capacity and Operation Strategies develop systems to monitor traffic flow and roadway conditions, and provide strategies such as traffic monitoring, traffic information/warning, signal control/metering, and congestion mitigation to improve the flow of traffic on the corridor or region/surrounding area, effectively "taking back" lost capacity. Locations of traffic management were identified using several criteria, including current and future volume to capacity ratio, bottleneck data, and signal density.

Transit Strategies apply to the development of systems to more efficiently manage fleets of transit vehicles or transit rail. This strategy includes systems to provide transit traveler information, transit signal priority, electronic fare payment, and other transit communication and management systems. Locations of transit management were identified by transit ridership.

Safety Strategies provide rapid and effective response to incidents and emergencies. These strategies include systems to detect and verify incidents, along with coordinated agency response to the incidents. It also provides emergency call taking, public safety dispatch, and emergency center operations.

Connected and Autonomous (CAV) Strategies can synergize with any of the above strategies and take advantage of emerging technologies to create better communication between vehicles and infrastructure, as well as to help autonomous vehicles travel more efficiently. These strategies can create safer and more efficient roadways by using new technology to create benefits that previously were not possible. With the rapid pace of technological advancement, agencies must be aware of the risks associated with existing and future technologies in the CAV sector. Hardware for connected vehicle (CV) infrastructure is constantly evolving, and agencies must consider this in the context of their planning horizons. It is important for agencies to protect limited public funds by properly assessing associated risk and determining potential returns-on-investment (ROI) for CAV technologies.

While this section highlights four strategy areas for TSM&O solutions, it is not intended to limit solutions to only these categories or solutions. Additional service areas, such as work zones, commercial vehicles, multimodal improvements, travel demand management and data management should be considered as resources, as new technologies become available and increasingly prevalent.

The selection of additional TSM&O strategies should be determined as additional studies for specific projects, corridors, or areas are undertaken. The outcomes of these studies may assist in identifying additional TSM&O strategies or selecting TSM&O strategies that could be incorporated into projects.

In many cases, the existing equipment can assist in identifying strategies as basic traffic management equipment, such as fiber optics and communication systems, are the basis for many TSM&O strategies, data collection and monitoring. Opportunities to install fiber optics and communications, independent of specific TSM&O strategies, is also encouraged to foster future improvements, consistent with the Master Plan and strategic network.

In addition, coordination and management are essential to the success of TSM&O/ITS investments. Improvements and upgrades should be considered to ensure efficient communication, monitoring, operational coordination, data collection and sharing, information synthesis and distribution among agencies in the regional TSM&O/ITS system. These could include implementing the Lee County Integrated Corridor Management (ICM) system; collaboration among the FDOT Regional Traffic Management Center (RTMC), County's traffic engineering offices, and transit agency's operation and management centers; and developing real-time or archival data-sharing through SunGuide or the Regional Integrated Transportation Information System (RITIS).

The TSM&O strategies identified for the TSM&O Master Plan, based on the four categories outlined above, can be found in Appendix A. While more strategies exist, these strategies were identified through analysis of local needs and knowledge of TSM&O processes. Please note the $ sign is an indication of the cost, with $ being a lower cost than $$$, and identified for both capital and operating costs.

6.1.2 Example Project Implementation

In coordination with the FDOT, an example corridor was selected for evaluation and identification of TSM&O strategies for implementation. Based on the outcome of the previous sections, the project utilized is SR 78 (Pine Island Road), from Santa Barbara Boulevard to NE 24th Avenue/Hancock Creek S. Boulevard. Consideration included the previously identified strategies, local context, potential benefit, and estimated cost.

To identify possible TSM&O strategies, it is important to understand the source of the problems and the desired outcomes for the facilities. Therefore, a planning-level desktop screening was included as an extension of the data collection efforts, including, but not limited to: traffic counts, (such as vehicular), access management, truck route and percentage, ITS infrastructure, and crash frequency and locations.

Utilizing a statewide TSM&O tool, the TSM&O Strategy Guide provided TSM&O strategies that may potentially reduce, minimize, or eliminate certain issues facing a given study corridor or regional network. The guide provides a general description of each strategy suggested, along with relative values for capital and operating costs, complementary and conflicting strategies, available benefit-cost ratios, and links for additional information. The purpose of the TSM&O Strategy Guide is to aid transportation planners and engineers in identifying potential TSM&O strategies based on the context of their study area, allowing for and starting the detailed discussions and problem-solving with TSM&O and ITS professionals within an organization.

For the Pine Island Road corridor, the following issues were identified and applied to the TSM&O Strategy Guide prompts for potential strategies:

- High Crash Rate – Angles (at Intersection)
- High Crash Rate – Angles (along Roadway)
  - left-turn conflict points throughout corridor
- High Crash Rate – Rear ends
  - 50.1% of all crashes along the study corridor were rear-end crashes
- Over Capacity – Moderate (V/C = 1.01-1.10)
- Large Queues at Intersection (re-timings)
  - Andalusia Boulevard was identified as a potential candidate for signal re-timing
  - Signalized intersections in the corridor have been identified for potential coordination
- Minimal Bicycle/Pedestrian Infrastructure
  - Sidewalk gaps throughout corridor

- Entire corridor is designated Pine Island Road District, based on criteria, the adjacent land uses would qualify for Pine Island Road District – Corridor Zoning, which is intended to support movements between Pine Island Road District – Village Zoning areas
- Village Zoning areas should promote maximum pedestrian friendliness and minimal automobile traffic
  - There was one bicycle fatality in study area (EB 500' west of NE 15th Ave)
- Evacuation Route (improvements to support designation)
  - SR 78 (Pine Island Road; Bayshore Road) is a designated evacuation route
  - provides the only access point between the mainland and Pine Island

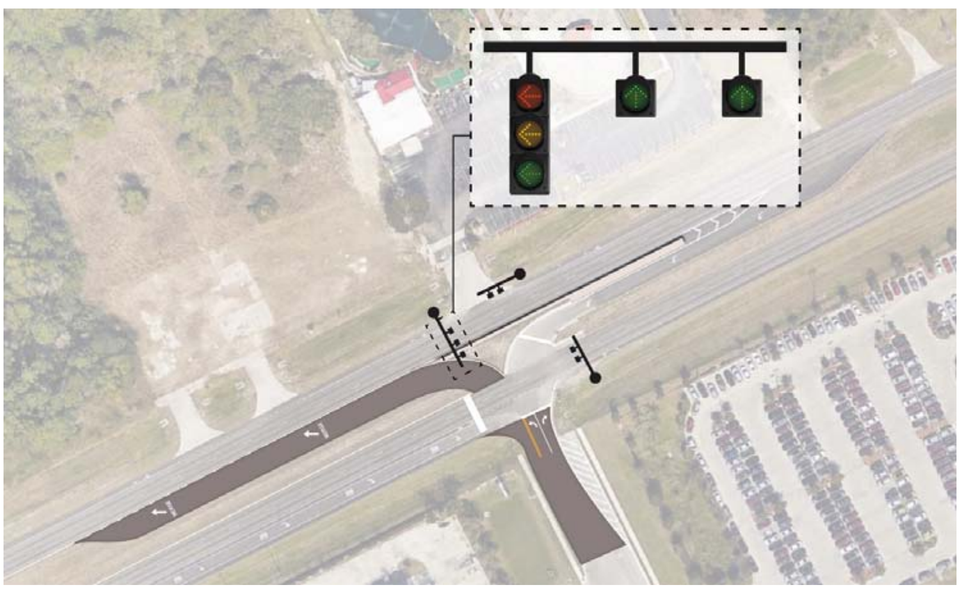
As a result of this evaluation, potential strategies were identified to carry forward the potential TSM&O strategies for the prioritized corridor. The intent of this evaluation is not to develop specific concepts and will not include public input; however, it will guide future efforts in corridor improvements and identify future performance measures.

The method of screening and evaluating these options involved assessing the deciding datasets which led to the corridor being identified as the highest priority. Doing so ensures that the candidate options for each alternative recommendation meet the project objectives and needs. Based on the transportation desktop review, the candidate improvements were separated based type of strategies, as described above. The following strategies are not intended to represent all available strategies, as the purpose and need may change based on additional data collection efforts. The following summarizes the potential TSM&O strategies and planning-level costs.

Capacity and Operation Strategies

TSM&O Strategy / Issues Resolved	Explanation of Strategy	Leading Agency	Planning-Level Costs
Strategy: Signal Retiming *Issues Resolved:* • *Over capacity – Moderate (V/C = 1.01-1.10)* • *Large Queues at Intersection*	Traffic signal re-timing is a basic TSM&O strategy that is widely and consistently implemented in some parts of Central Florida. Due to the ever-changing nature of traffic, signal timings must be periodically reviewed and updated to minimize delays to travelers. Re-timing is often the first step in improving operations at an existing signal. Traffic signal re-timing should take into account the level of pedestrian and bicycling activity at the intersection or corridor of interest. Depending on the signal technology at the intersection(s), re-timing may range from updating green phases to revising corridor-wide coordination. An additional TSM&O strategy the could be utilized is Adaptive Signal Control Technologies (ASCT) which is an advanced signal timing strategy that can account for real-time fluctuations in traffic patterns. However, the system is more expensive and would require the personnel to monitor and the technical expertise to operate and maintain.	County	$4,000
Strategy: Operations: Advanced Detection Devices	Some of the signalized intersections along the corridor do not appear to have advanced detection via loops and/or video cameras. Based on the desktop review, the corridor experiences a heavy queue at the intersection of SR 78 and Andalusia Boulevard, which is one of the locations without detection. This intersection, as well as any other	County / FDOT	Varies

<u>*Issues Resolved*</u>: • *Over capacity – Moderate (V/C = 1.01-1.10)* • *Large Queues at Intersection*	signalized intersection without advanced detection, should be evaluated for the potential of adding advanced detection devices. With the inclusion of these devices, the intersection(s) can be actuated to flush potential queues occurring along the mainline.		
<u>Strategy</u>: Turbo Signal (aka Continuous Green T-Intersections -- CGT) <u>*Issues Resolved*</u>: • *Over capacity – Moderate (V/C = 1.01-1.10)* • *Large Queues at Intersection* • *High Crash Rate – Angles (at Intersection)*	The continuous green t-intersections design allows the main line through traffic to pass through the intersection without stopping (top side of the "T"), while also eliminating conflicting vehicular movements. This main line approach to the intersection is denoted by a steady green arrow, as well as the appropriate pavement markings. Based on the national studies, the CGT resulted in increased safety and throughput, as the injury crashed were reduced by 70 percent and the total crashed by 60 percent. This treatment should only be considered as a potential strategy for T-intersections, with limited to no U-turns at the bottom side of the "T".	FDOT / County	$576,696



Conceptual Layout of Turbo Signal at SR 78 and NE 2nd Place

<u>Strategy</u>: Quadrant Roadway (QR) <u>*Issues Resolved*</u>: • *Over capacity – Moderate (V/C = 1.01-1.10)* • *Large Queues at Intersection*	A QR intersection is a promising design for an intersection of two busy suburban or urban roadways. The intersection works by rerouting a couple or all four left–turn movements at a four–legged intersection onto a road that connects the two intersecting roads. Figure 1 shows the geometry of a QR intersection where the connection road is placed in the southwest quadrant. The location of the connector road depends on traffic flow and availability of right–of–way. FHWA studies have found that the throughput showed a 5 to 20% reduction in travel time compared to conventional intersections. The QR intersection increases operational efficiency through a congested intersection by moving the left turns away from the main intersection	FDOT / County / City	Varies

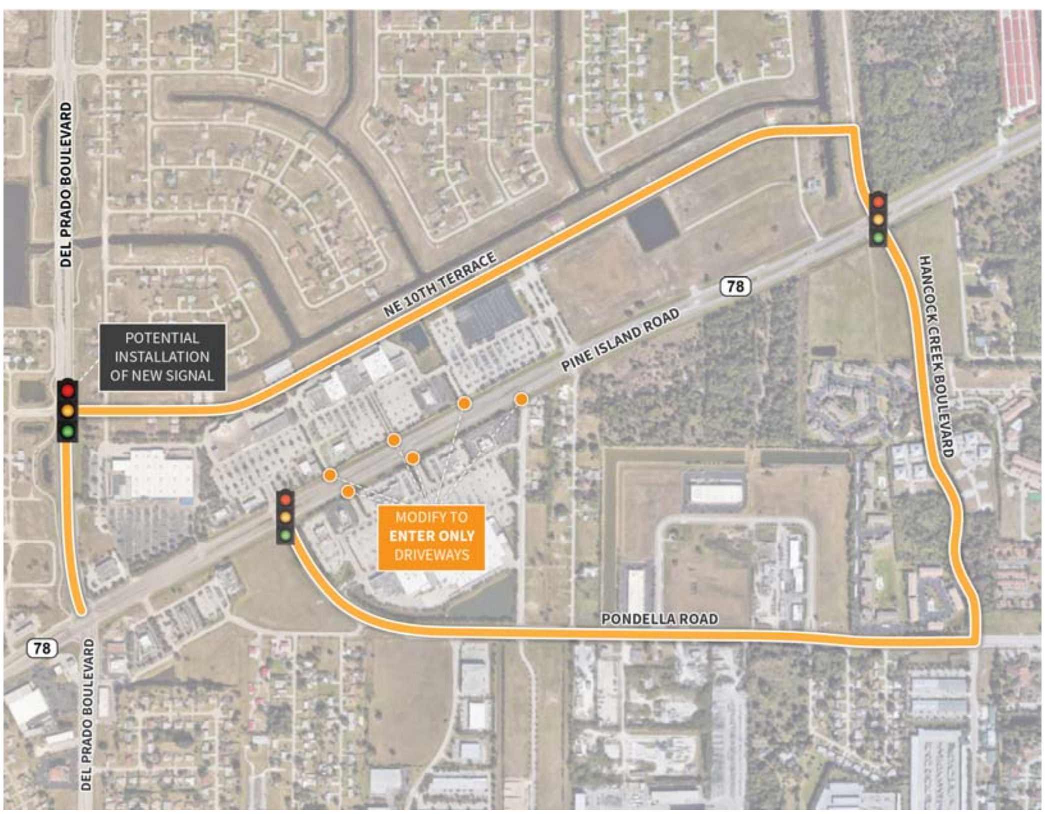
	and allowing a two–phase signal at the main intersection. While additional right–of way would be needed in the connection road quadrant, and extra cost would be necessary to build the connecting roadway, the QR intersection could be used to reduce congestion at a busy intersection in a developing area. It could also serve as a temporary congestion reliever until a grade–separated solution can be built. In addition, the QR intersection accommodates pedestrians well.		

Example of a QR Intersection

<u>Strategy</u>: Frontage Road / Auxiliary Lane *<u>Issues Resolved</u>:* • *Over capacity – Moderate (V/C = 1.01-1.10)* • *Large Queues at Intersection*	Due to the amount of driveway connections in sections of SR 78, the addition of a separated one-way frontage road will help with moving the right-turning vehicles from the through lanes, operating as a continuous right turn lane, allowing for the four-lane corridor to operate with more capacity. These continuous turn lanes are not excessive in length; however, they will provide a right-turning vehicle ample time to move into the right turn lane and decelerate. Note, the continuous right turn lane would require the appropriate signage to direct drivers to the appropriate entry and exit points.	FDOT / County	$1.64M

Conceptual Layout of Frontage Road (Continuous Right Turn Lane with Raised Barrier)
SR 78, east of Andalusia Boulevard

Strategy: Trip Connectivity and Re-routing *Issues Resolved:* • *Over capacity – Moderate (V/C = 1.01-1.10)* • *Large Queues at Intersection* • *High Crash Rate – Angles (at Intersection)* • *High Crash Rate – Angles (along Roadway)*	The area around the intersection of SR 78 and Del Prado Boulevard includes several retail shopping plazas, anchored by big box retail stores (such as Publix and Target). As a result, the area experiences more traffic accessible through multiple driveway connections. Based on the desktop review, the Del Prado Crossing and North Point shopping plaza has a parallel roadway network to the north (via NE 10th Terrace) and south (via Pondella Road). To alleviate congestion and safety concerns along this segment, as well as at the intersections, the existing roadway network could be modified and reconstructed to direct the vehicles towards Del Prado Boulevard and/or NE 24th Avenue / Hancock Creek S Boulevard. To take advantage of the network and parallel East-West facilities, a detailed regional network analysis should be conducted to quantify the number of vehicles at each connection. Potential modifications to support this strategy could include installing a signal at Del Prado Boulevard and NE 10th Terrace, restricting the right-in/right-out driveway connections to right-in only, and coordinate closely with the surrounding developers to determine the availability of connecting the future developments (as there are several parcels currently vacant towards the east) towards building the parallel network.	County / City / FDOT	Varies



Regional Network North Point / Del Prado Crossing Shopping Plazas

Strategy: Widen to 6-Lanes	Roadway widening is a common practice used to alleviate congestion and capacity issues along a given corridor. Widening typically requires extensive studies of engineering feasibility and environmental impacts, as well as larger construction costs associated. As a result, this strategy	FDOT / County	$18.8M

Widen to 6-lanes (cont.) *Issues Resolved:* • *Over capacity – Moderate (V/C = 1.01-1.10)* • *Large Queues at Intersection*	is typically one of the more expensive TSM&O strategies but can provide a significant boost to vehicle throughput. Based on the future long-term model and historical growth trends, the corridor is anticipated to operate at an adverse condition. Although, the capacity is congested based on traditional planning methods, it is still advisable to consider additional TSM&O strategies that take advantage of the road work to deploy ITS infrastructure that will complement the widening improvement and improve operations of the facility. Roadway widening generally improves congestion but may also encourage higher travel speeds and potentially undesirable travel conditions.		

Transit Strategies

TSM&O Strategy / Issues Resolved	Explanation of Strategy	Leading Agency	Planning-Level Costs
Strategy: Transit Stop Evaluation *Issues Resolved:* • *Minimal Bicycle/Pedestrian Infrastructure* • *Large Queues at Intersection*	The placement and location of the bus stops should be evaluated to assure the safety of the riders and ability for the bus to re-enter the travel lane. Based on previous coordination, the LeeTran would prefer to locate bus stops close to signalized intersection, on the receiving side. In addition, the bus stops should be evaluated for consolidation, as some bus stops are located within 500 feet of each other, as well as bring the transit stops into ADA compliance, if not already, by installing landing pads at all transit stops, provide pedestrian connections (i.e., extend sidewalk) between sidewalks and bus stops, and install additional amenities such as bicycle racks.	LeeTran	Varies

Existing Bus Stop along North Side of SR 78 (No sidewalk connection with sign and bench located within Open Swale area)

Safety Strategies

TSM&O Strategy / Issues Resolved	Explanation of Strategy	Leading Agency	Planning-Level Costs
Strategy: Restricted Crossing U-Turn (R-CUT) *Issues Resolved:* • *High Crash Rate – Angles (at Intersection)* • *High Crash Rate – Angles (along Roadway)*	A restricted crossing U-turn intersection is an intersection design that restricts left turns at an intersection, but allows the same movement downstream, via a U-turn. The goal of an RCUT is to restrict or relocated certain movements to improve a roads overall safety and reduce delays. The basic RCUT restricts the incoming and outgoing side streets to right-turn movements only. Vehicles with the desire to turn left, must do so indirectly by first turning right onto SR 78 and make a U-turn at the next median downstream. Studies have shown a 30% reduction in crash rate, and up to a 50% reduction in crash severity. One specific example along SR 78 that was evaluated is the eastern most driveway connection to the North Point shopping plaza / Target plaza. This location would include the construction of a directional median island and the reconstruction of the Target driveway to a right-in only connection. The overall network exists today, as there are left turn lanes downstream with a dedicated lane allowing U-turns.	FDOT / County	Varies

Conceptual Layout of RCUT at SR 78 and Hibiscus Drive

Strategy: Roundabout *Issues Resolved:* • *High Crash Rate – Rear ends* • *Village Zoning areas should promote maximum pedestrian friendliness and minimal automobile traffic*	Roundabouts are a type of intersection in which vehicles travel around a central island almost continuously. For small- and medium-sized intersections, roundabouts may provide a safer and lower-maintenance solution than typical traffic control devices. Research has shown that roundabouts have an improved safety performance over comparable intersections, especially in reducing the number of severe crashes. Roundabouts are designed to significantly reduce the frequency and severity of angle and head-on collisions, which can be extremely dangerous. There are several types of roundabouts, including mini-roundabouts, single-lane roundabouts, and multi-lane roundabouts. A study conducted in Maryland Department of Transportation found that each two-lane roundabout implemented could provide a benefit-cost ratio of up to 15.3 to 1 over the fifteen-year life cycle of the roundabout. This was largely due to the reduction in crashes and injuries. The majority of the crashes along SR 78 are rear-end collisions (50%), with 4 fatalities occurring within the past 5 years. Roundabouts, when designed and constructed in the "right place", have been studied to provide a 37 percent reduction in overall collisions; 75 percent reduction in injury collisions; 90 percent reduction in fatality collisions, and a 40 percent reduction in pedestrian collisions. However, a location would have to be evaluated and agreed to base on crash history, operations, existing geometrics, and cost. In addition, a champion would need to be identified to move the project forward.	FDOT / County / City	Varies
Strategy: Bicycle Alert System *Issues Resolved:* • *Minimal Bicycle / Pedestrian Infrastructure* • *Bicycle Safety*	Due to the number of bicycle accidents along the corridors, a Bicycle Alert System is innovative ITS solutions that focuses on the safety of the bicyclists. Bicycle warning systems can use detectors and electronic signs to identify bicycle traffic and notify motorists when a cyclist is in an upcoming segment.	County / FDOT	Varies
Strategy: Enhanced Bike/Ped Infrastructure *Issues Resolved:* • *Minimal Bicycle / Pedestrian Infrastructure* • *Village Zoning areas should promote maximum pedestrian friendliness and minimal automobile traffic*	Sidewalks play a vital role in community life as they enhance connectivity and promote walking with a healthy lifestyle. In addition, they provide a safe avenue for pedestrians walking, running, and/or accessing bus stops. SR 78 currently provides limited to no sidewalk connectivity, as they exist around signalized intersections and at new developments. In addition, bike markings are provided on a few segments of the corridor within the existing road shoulder. To increase safety for all modes of travel, sidewalks would be recommended throughout the corridor, specifically at locations where bus stops exist. In addition, bike lanes can be added to assist in providing a safe bicycle network for cyclist. Other bicycle strategies could include advanced pedestrian detection systems, the signal timings can be adapting in real-time to better meet pedestrian needs is also a low-cost countermeasure.	FDOT / County	Varies

Strategy: Access Management Modifications *Issues Resolved:* • *High Crash Rate – Angles (at Intersection)* • *High Crash Rate – Angles (along Roadway)* • *High Crash Rate – Rear ends* • *Minimal Bicycle/Pedestrian Infrastructure*	Consistent with the recent FDOT safety project improvements, additional consideration should be given to the potential reduction of driveways and/or median access. There are a several vacant parcels, with multiple driveway connections, along the western end of the corridor. These parcels should be evaluated and planned for cross/joint access, driveway reduction, and construction of sidewalk(s). However, a champion would need to be identified to move the project forward.	FDOT or County	Varies
Strategy: Raised Separators *Issues Resolved:* • *High Crash Rate – Angles (at Intersection)* • *High Crash Rate – Angles (along Roadway)*	The corridor currently includes 4 signalized locations across a 4-mile corridor. As a result, there are several medians (both full-access and directional) throughout the study area. Combine the multiple medians with the high number of right-in/right-out driveway connections, safety becomes a concern. One of the 4 fatalities along the corridor occurred as part of an angle crash at the Target shopping plaza (east of Del Prado Boulevard). To promote the safe movement of vehicular traffic, raised separators could be constructed within the existing gore area. This would result in deterring drivers from crossing two (2) lanes of traffic to access the closest left-turn lane. Instead, the driver would make a right turn, safely merging downstream to make a left turn or U-turn.	FDOT / County	Varies

Example of Raised Concrete Separator

Connected and Autonomous (CAV) Strategies

TSM&O Strategy / Issues Resolved	Explanation of Strategy	Leading Agency	Planning-Level Costs
Strategy: Connected Vehicle System *Issues Resolved:* • *Evacuation Route (improvements to support designation)* • *Large Queues at Intersection*	A connected vehicle system along SR 78 would be proposed at each intersection. The connected vehicle infrastructure would be implemented at each intersection along SR 78 and be used for both Transit Signal Priority, and Emergency Vehicle Pre-emption. This system will help maintain accurate transit arrival times and ensure that emergency vehicles will be able to safely enter and exit an intersection. The infrastructure will also help future proof the corridor as we approach the introduction of wide scale implementation. On-Board Units will be installed in applicable transit and emergency vehicles that utilize the corridor. Lee County will be exploring connected vehicle technology, and its feasibility for implementation. This program can be leveraged to explore establishing Pine Island as a connected corridor. Future proofing the corridor means that the corridor will be able to provide Basic Safety Messages, SPaT information, and other connected vehicle data in the future.	FDOT / County	varies

7

Implementation

7.1 TSM&O Implementation

Implementation of TSM&O strategies and solutions can provide access to funding and programming protocols that are specifically reserved for TSM&O projects that are designed to implement strategies that serve multiple modes and encourage regional connectivity. These funding and programming protocols can be instrumental in giving projects the boost needed for implementation.

As part of TSM&O implementation, the use of performance measures serves to provide quantifiable measures that can be used to track the progress and impacts of strategies and solutions at the regional and project specific level. Performance measures expand over several categories, including performance, safety, capacity, and transit. Though each performance measure is designed to provide a singular measure, the outputs can be used to assist in both the planning and operational capacity, delivering important metrics to planners, engineers, elected officials, and the general public.

Performance measures are an important aspect of the TSM&O process to show monitoring, reporting, and updates of how the system is performing. Using quantitative metrics provides practitioners with valuable data to evaluate how improvements and solutions on the network could be used to make the transportation system function more efficiently and to justify needed improvements.

7.2 Regional ITS Architecture (RITSA)

The FDOT District 1 Regional ITS Architecture (RITSA) is a system engineering process roadmap for the next 20 years, serving as a guide for transportation system integration in the FDOT District 1 area. Developed cooperatively across the region's transportation agencies, RITSA expands across all modes of transportation representing a shared vision of the integration of each agency's transportation network to provide a safe, reliable and efficient transportation system for all users. Representing a shared vision of the agencies within FDOT District 1, RITSA provides a guide for the integration of TSM&O projects incorporating needs across traffic, safety and transit. The involvement of stakeholders across multiple agencies, including Lee County MPO and local jurisdictions, ensures that as TSM&O strategies move forward. A primary purpose of the FDOT District 1 RITSA is to identify the integration opportunities among the stakeholder ITS elements.

As a system engineering process, RITSA describes the process for deployment of ITS (and TSM&O) strategies, as shown in Figure 13, depicting the systems engineering process life cycle in comparison to the traditional project development process.

The FDOT District 1 RITSA was designed to fit into the statewide Regional ITS Architecture including assisting with satisfying the requirement from FHWA Rule 940 and FTA policy directives. Functional areas and projects were identified for inclusion in RITSA and provide status, roles and responsibilities across the region. The inclusion of these goals in the RITSA Operation Concepts for FDOT District 1 may assist in providing an avenue for projects to continue moving forward as these goals are achieved. The implementation of TSM&O and ITS solutions and strategies serve to complete these goals.

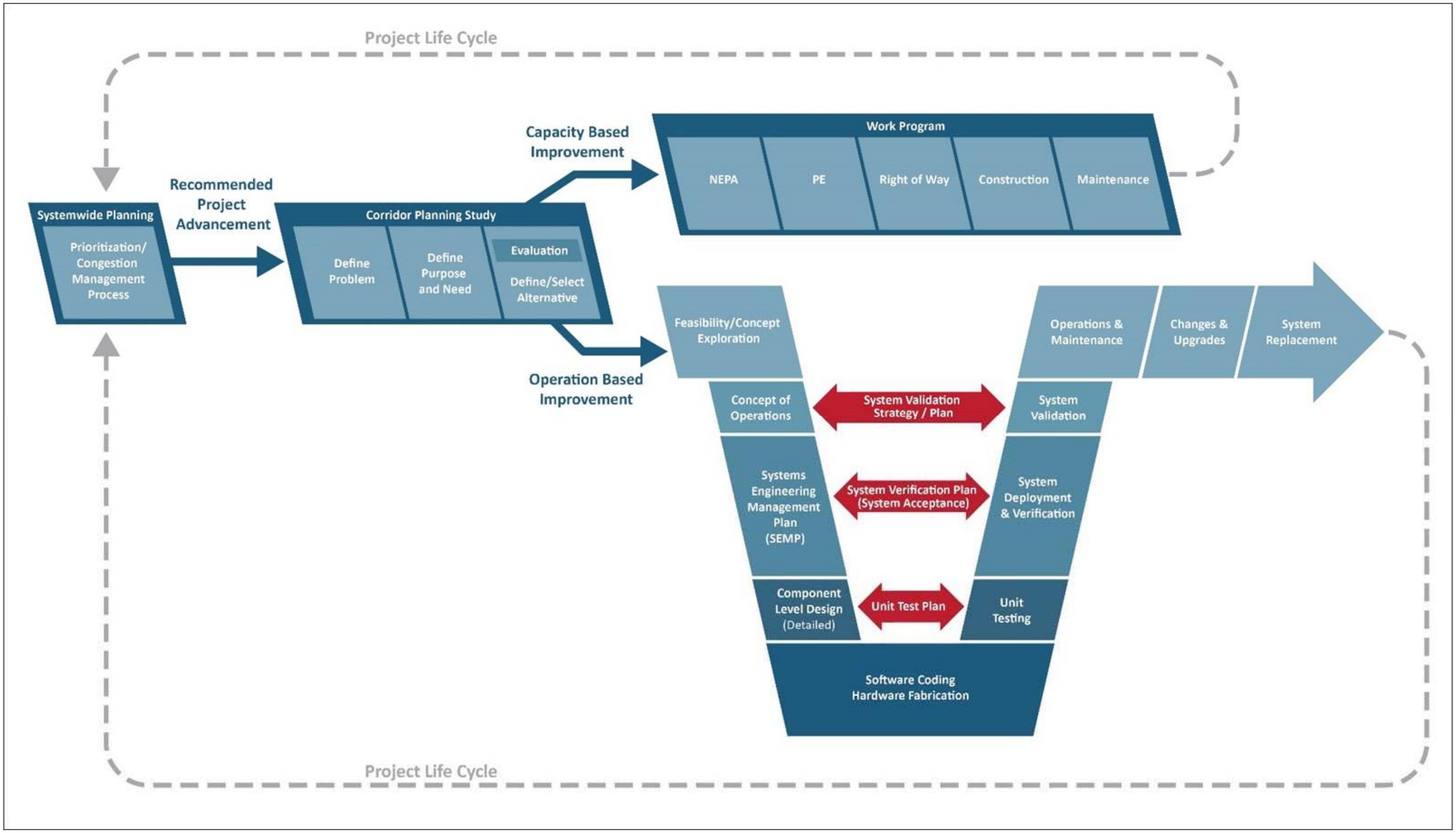
7.3 Funding and Programming Protocol

TSM&O projects are usually identified by transportation stakeholders through a coordinated review of the region's traffic, safety, and transit needs. Once a TSM&O strategy has been identified, it needs to be evaluated similar to other transportation projects in the region. The MPO and FDOT District 1 can work together to prioritize these projects based on regionwide transportation needs and resources. Funding availability is a key factor in determining whether a TSM&O strategy can advance to programming in the Transportation Improvement Program (TIP) or FDOT's Work Program (WP). It is important that the corridor is identified and listed within the adopted MPO LRTP.

In addition to development as stand-alone projects, TSM&O strategies have the potential to be added to projects that are currently in the FDOT Work Program, if schedule and funding permits. This is another reason for keeping all disciplines engaged throughout the project process. Working with the FDOT District 1 Work Program staff, projects on the TSM&O Strategic Network can be identified earlier in the project development process.

The Planning process is the start of the TSM&O lifecycle, utilizing existing datasets, identifying the specific issues and needs, and evaluating appropriate strategies to improve the conditions for the traveling public. Therefore, one example of utilizing existing project is coordinating with the resurfacing team regarding the project list. If a prioritized corridor is scheduled for resurfacing within the design phase, the strategy(ies) could be included and funded as part of the resurfacing program, if not exceeding the resurfacing criteria and funding allocations.

Figure 13 - Project Life Cycle Process



Depending on the project, funding can come from federal, state or local sources. As funds are made available, FDOT and the MPO can coordinate and decide how funds will be allocated. The MPO usually makes recommendations regarding surface transportation, congestion mitigation, air quality and federal transit projects. Whereas, for the major transportation projects, such as Interstate Managed Lanes projects is funded with federal and / or state funds, through the working relationship between FDOT and MPO. In addition, the local agency, such as Lee County, can apply for state and federal grants. A few available grants and / or programs made available to the local agencies include:

County Incentive Grant Program (CIGP)
The CIGP was created for the purpose of providing grants to counties to improve a transportation facility, including transit located on the State Highway System (SHS) or transit relieving traffic congestion on the SHS.

Local Agency Program (LAP Program)
The LAP establishes consistent and uniform practices for authorizing Local Agencies to use federal funds provided through FDOT to design and construct projects. The LAP Program is not a funding program, but a delivery method for Local Agencies. FDOT LAP Projects are often funded with Transportation Alternatives, Safety, Safe Routes to School, etc.

Highway Safety Improvement Program (HSIP)
The HSIP is a core Federal-aid program with the purpose of achieving a significant reduction in fatalities and serious injuries on all public roads. As per 23 U.S.C. 148(h) and 23 CFR 924.15, states are required to report annually on the progress being made to advance HSIP implementation and evaluation efforts. The format of this report is consistent with the HSIP Reporting Guidance dated December 29, 2016 and consists of five sections:

- Program structure;
- Progress in implementing highway safety improvement projects;
- Progress in achieving safety outcomes and performance targets;
- Effectiveness of the improvements;
- Compliance assessment.

Transportation Regional Incentive Program (TRIP)
The TRIP program provides funding to improve regionally significant transportation facilities in regional transportation areas defined by Florida Statute. State funds are available throughout Florida to provide incentives for local governments and the private sector to help pay for critically needed projects that benefit regional travel and commerce.

Florida Traffic and Bicycle Safety Education Program (FTBSEP)
The FTBSEP has developed pedestrian and bicycle safety education lessons and curricula over the last 25 years, as well as training teachers and others how to effectively use it to teach children. Over the past year, the FTBSEP and Florida SRTS worked on developing new lessons and curricula that can teach children in grades K-12. Safety topics, skills, and teaching methods are age and developmentally appropriate. Additionally, teachers are given lead-up skills and supplemental materials to ensure children master the skills. For example, videos have been developed that teach each skill (e.g., crossing the road at an intersection) so children can see safe behaviors before performing the skills themselves. Additionally, lessons are developed in a way that children see the skills, then perform a lead-up skill,

and finally, progress to the actual behavior. Experience has shown that getting children up and out outside, walking and biking, helps reinforce the safety skills being taught.

Florida Safe Routes to School (SRTS)
SRTS is a statewide program, funded by the FDOT, whose goal is to make it safer for more children to walk and bicycle to school. Florida SRTS funds projects that address unsafe or lack of infrastructure, as well as programs that promote walking and bicycling through education/encouragement programs aimed at children, parents, and the community.

Other Sources
Other potential funding sources include city funds and / or federal funds. FDOT will require a Local Funding Agreement (LFA) or a Joint Participation Agreement (JPA) depending on the nature of the funding. Certain improvements, such as landscaping constructed within the FDOT jurisdiction may also require that a maintenance agreement be secured.

It is also vital for the lead agency to secure and budget the operation and maintenance funds for a TSM&O strategy in the early stages. FDOT's priority is to fund planning and development of TSM&O strategies, only if funding for operation and maintenance is identified and dedicated.

A proportion of DITS funds are set aside each year for operation and maintenance of eligible TSM&O projects by an allocation formula. However, the set-aside DITS fund is often insufficient and are designated for SIS facilities only. Other state funds and toll revenues are frequently used to supplement DITS to fund TSM&O operations and maintenance along SIS facilities.

Signal operation and maintenance agreements are often used to outline responsibilities among FDOT and the local agencies, similar to the existing Operations agreement between Lee County and the FDOT Traffic Operations unit. FDOT looks to local agencies to provide operations and maintenance support for arterial projects. DDR are the potential state funding sources for operations and maintenance of projects on arterials. However, state funds are constrained and the competition for them is fierce. There are opportunities of using federal funding (STBG, NHPP, and CMAQC) for TSM&O operations, which have not been fully exercised. As such, a close coordination between FDOT and the MPO is important for allocating federal funds for arterial TSM&O projects, especially for operations.

7.4 Performances Measures

As defined by the FHWA, performance measurement is essential as the means of determining program effectiveness, identifying how changes are affecting system operations, and guiding decision-making. Operations performance measures demonstrate the extent of transportation problems and can be used to "make the case" for operations within an agency and to decision-makers and the traveling public, as well as to demonstrate to them what is being accomplished with public funds on the transportation system.

Each prioritized corridor will have different levels of congestion and characteristics, resulting in different strategies with a different purpose and need. Therefore, the performance of each strategy should be evaluated individually to determine if the purpose and need was satisfied and improved. The first step in performance evaluation is to define an overall baseline, requiring the necessary data be collected to evaluate the operations characteristics (i.e., counts, travel time, etc.). The current datasets collected by the FDOT will be made available to the local stakeholders; however, the Master Plan should be reviewed and potentially updated when new datasets become available and / or specific performance measures are defined.

It is recommended that the local stakeholders create a comprehensive performance measurement system. This includes linking performance measures to TSM&O goals, establishing common performance measure definitions (such as the defining of performance measures for all aspects of operations), specifying performance targets, and identifying data sources to support performance measures.

7.5 Monitoring and Update

It is recommended that this TSM&O Master Plan be updated every five years to correlate with the latest travel demand modeling data and updated MPO Long Range Transportation Plan (LRTP). Due to the technological advances in transportation engineering and operations, as well as the datasets being collected daily by the FDOT and local stakeholders, conducting an annual evaluation of the prioritized corridors and potential TSM&O strategies is suggested. This annual evaluation could result in identifying a revised strategic network, TSM&O strategies, and prioritization.

8

Stakeholders

8.1 Identification

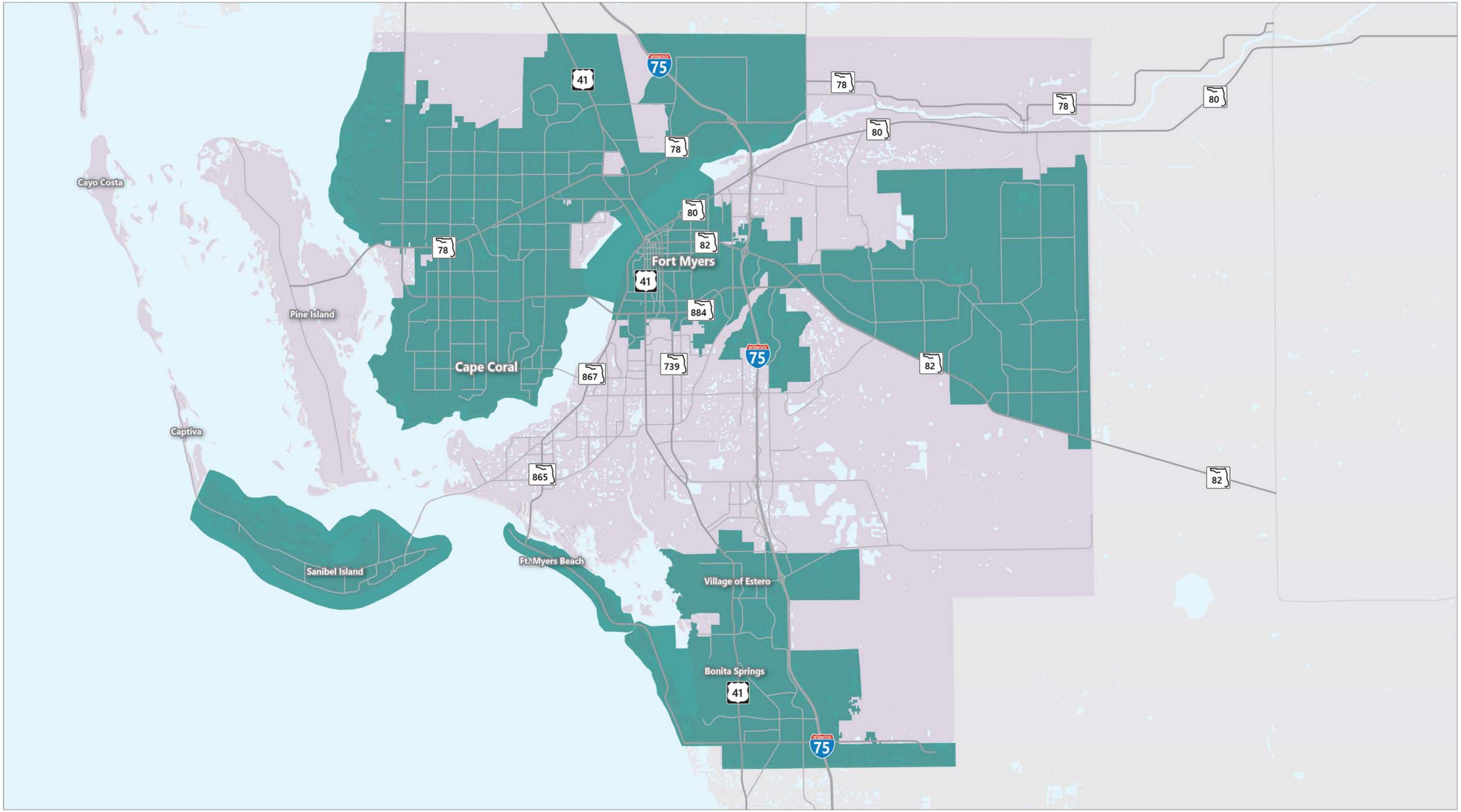
The TSM&O process is a stakeholder-driven process, with engagement and identification being a critical part in every stage of the process. This requires efficient collaboration and cooperation among the stakeholders, both public and private. Stakeholders must work together to ensure TSM&O strategies are defined, programmed, planned for, designed, constructed, operated, and maintained. These TSM&O strategies can be initiated and lead by the MPO, FDOT, and / or local government. However, the MPO is critical to the overall process, as the roadways will need to be identified within the MPO's LRTP and the strategies prioritized (with the other funding initiatives) based on the regional needs and efforts. As part of the development of this TSM&O Master Plan, Table 18 provides a list of the cities and local stakeholders included within the Lee County MPO region.

Table 18 – Stakeholders

FDOT, District 1	Local Transit Agencies (LeeTran)
Lee County	County School Districts
City of Bonita Springs	County Public Safety Agencies – Fire / EMS
City of Cape Coral	County Public Safety Agencies – Sheriff's Office
City of Ft. Myers	City Public Safety Agencies – Police
City of Sanibel	Lehigh Acres Municipal Improvement District
Town of Ft. Myers Beach	South Florida Water Management District
Village of Estero	Southwest Florida Regional Planning Council
Florida Highway Patrol (FHP)	

The local stakeholders and jurisdictional boundaries are illustrated on Figure 14.

Source: Google Maps



N.T.S.

Lee County

Census Places

Figure 14

Stakeholders and Jurisdictions

Lee County MPO

TSM&O Master Plan

8.2 Engagement

The TSM&O program requires collaboration between transportation-related disciplines continuously throughout the process; where experts work together, not just to keep each other informed, but to create new value for system users. This can include multiple key stakeholders leading, supporting or engaging throughout the strategy process. As identified by FHWA, the existing DOT and MPO planning and programming conventions for formal agency capital programs include a defined long-range investment strategy by program area, a short-range plan with a program of specific projects, and an agency line-item capital budget (sometimes with operating and maintenance costs included). Therefore, it is important that all stakeholders are, at a minimum, engaged when a recommend strategy impacts their facility. Table 19 provides the differing levels of anticipated involvement for each of the major stakeholders. Note, this identifies only anticipated involvement, as the lead and support agency can change based on project specifics.

Table 19 – Partner Agency Levels of Involvement in Project Life Cycle

	PLANNING		PROJECT DEVELOPMENT				OPERATIONS & MAINTENANCE		
	SYSTEM PLANNING	PLANNING STUDY	CONCEPT DEVELOPMENT	DESIGN	CONSTRUCTION	TESTING	OPERATIONS	MONITORING	MAINTENANCE
MPO	LEAD	SUPPORT	SUPPORT	ENGAGED	ENGAGED	ENGAGED	ENGAGED	SUPPORT	ENGAGED
COUNTY	SUPPORT	LEAD	LEAD	SUPPORT	LEAD	LEAD	LEAD	LEAD	LEAD
TRANSIT	SUPPORT	SUPPORT	SUPPORT	ENGAGED	ENGAGED	ENGAGED	SUPPORT	ENGAGED	ENGAGED
CITIES*	ENGAGED	ENGAGED	ENGAGED	ENGAGED	ENGAGED	ENGAGED	ENGAGED	ENGAGED	ENGAGED
FDOT D1	LEAD	LEAD	LEAD	LEAD	LEAD	LEAD	LEAD	SUPPORT	SUPPORT

** Note: Each of the agencies represents a single stakeholder; however, the MPO region includes multiple cities; therefore, the responsibilities were shown as a single line item, as each City will have a similar level of involvement when located within their respective jurisdiction.*

As with most transportation programs, different units within a jurisdiction are primarily responsible for different deliverables at various stages of a project. Multidisciplinary collaboration is also a key to the success of the TSM&O program. As can be expected, the level of involvement of each discipline fluctuates over time. In one stage a certain discipline may be leading, and in another stage, it only provides support. Nevertheless, a good TSM&O program maintains representatives from each discipline and each stakeholder engaged throughout the entire duration of the program.

To better visualize the fluctuations in the involvement of each discipline, the steps include different phases.

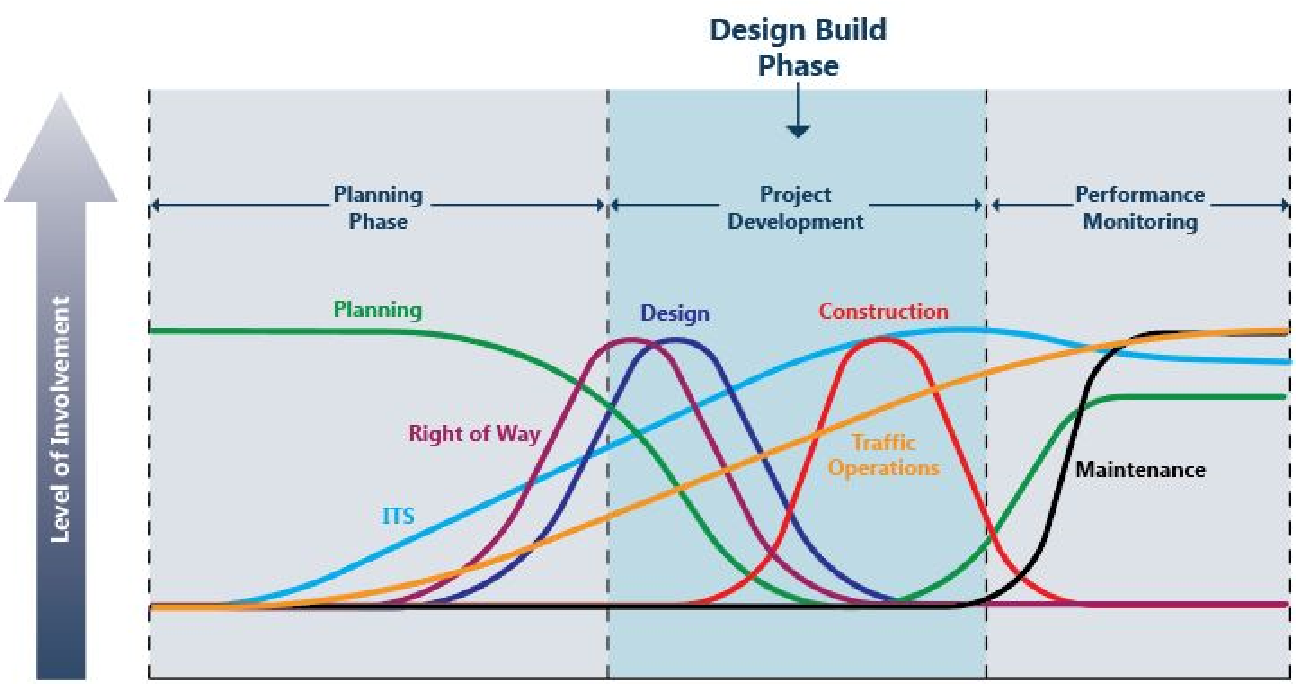
- **Planning Phase:** During the planning phase, important elements that will define potential strategies and alternatives are identified. These include developing systemwide goals and objectives, prioritizing projects, and refining purpose and need.

- **Project Development:** The project development phase follows the planning phase. It encompasses concept development, environmental documentation, design, construction, and testing.
- **Performance Monitoring:** After the completion of a project, it is recommended that performance monitoring be carried out to both assess whether the completed project's purpose and need have been fulfilled, and to feed information into the next cycle of the TSM&O program.

As shown in Figure 15, the planning role is predominant at the beginning and end of the TSM&O lifecycle. These correspond to roles in systems- and project-level planning and performance monitoring, respectively. Other disciplines (i.e., traffic operations, ITS engineering, design, right of way, and construction) have lower levels of involvement in the planning-led phase but take center stage in the design and implementation phases of a project. During these phases, the planning role is often reduced to providing support. At the end of the TSM&O project/strategy(s), traffic operations and maintenance staff take on larger roles as the newly implemented project starts needing upkeep and updates.

Each discipline may vary per stakeholder and could include additional staff. For instance, the FDOT Planning group, under the Intermodal Systems Development unit, has recently created the Planning & Design Studio to assist the FDOT MPO liaisons with developing creative and effective solutions to support the FDOT goals (i.e. TSM&O, Complete Streets, etc.).

Figure 15 - TSM&O Program Roles and Responsibilities



9

Next Steps

9.1 Next Steps

For long-term sustainability and success, it is important to regularly revisit the TSM&O Master Plan and incorporate necessary enhancements. The following components should be considered as part of the next phase of this plan.

- Review technological advances in transportation and include additional service areas/packages, such as TSM&O work zone management, freight management, advances in CAV, etc.
- Include TSM&O Strategies within Lee County TIP, Lee County MPO Project Priority List, and Lee County MPO LRTP.
- Implement architecture and coordination/collaboration enhancements.
- Provide quarterly performance measurement and reports.
- Conduct an Annual Master Plan evaluation for project identification, including
    - Re-evaluating the Project Prioritization List
    - Re-evaluating and updating TSM&O Strategies and Gaps
    - Updating planned and funded transportation plans

By taking a holistic approach to transportation systems, management and operations are expanded beyond a single project, corridor, or strategy. This TSM&O Master Plan is designed to maintain, restore, and enhance transportation networks across all modes and benefit all users for a safer, more efficient and effective transportation systems.

A

Appendix A – Technical Memorandum

Summary List of TSM&O Strategies

Table of Contents

1

TSM&O Strategies

This chapter is intended to be a point of reference for the TSM&O strategies considered as part of the corridor evaluation. The information outlined is provided below in a user-friendly format. TSM&O strategies are sorted alphabetically into the following categories:

- Safety Improvements
- Capacity Improvements
- Multimodal Improvements
- Automated / Connected Vehicle Support Improvements
- Dynamic Strategies
- Travel Demand Management
- Emergency Management
- Information and Data Management

1.1 Strategies – Safety Improvements

Safety improvement strategies are primarily intended to enhance the safety of the transportation user. Some of these strategies may provide additional benefits beyond safety improvements, while others may provide greater safety at the cost of reduced capacity. For those strategies with clear benefits for both safety and capacity, deference was given to safety and those strategies were categorized as safety improvements.

1.1.1 Arterial Access Management

General Description – Arterial access management is an area of emphasis for FDOT. Access management is defined by FDOT as the careful planning of the location, type, and design of access to businesses and major facilities. Access management can improve safety by reducing the number of conflict points—particularly those involving unsignalized left turns from driveways. In specific situations, access management can also reduce delay by separating conflicting movements.

Costs – Capital - $$ Operating - +$

Complementary Strategies – Arterial Access Management incorporates a variety of TSM&O strategies, including:

-Dynamic Message Sign(s)
-Integrated Corridor Management (ICM)
-Active Arterial Management (AAM)
-Event Management
-Work Zone Management
-Travel Demand Management (TDM)
-Traffic Incident Management (TIM)
-En-route Driver Information
-Route Guidance
-Freight Mobility

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link – To be determined.

Additional Information –
https://ops.fhwa.dot.gov/access_mgmt/docs/benefits_am_trifold.htm
https://ops.fhwa.dot.gov/publications/amprimer/access_mgmt_primer.htm
https://safety.fhwa.dot.gov/provencountermeasures/corridor_access_mgmt/

1.1.2 Bicycle Alert System

General Description – Bicycle Alert Systems are innovative ITS solutions that focus on the safety of the bicyclists. Bicycle warning systems can use detectors and electronic signs to identify bicycle traffic and notify motorists when a cyclist is in an upcoming segment. Other solutions include: GIS/GPS bike route mapping, bicycle safe rumble strips, trail-roadway intersections, shared lane signing markings and automated bicycle parking.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Bicycle Alert System incorporates a variety of TSM&O strategies, including:

-Enhance bike/ped infrastructure
-Pedestrian Safety Systems
-Dynamic Message Sign(s)
-Travel Demand Management (TDM)
-Traffic Incident Management (TIM)
-Predictive Traveler Information
-En-route Driver Information
-Route Guidance

-Innovative Intersection Designs
-Variable Speed Limit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Transit Traveler Information
-Fixed Route Transit
-Freight Mobility

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://safety.fhwa.dot.gov/ped_bike/

1.1.3 Highway Rail Intersection

General Description – Highway Rail Intersection is the application of advanced technologies to improve safety of at-grade highway intersections. This strategy incorporates a number of techniques to improve the safety of the interface between the railroad and a highway. For example, an automated enforcement system using sensor technology and high-resolution CCTV cameras can be used to enforce when the barriers are closed. Vehicle proximity alert systems can also be used to warn drivers about the impending arrival of a train. Positive train separation techniques can also be used to automatically detect obstacles ahead of the train and apply brakes automatically. Variable message signs can also be used to warn drivers that a second train is approaching.

Costs – Capital - $$ Operating - $
Complementary Strategies – Highway Rail Intersection works well with these TSM&O strategies, including:
-Dynamic Message Sign(s)
-Work Zone Management
-Traffic Incident Management (TIM)
-Predictive Traveler Information
-En-route Driver Information
-Route Guidance
-Variable Speed Limit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Transit Traveler Information
-Fixed Route Transit
-Innovative Intersection Design

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ntl.bts.gov/lib/jpodocs/repts_te/13587.html

1.1.4 Innovative Intersection Designs

General Description – Sometimes an intersection improvement is exactly what a certain location needs to improve driving conditions. Innovative intersection designs are often able to reduce traffic congestion and many safety concerns. Again, choosing the proper tool from the tool box is imperative to a smoothly run transportation system. There are numerous types of innovative intersection designs. Some of the most commonly used are displaced left turn intersections, restricted crossing U-turn intersections, median U-turn intersections, and diverging diamond intersections at interchanges.

Many of these designs can be found across the United States, from Maryland to New York, Michigan to North Carolina. Florida recently completed its first diverging diamond interchange. With mobility needs and population increasing and limited resources and right-of-way, regions need to be more creative. These intersections offer alternative ways to reduce congestion as opposed to just widening the roadways. Examples of innovative intersection designs include:

-Continuous Flow Intersections (CFI)
-Thru-Turn Intersections
-Single-Point Urban Interchange
-Diverging Diamond Interchanges
-Town Center Intersections (TCI)
-Quadrant Intersections
-Modern Roundabouts

The goal is to find the right tool for the applicable situation to ultimately make intersections safer for the traveling public.

Costs – Capital - $$ Operating – N/A

Complementary Strategies – Innovative Intersection Designs incorporate a variety of TSM&O strategies, including:

-Enhance bike/ped infrastructure
-Pedestrian Safety Systems
-Bicycle Alert System
-Dynamic Message Sign(s)
-Travel Demand Management (TDM)
-Predictive Traveler Information
-En-route Driver Information
-Route Guidance
-Variable Speed Limit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Transit Traveler Information
-Fixed Route Transit
-Freight Mobility

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.fhwa.dot.gov/publications/research/safety/09060/09060.pdf
https://safety.fhwa.dot.gov/intersection/alter_design/pdf/fhwasa14069_mut_infoguide.pdf
https://www.fhwa.dot.gov/publications/research/safety/09058/09058.pdf

1.1.5 Install CCTV

General Description – A closed-circuit television (CCTV) system for roadways allows traffic operators to respond to roadway issues more quickly and effectively. This includes identifying traffic accidents, verifying reported accidents, and allows operators to make appropriate adjustments to the surrounding network's operations (ramp gate closures, DMS updates, etc.). CCTV can also be used to monitor traffic patterns, adverse weather conditions, wrong-way driving, and delays along standard facilities and work zone areas. CCTVs may also spot criminal activity; operators can alert law enforcement to the issue, verify the issue, and provide guidance to law enforcement officers on location and situation.

Costs – Capital - $ Operating - $

Complementary Strategies – CCTV installation works well with or support these strategies:

-Adaptive Signal Control
-Install Bluetooth
-Controller Upgrades
-Signal ATMS
-Advanced Intersection Detection
-Communications/Network Upgrades (Fiber)
-Traffic Management Center (TMC)
-Traffic Incident Management (TIM)
-Integrated Corridor Management (ICM)
-Data Management - Big Data
-Data Management - Transportation Data Analytics
-Performance Measurement
-Road Weather Information System (RWIS)
-Signal Phase and Timing (SPaT)
-Traffic Signal Preemption

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.pcb.its.dot.gov/t3/s160316/s160316_TMC_Video_Best_Practices_presentation_Keltner.asp
https://ops.fhwa.dot.gov/publications/fhwahop06006/chapter_5.htm

1.1.6 Interchange Improvements

General Description – Interchange improvements may be implemented to reduce safety hazards or traffic congestion. These improvements can be singular improvements or large-scale reconstruction of interchanges. For example, ramp traffic spilling back onto the arterial roadway may be alleviated by implementing an additional storage lane along the ramp, which will reduce the queue and reduce the associated rear-end collisions. This relatively small improvement can lead to reduced traffic incidents on the arterial and improve ramp storage. Alternatively, a large-scale reconstruction may involve replacing a standard interchange with a Diverging Diamond Interchange (DDI), which will eliminate left-turn conflict points and reduce the number of signal phases, leading to increased throughput. Depending on which improvement(s) are installed, the capital costs may be significant.

Costs – Capital - $$$ Operating - $

Complementary Strategies – Interchange improvements may work well with or support the following TSM&O strategies:

-Work Zone Management
-Integrated Corridor Management (ICM)
-Dynamic Message Sign(s)
-Travel Demand Management (TDM)
-Traffic Incident Management (TIM)
-Pre-Trip Travel Information
-En-Route Driver Information
-Predictive Traveler Information
-Route Guidance
-Variable Speed Limit

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.fhwa.dot.gov/design/interstate/pubs/access/access.pdf
https://safety.fhwa.dot.gov/intersection/alter_design/

1.1.7 Intersection Collision Avoidance

General Description – Intersection Collision Avoidance employs highspeed wireless communications, roadside and in-vehicle technology to warn drivers of any potential conflict at intersections. For example, a driver approaching an intersection too fast to stop as the light turns red can be detected, and an appropriate accident mitigation strategy can be implemented, such as turning the lights all red or extending the green for the driver's approach.

Although this strategy is the subject of a research program currently funded by the FHWA, this is particularly relevant to arterial traffic management. Due to the need for cooperation between roadside equipment for traffic control and on-board vehicle equipment, it will be necessary for local agencies to work together with automotive suppliers and manufacturers.

Costs – Capital - $ Operating - $

Complementary Strategies – Intersection Collision Avoidance can be supported by the following TSM&O strategies:

-Install CCTV
-Install Bluetooth
-Communications/Network Upgrades (fiber)
-Signal ATMS
-Retroreflective Signal Back Plates
-Traffic Signal Preemption (Emergency Vehicles)
-Advanced Intersection Detection
-Data Management - Big Data
-Data Management - Transportation Data Analytics
-Performance Measurement
-Road Weather Information System (RWIS)
-Signal Phase and Timing (SPaT)

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.its.dot.gov/research_archives/cicas/

1.1.8 Lateral Collision Avoidance

General Description – Lateral Collision Avoidance utilizes technology on board the vehicle to warn the driver of a lane departure that might lead to a collision. Sensors on board the vehicle detect the lane and detect the presence of other vehicles. Alerts can take the form of an audible tone or vibration of the steering wheel. This tool is promising when applied to the transit industry, ensuring safety from other cars or curb-running, which is when buses hit curbs on tight turns, damaging costly equipment.

Costs – Capital - $ Operating - $

Complementary Strategies – Collision Avoidance measures may work well with these TSM&O strategies:

-Install Bluetooth
-Install CCTV
-Communications/Network Upgrades (fiber)
-Controller upgrades
-Traffic Incident Management (TIM)
-Connected Vehicle technologies
-Road Weather Information System (RWIS)
-Data Management - Big Data
-Data Management - Transportation Data Analytics

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.
Proven TSM&O Strategy Handout Link - To be determined.
Additional Information –
http://fresno.ts.odu.edu/newitsd/ITS_Serv_Tech/collision_avoidance/coll_avoid_lat/collision_avoidance_lateral_summary_print.htm
https://www.fhwa.dot.gov/publications/research/safety/09049/

1.1.9 Longitudinal Collision Avoidance

General Description – Longitudinal Collisions Avoidance, also known as adaptive cruise control, employs sensors on board the vehicle to detect the current speed and the distance between the users' vehicle and the vehicle ahead. The system can either generate an alert or automatically apply the brakes to maintain a safe distance.

Costs – Capital - $ Operating - $

Complementary Strategies – Collision Avoidance measures may work well with these TSM&O strategies:

-Install Bluetooth
-Install CCTV
-Communications/Network Upgrades (fiber)
-Controller upgrades
-Traffic Incident Management (TIM)
-Connected Vehicle technologies

-Road Weather Information System (RWIS)
-Data Management - Big Data
-Data Management - Transportation Data Analytics

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.fhwa.dot.gov/publications/research/safety/09049/

1.1.10 On-board Safety and Security Monitoring

General Description – On-Board Safety and Security Monitoring is a tool that can inform truck drivers if an unsafe situation arises during operation of the vehicle. Through on-board sensors, continuous monitoring of the system allows for safer trips. This alert system can monitor cargo, alert drivers of potentially unsafe circumstances, address driver fatigue, problems with vehicle systems or issues related to the cargo on board the vehicle. Similarly, if an incident were to occur, on-board alerts could be sent back to the central back office to notify them of the occurrence and disseminate that information to first responders more quickly.

Costs – Capital - $ Operating - $

Complementary Strategies – On-board Safety and Security Monitoring works well with these other TSM&O strategies:
-Automated Roadside Safety Inspection
-Commercial Vehicle Administration Process
-Commercial Vehicle Electronic Clearance
-Dynamic Message Sign(s)
-Integrated Corridor Management (ICM)
-Active Arterial Management (AAM)
-Dynamic Routing
-Hazardous Materials Security & Incident Response
-Pre-trip Travel Information
-Route Guidance

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ntl.bts.gov/lib/51000/51300/51335/Onboard-Monitoring-and-Reporting-for-CMV-Safety-Final-Report-Dec2007.pdf

1.1.11 Pedestrian Safety Systems

General Description – Pedestrian Safety Systems utilize innovative ITS solutions that focus on the safety of the users on foot. These systems can help protect pedestrians by activating in-pavement lighting to alert drivers as pedestrians enter crosswalks. Countdown pedestrian signals are a highly common application that assist pedestrians in knowing how much time remains to cross and aids

motorists to judge timeframes when pedestrian traffic is expected. Other innovative solutions include:
-Infrared detectors - Microwave detectors which can talk back to the controller and minimize or extend clearance times.
-Illuminated Pushbuttons - Accessible pedestrian signals that produce a sound, vibration, or both during the walk interval.
-Rectangular Rapid Flashing Beach (RRFB) - Low-cost countermeasure to increase driver compliance in yielding to pedestrians at midblock locations.
-Advanced Pedestrian Detection Systems - Adapting signal timings in real-time to better meet pedestrian needs is also a low-cost countermeasure.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Pedestrian Safety Systems incorporate a variety of TSM&O strategies, including:

-Enhance bike/ped infrastructure
-Bicycle Alert System
-Work Zone Management
-Travel Demand Management (TDM)
-Traffic Incident Management (TIM)
-Predictive Traveler Information
-En-route Driver Information
-Route Guidance
-Innovative Intersection Designs
-Variable Speed Limit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Transit Traveler Information
-Fixed Route Transit
-Electronic Toll Collection
-Regional Payment System
-Freight Mobility

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=11
https://www.fhwa.dot.gov/publications/research/safety/pedbike/0102.pdf
https://safety.fhwa.dot.gov/intersection/conventional/unsignalized/tech_sum/fhwasa09009/
https://one.nhtsa.gov/DOT/NHTSA/NVS/Crash%20Avoidance/Technical%20Publications/2016/812312_V2PPedestrianReport.pdf

1.1.12 Pre-Crash Restraint Deployment

General Description – Pre-Crash Restraint Deployment makes use of on-board sensors to anticipate vehicle crashes by measuring the angle of the steering wheel, vehicle wheels and the status of the brakes. If the crash cannot be avoided, actuators will automatically deploy additional restraints to mitigate damage to the vehicle and the passengers.

Costs – Capital - $ Operating - $

Complementary Strategies –

Conflicting Strategies –

Example Benefit-Cost Ratio –

Proven TSM&O Strategy Handout Link -

Additional Information –

1.1.13 Public Travel Security

General Description – Public Travel Security uses ITS technologies such as video feeds, sensors, telecommunications, command-and-control, etc., working together to increase the level of travel security for the traveling public. Sensors monitor roadways, structures, transit facilities, transit vehicles, transit stations, parking lots, bus stops and generate alarms either automatically or manually when necessary.

It is viewed as a necessary tool to keep transportation infrastructure and the community safe. The reason why this needs to be implemented could easily be tied to a benefit-to-cost ratio: the amount of money saved from stolen or damaged infrastructure would provide a positive return on investment. CFX already implements this strategy through the monitoring of expressways and toll plazas; monitoring authorized versus unauthorized contractors or notifying Road Rangers when cars have broken down on their system.

Costs – Capital - $ Operating - $

Complementary Strategies – Public Travel Security works well with these TSM&O strategies, including:

-Event Management
-Integrated Corridor Management (ICM)
-Hazardous Materials Security & Incident Response
-On-board Safety and Security Monitoring
-Dynamic Message Sign(s)
-Predictive Traveler Information
-En-route Driver Information
-Route Guidance
-Emergency Notification & Personal Security
-Emergency Vehicle Management
-Disaster Response and Evacuation
-Transit Traveler Information

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.fhwa.dot.gov/security/emergencymgmt/profcapacitybldg/tipem.cfm#good
http://www.cflsmartroads.com/security.html

1.1.14 Queue Warning System

General Description – Q-WARN is used to inform travelers of the presence of downstream stop-and-go traffic (based on real-time traffic detection) using warning signs and flashing lights. Drivers can anticipate an upcoming situation of emergency braking by slowing down ahead of time and avoid erratic behavior, ultimately reducing queuing-related collisions. Dynamic message signs show a symbol or word, along with flashing lights, to inform motorists of queues with significant slowdowns ahead. Sensors in the highway detect traffic speeds and flows and these are passed to a specially developed algorithm that determines what messages should be displayed on various parts of the highway. This strategy might also be combined with the use of a variable speed limit system to reduce severe acceleration and deceleration on the approach to a bottleneck. Speed harmonization and lane control signals that provide incident management capabilities can also be combined with queue warning. The system can be automated or controlled by a traffic management center operator. Work zones also benefit from Q-WARN with portable dynamic message sign units placed upstream of expected queue points.

Costs – Capital - $ Operating - $

Complementary Strategies – Queue Warning System works well with these other TSM&O strategies:

- -Dynamic Message Sign(s)
- -Variable Speed Limit
- -Work Zone Management
- -Active Arterial Management (AAM)
- -Event Management
- -Integrated Corridor Management (ICM)
- -Traffic Incident Management (TIM)
- -Predictive Traveler Information
- -En-route Driver Information
- -Route Guidance

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link – To be determined.

Additional Information –
http://dot.state.mn.us/research/reports/2017/201720.pdf
http://trrjournalonline.trb.org/doi/pdf/10.3141/2555-06

1.1.1 Retroreflective Signal Back Plates

General Description – Retroreflective Signal Back Plates can be added to a traffic signal to improve the visibility of the illuminated face of the signal by introducing a controlled-contrast background. The improved visibility of a signal head with a backplate is made even more conspicuous by framing it with a retroreflective border. Signal heads that have backplates equipped with retroreflective borders are more visible and conspicuous in both daytime and nighttime conditions. This low-cost strategy is meant to improve safety at the subject intersection by reducing visibility issues for motorists.

Costs – Capital - $ Operating - $

Complementary Strategies – Retroreflective Signal Back Plates work well with these other TSM&O strategies:

-Integrated Corridor Management (ICM)
-Traffic Incident Management (TIM)
-Active Arterial Management (AAM)
-Event Management
-Work Zone Management
-Transit Signal Priority
-Adaptive Signal Control
-Traffic Signal Re-timing
-Traffic Signal Preemption
-Queue Warning
-Dynamic Message Sign(s)
-Innovative Intersection Designs

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://safety.fhwa.dot.gov/provencountermeasures/blackplate/

1.1.2 Road Ranger Service Patrol

General Description – Road Ranger Service Patrol generally consists of trained personnel who use specially equipped vehicles to patrol congested highways searching for and responding to traffic incidents. General services include: pushing vehicles out of travel lanes, providing gasoline, changing flat tires, and providing minor repairs to help motorists safely drive their vehicle from the highway. The FDOT Road Ranger program also allows motorists two local phone calls if necessary. Road Ranger Service Patrol vehicles are equipped with warning lights or a variable message sign alerting traffic to move over.

Costs – Capital - $ Operating - $$$

Complementary Strategies – Road Ranger Service Patrol works well with these other TSM&O strategies:
-Integrated Corridor Management (ICM)
-Traffic Incident Management (TIM)
-Active Arterial Management (AAM)
-Event Management
-Work Zone Management
-Dynamic Message Sign(s)
-Queue Warning
-Road Weather Information System (RWIS)

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – The Benefit-Cost Analysis for FDOT's statewide Road Ranger program, conducted using the TOPS-BC application, identified a BCR of 6.68. The benefits considered include delay and fuel savings. Consideration of other benefits may increase the BCR. The methodology and inputs used for the BCA are provided in the Transportation Systems Management and Operations Benefit Cost Analysis Compendium (FHEWA, 2015).

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/publications/fhwahop08031/fsp2_0.htm
http://www.fdot.gov/traffic/traf_incident/rrangers/rranger.shtm

1.1.3 Roadway Diet

General Description – Roadway Diet is a traffic calming solution whereby travel lanes on a given corridor are removed (typically from four travel lanes to three) to provide better infrastructure and mobility for other modes of transportation, including transit, bicycle, and pedestrian.

This will likely provide a more comfortable experience for alternative modes, increasing their throughput while decreasing capacity for motor vehicles. Businesses adjacent to the improved corridor may also experience increased visitors as a result of the traffic calming and additional pedestrian / bicycle traffic.

Costs – Capital - $$$ Operating - $

Complementary Strategies – Roadway Diet may work well with these TSM&O strategies:

-Enhance bike/ped infrastructure
-Bicycle Alert System
-Travel Demand Management (TDM)
-Traffic Incident Management (TIM)
-Predictive Traveler Information
-En-route Driver Information
-Innovative Intersection Designs
-Variable Speed Limit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Transit Traveler Information
-Fixed Route Transit

Conflicting Strategies – Roadway Diet replaces motor vehicle travel lanes with infrastructure for alternative modes of transportation. This has the effect of calming traffic, increasing throughput for alternative modes of transportation, and decreasing vehicle capacity and demand on a given corridor. This strategy would conflict with the standard practice of Roadway Widening. Also, Roadway Diet may be a hindrance to freight movement if applied on designated freight corridors. However, Roadway Diet may benefit freight movements along city streets as it provides more controlled bicycle/pedestrian movements, leading to improved safety for all users.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://safety.fhwa.dot.gov/road_diets/guidance/info_guide/

1.1.1 Road Weather Information System

General Description – As defined by FHWA, a Road Weather Information System (RWIS) is comprised of Environmental Sensor Stations (ESS) in the field, a communication system for data transfer, and central systems to collect field data from numerous ESS. These stations measure atmospheric, pavement and/or water level conditions. Central RWIS hardware and software are used to process observations from ESS to develop nowcasts or forecasts and display or disseminate road weather information in a format that can be easily interpreted by a manager. RWIS data are used by road operators and maintainers to support decision making. According to FHWA, "there are three types of road weather information: atmospheric data, pavement data, and water level data. Atmospheric data include air temperature and humidity, visibility distance, wind speed and direction, precipitation type and rate, cloud cover, tornado or waterspout occurrence, lightning, storm cell location and track, as well as air quality. Pavement data include pavement temperature, pavement freezing point, pavement condition (e.g., wet, icy, flooded), pavement chemical concentration, and subsurface conditions (e.g., soil temperature). Water level data include stream, river, and lake levels near roads, as well as tide levels (i.e., hurricane storm surge)."

Costs – Capital - $ Operating - $$

Complementary Strategies – RWIS works well with these other TSM&O strategies:

-Integrated Corridor Management (ICM)
-Traffic Incident Management (TIM)
-Active Arterial Management (AAM)
-Road Ranger Service Patrol
-Event Management
-Work Zone Management
-Dynamic Message Sign(s)
-Queue Warning

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – FHWA highlighted several RWIS projects and their associated benefit-cost ratios. In Oregon, the BCR for 2 automated wind warning systems were 4.13 and 2.80. In Michigan, the BCR for a Rural RWIS project ranged from 2.8 to 7.0. A research project considering Iowa, Michigan and Nevada determined a RWIS project would yield BCRs between 1.8 and 36.7 depending on the location of the implementation. (from ITS Benefits, Costs, and Lessons Learned. 2017 FHWA JPO. FHWA-JPO-17-500)

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/weather/faq.htm
https://ops.fhwa.dot.gov/weather/mitigating_impacts/best_practices.htm
https://ops.fhwa.dot.gov/publications/fhwahop12046/index.htm

1.1.2 Roundabout

General Description – Roundabouts are a type of intersection in which vehicles travel around a central island almost continuously. Roundabouts can be a better and lower-maintenance solution for small and medium-sized intersections. Research has shown that roundabouts have an improved safety performance over comparable intersections, especially in reducing the number of severe crashes. There are several types of roundabout, including mini-roundabouts, single-lane roundabouts, and multi-lane roundabouts.

Costs – Capital - $$$ Operating - $

Complementary Strategies – Roundabouts work well with these other TSM&O strategies:
-Arterial Access Management
-Roadway Diet
-Enhance Bike/Ped Infrastructure
-Innovative Intersection Designs

Conflicting Strategies – Strategies related to traffic signals will generally conflict with this strategy, as roundabouts are considered to be an alternative to signalized intersections. However, there are certain two-lane roundabouts in Europe that use signals to control left-turn movements within the roundabout. This is meant to control the flow of traffic in a similar fashion to ramp metering.

Example Benefit-Cost Ratio – The Benefit-Cost Analysis for Maryland's fifteen (15) roundabouts, conducted using the TOPS-BC application, identified a BCR of 15.3 per roundabout. This is heavily influenced by the decrease in significant crashes. The methodology and inputs used for the BCA are provided in the Transportation Systems Management and Operations Benefit Cost Analysis Compendium (FHWA, 2015).

Proven TSM&O Strategy Handout Link – To be determined.

Additional Information –
https://safety.fhwa.dot.gov/intersection/innovative/roundabouts/
https://www.fhwa.dot.gov/publications/research/safety/00067/00067.pdf

1.1.3 Work Zone Management

General Description – Maintaining safe and smooth traffic flow through work zones is increasingly relevant. The safety of construction crews and travelers must be first priority of any Work Zone Management strategy. In work zones, safety can be enhanced through separation and barriers, lighting, speed control, education, enforcement, and more. Once safety is addressed, agencies can optimize construction staging, lane closures, detours, and incident management to reduce delays to the traveling public.

Costs – Capital - $$ Operating - $

Complementary Strategies – Work Zone Management works well with these TSM&O strategies:
-Travel Demand Management (TDM)
-Active Arterial Management (AAM)
-Integrated Corridor Management (ICM)
-Traffic Incident Management (TIM)
-Dynamic Message Sign(s)
-Event Management
-Adaptive Signal Control

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/wz/traffic_mgmt/
https://ops.fhwa.dot.gov/wz/index.asp

1.1.4 Wrong Way Driving Countermeasures

General Description – Wrong Way Driving Countermeasures use intelligent solutions like LED WRONG WAY signs on ramps to grab the attention of wrong way drivers prior to entering the mainline. Other countermeasures include using microwave vehicle detection systems to detect wrong way drivers and alert traffic management centers and highway patrol immediately. Wrong way crashes, while they do not occur as often, result in incapacitation or death 50% of the time, which is much higher than the average crash. Wrong way driving is usually linked to intoxicated drivers, roadway design challenges, or lighting or signing concepts. By using this simple technology, this strategy could be used to protect drivers of major Freeways and Expressways from wrong way drivers. Major deployments can be found in Texas, Florida, California, New Mexico and Washington. In Florida, wrong way driving countermeasures are being used along the Florida's Turnpike and Central Florida Expressways (CFX) system.

Costs – Capital - $$ Operating - $

Complementary Strategies – Wrong Way Driving Countermeasures incorporate a variety of TSM&O strategies, including:

- -Dynamic Message Sign(s)
- -Traffic Incident Management (TIM)
- -Integrated Corridor Management (ICM)
- -En-route Driver Information
- -Route Guidance
- -Variable Speed Limit
- -Freight Mobility

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.cga.ct.gov/2008/rpt/2008-r-0491.htm
https://safety.fhwa.dot.gov/intersection/other_topics/wwd/
http://stars.library.ucf.edu/etd/5334/
https://www.cfxway.com/for-travelers/projects/wrong-way-driving-detection-and-prevention-system/

1.2 Strategies – Capacity Improvements

Capacity improvement strategies are primarily focused on improving the throughput of vehicles within the transportation network. Certain strategies are tailored to freeway capacity improvement, while others are focused on arterial throughput.

1.2.1 Active Arterial Management (AAM)

General Description - FHWA defines AAM as: "The active prioritization of objectives and collection of information to efficiently manage traffic signal infrastructure and control devices to maximize safety and throughput while minimizing delays. The working definition of traffic signal maintenance is the preventative and responsive activities to preserve traffic signal infrastructure and control devices necessary for the safe and efficient utilization of arterial, collector and local roadways." The 2017 TSM&O Strategic Plan (FDOT CO) notes that AAM applies freeway management practices to major urban arterials.

Essentially, AAM is the use of sensors and advanced traffic signal control on major arterials that are used to collect traffic flow and travel time data, while TMC operations provide the ability to adapt signal timings to prevailing traffic conditions. A lower-cost version of AAM involves the use of a more limited range of sensors and less sophisticated traffic control, supported by the technical resources with a focus on maintaining traffic signal timings on a regular basis.

Costs – Capital - $ Operating - $$$

Complementary Strategies – AAM works well with these other TSM&O strategies:
-Integrated Corridor Management (ICM)
-Traffic Incident Management (TIM)
-Controller Upgrades
-Event Management
-Transit Signal Priority
-Adaptive Signal Control
-Traffic Signal Re-timing
-Queue Warning
-Dynamic Message Sign(s)
-Work Zone Management
-Pre-Trip Travel Information
-Predictive Traveler Information
-Route Guidance

Conflicting Strategies - To be determined.

Example Benefit-Cost Ratio – The Benefit-Cost Analysis of FDOT District 4's Active Arterial Management program, conducted using the TOPS-BC application, identified the BCR for each major roadway included in the AAM program. The aggregate BCR was estimated to be 10.05 for the entire system. The methodology and inputs used for the BCA are provided in the Transportation Systems Management and Operations Benefit Cost Analysis Compendium (FHWA, 2015).

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://ops.fhwa.dot.gov/arterial_mgmt/

1.2.2 Adaptive Ramp Metering

General Description – Adaptive Ramp Metering involves the installation of traffic signals at the end of entrance ramps to freeways and expressways. Sensors on the mainline detect prevailing traffic conditions and specially developed algorithms are used to meter traffic from the on ramp onto the mainline.

This minimizes the disruption to mainline traffic flow caused by additional traffic entering at on ramps. Vehicles entering the roadway are temporarily stored on the on-ramps, while the loops will measure and calculate the traffic flow, speed and occupancy levels; allowing the vehicle to enter the freeway in a permissive manner, avoiding "bottle neck" concerns and improving safety.

A further evolution of this strategy involves the use of adaptive traffic signal control techniques to identify bottlenecks, automatically detect incidents and integrate the ramp meters with adjacent arterial traffic signal operations. While there has not been a study to support coordinating ramp metering signals with arterial traffic signals, the two systems working together may have significant benefits for the traffic performance of a corridor. When installing ramp meters, it is important to monitor the immediate area's varying traffic conditions, as the delay caused by the ramp meter waiting period may cause some drivers to choose other routes. In addition, the ramp queue should be reviewed and monitored to ensure that it does not negatively affect the arterials.

Costs – Capital - $ Operating - $$

Complementary Strategies – Adaptive Ramp Metering works well with these other TSM&O strategies:

-Roadway Widening (to expand ramp capacity)
-Roadway Widening (to expand adjacent arterial facility)
-Integrated Corridor Management (ICM)
-Dynamic Junction Control
-Adaptive Signal Control
-Dynamic Message Sign(s)
-Predictive Traveler Information
-Pre-Trip Travel Information
-Route Guidance

Conflicting Strategies – Adaptive Ramp Metering may not work well with Dynamic Junction Control, as both strategies are intended to relieve mainline congestion issues through ramp access. Literature regarding the combination of these two strategies is not currently available.

Example Benefit-Cost Ratio – The Benefit-Cost Analysis of a hypothetical centrally controlled ramp metering project, conducted using the TOPS-BC application, estimated a BCR of 46.32. Travel time was identified as the largest benefit for a hypothetical ramp metering project. The methodology and inputs used for the BCA are provided in the Transportation Systems Management and Operations Benefit Cost Analysis Compendium (FHWA, 2015).

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/publications/ramp_mgmt_handbook/manual/manual/5_1.html
https://ops.fhwa.dot.gov/freewaymgmt/ramp_mgmnt.htm

1.2.3 Adaptive Signal Control

General Description – Adaptive Signal Control responds more intelligently to fluctuations in traffic patterns by utilizing sensors for traffic data, and specially developed algorithms that then take the traffic data and derive signal timings that are customized to the prevailing conditions. Traffic signal timings adapt continuously to the changes and fluctuations in traffic flows, optimizing the control of traffic along corridors. These systems can account for changes in traffic speeds due to severe weather or unique situations.

According to NCHRP Synthesis 403 "Adaptive Traffic Control Systems: Domestic and Foreign State of Practice," there are more than 25 major implementations of adaptive traffic signal control in the United States. These include those already implemented within Polk County and Manatee County. The adoption of this strategy has significantly improved traffic flow along major arterials in some instances, providing benefits in time and fuel savings and an enhanced user experience.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Adaptive Signal Control works well with these other TSM&O strategies:

-Integrated Corridor Management (ICM)
-Event Management
-Work Zone Management
-Travel Demand Management (TDM)
-Transit Signal Priority
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Queue Jump
-Transit Traveler Information
-Fixed Route Transit
-Regional Payment System
-Electronic Transit Ticketing

Conflicting Strategies – Roundabouts will conflict with this strategy, as they are considered to be an alternative to signalized intersections.

Example Benefit-Cost Ratio – The Benefit-Cost Analysis of Adaptive Signal Control in Greeley and Woodland Park, Colorado, conducted using the TOPS-BC application, projected BCRs of 3.79 and 6.10 for two similar urban arterials.

Also, another BCA of Adaptive Signal Control was conducted for an unnamed principle arterial (urban). The TOPS-BC application estimated a BCR of 5.64.

The methodology and inputs used for the BCA are provided in the Transportation Systems Management and Operations Benefit Cost Analysis Compendium (FHWA, 2015).

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.fhwa.dot.gov/innovation/everydaycounts/edc-1/asct-faqs.cfm
http://www.fdot.gov/traffic/ITS/ArterialManagement/FDOT_ASCT.pdf

1.2.4 Advanced Intersection Detection

General Description – Advanced intersection detection incorporates some type of advance detection beyond the standard vehicle detection loop. Additional detection may include an advance detector loop that is placed further away from the intersection to provide advance detection of approaching vehicles. In coordination with adaptive signal control, this advance detector loop can be used to reduce wait times for approaching traffic and more accurately determine the number of vehicles queuing at the intersection. Alternatively, Advanced Intersection Detection may include replacing the existing standard vehicle detection loop with a video image vehicle detection system (VIVDS) or similar technology. Depending on the conditions of the roadway and other factors, replacing standard loops with VIVDS may be a cost-effective option that also improves vehicle detection at intersections.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Advanced Intersection Detection works well with the following strategies:

-Adaptive Signal Control
-Install Bluetooth
-Install CCTV
-Controller Upgrades
-Signal ATMS
-Active Arterial Management (AAM)
-Communications/Network Upgrades (Fiber)

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://static.tti.tamu.edu/tti.tamu.edu/documents/4285-S.pdf
https://safety.fhwa.dot.gov/intersection/conventional/signalized/tech_sum/fhwasa09008/

1.2.5 Event Management

General Description – Event Management is a strategy that appeals to all stakeholders because most agencies have events that take place within their limits. Events can wreak havoc on a transportation system due to the nature of an influx of vehicle and pedestrian traffic for a specific amount of time within a condensed area. Event Management, similar to how incident and active arterial management techniques perform, uses a combination of traffic control and traveler information techniques, along with parking management, to manage the flow of transportation during major events. Typically, this involves a traffic management center and an extensive communication network, link to sensors on the transportation network and staff directing traffic. Working together as a region on how to address dissemination to the traveling public of how traffic management will be handled can create informed drivers who may opt for other mode choices (transit, SunRail, etc.) and/or have a clearer pathway to destinations.

Because of this, there is a continuous need for excellence in event management and event parking. Transit ridership could also benefit from well-coordinated event management plans by encouraging alternate means of transportation other than personal vehicles.

Costs – Capital - $$$ Operating - $$

Complementary Strategies – Event Management incorporates a variety of TSM&O strategies, including:

-Dynamic Message Sign(s)
-Work Zone Management
-Travel Demand Management (TDM)
-Traffic Incident Management (TIM)
-Predictive Traveler Information
-En-route Driver Information
-Route Guidance
-Variable Speed Limit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Queue Jump
-Transit Traveler Information
-Fixed Route Transit
-Electronic Toll Collection
-Regional Payment System
-Freight Mobility

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/eto_tim_pse/preparedness/pse/handbook.htm

1.2.6 Extend Turn Lanes

General Description – The basic objective of a turn lane is to reasonably accommodate deceleration and storage of turning vehicles. When demand exceeds the length of the turn lane, vehicle queues will overflow into thru-lanes, potentially causing traffic accidents and/or travel delays. By extending turn lanes, this issue of queuing into travel lanes can be reduced or eliminated. This will improve the operation and safety of the corridor. To warrant turn lane extensions, turning volumes or an existing pattern of rear-end crashes along the turn lane need to exist. A longer turn-lane may lead to drivers mistaking the turn-lane for a thru-lane. Appropriate signage and pavement markings should alleviate this issue.

Costs – Capital - $$ Operating - $

Complementary Strategies – Extending Turn Lanes may work well with or support the following TSM&O strategies:

-Innovative Intersection Designs
-Roadway Widening
-Traffic Signal Re-timing
-Signal ATMS
-Variable Speed Limit
-Queue Jump*

*Extending the turn lane may be necessary to accommodate a Queue Jump. However, if a right-turn lane extension is needed to alleviate right-turn lane queues spilling into thru-lane traffic, then a bus will require a different lane for its Queue Jump maneuver.

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.lrrb.org/pdf/201025.pdf

1.2.7 Integrated Corridor Management (ICM)

General Description – An ICM transportation system is the ultimate objective when it comes to operating and maintaining a complex multi-modal traffic network. ICM involves an integrated approach to transportation along a specific designated corridor or corridors. Multiple agencies and multiple modes are coordinated through the use of shared back office systems and the adoption of compatible strategies. Through an ICM approach, transportation professionals manage the corridor as a multimodal system and make operational decisions for the benefit of the corridor as a whole. Multiple roadway types within the corridor as well as transit and other types of transportation facilities are managed in a coordinated fashion to try to optimize transportation service delivery and align agency strategies. This strategy provides the ability to treat transportation as a single system, increase the operational efficiency of the whole transportation network and maximize the effect of transportation investments. An important aspect of this strategy is the balancing of the system appropriately between all possible roadways and, more importantly, the inclusion of all modes of transportation: the intricate network of arterials, freeways, transit, freight and rail. This would support statewide TSM&O initiatives as well, where the use of technology is used to manage existing infrastructure, improving the transportation system with minimal investment and greater benefits to costs. Through the ICM initiative, the USDOT is providing guidance to assist agencies in implementing ICM and creating supporting analysis tools, approaches, and technical standards. USDOT selected two corridors - US 75 in Dallas, TX and I-15 in San Diego, CA - to demonstrate the nation's first ICM systems.

Costs – Capital - $$$ Operating - $$$

Complementary Strategies – Integrated Corridor Management (ICM) incorporates a variety of TSM&O strategies, including:

-Dynamic Message Sign(s)
-Event Management
-Work Zone Management
-Travel Demand Management (TDM)
-Traffic Incident Management (TIM)
-Predictive Traveler Information
-En-route Driver Information
-Route Guidance
-Variable Speed Limit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Queue Jump
-Transit Traveler Information
-Fixed Route Transit

-Electronic Toll Collection
-Regional Payment System
-Freight Mobility

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – The FHWA reviewed four ICM deployment reports (San Diego, Dallas, Minneapolis, and San Francisco) and identified BCRs ranging from 10.00 to 25.00. Benefits included reduced fuel consumption, travel time savings, improved TTR, and reduced emissions. (from ITS Benefits, Costs, and Lessons Learned. 2017 FHWA JPO. FHWA-JPO-17-500)

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.spcregion.org/pdf/ops/icm14/ICM%20DSS%20Dallas%20Presentation.pdf
https://ntl.bts.gov/lib/54000/54100/54136/US-75_ICMS_Requirements_-_Demonstration_Phase_FINAL_Formatted.pdf
http://www.sandag.org/index.asp?projectid=429&fuseaction=projects.detail

1.2.8 Ramp Closure

General Description – Closing a ramp can be an effective freeway management strategy, and can be deployed as a full removal, a temporary closure, or a scheduled closure. A full ramp closure involves the complete removal of the ramp, substantially changing the traffic pattern. A temporary closure or scheduled closure can be used in the event of major incidents, construction, emergencies, or special events, as needed. Ramp closures can improve operations on the freeway by providing a better balance of demand and capacity. In the event of a major incident on the freeway, a ramp closure may also be used to redirect arterial traffic in order to curtail the amount of congestion on the freeway and improve safety. Ramp closures can also be used as part of a work zone strategy to improve safety during construction efforts. A temporary ramp closure typically involves deploying physical barriers in front of the ramp and/or deploying message signs indicating the change in access. A full ramp closure is a more involved construction effort and should be used as a last resort to mitigate severe safety issues.

Costs – Capital - $$ Operating - $

Complementary Strategies – A Ramp Closure may work well with the following TSM&O strategies:
-Event Management
-Integrated Corridor Management (ICM)
-Work Zone Management
-Traffic Incident Management (TIM)
-Install CCTV
-Dynamic Message Sign
-Road Ranger Service Patrol
-En-Route Driver Information
-Pre-Trip Travel Information
-Predictive Traveler Information
-Data Management - Big Data
-Data Management - Transportation Data Analytics
-Traffic Management Center (TMC)

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/publications/ramp_mgmt_handbook/manual/manual/pdf/rm_handbook.pdf

1.2.9 Roadway Widening

General Description – Roadway widening is the standard industry practice for alleviating congestion and capacity issues along a given corridor. Roadway widening typically requires extensive studies of engineering feasibility and environmental impacts. Similarly, right-of-way acquisition is often required to accommodate the larger roadway footprint. Combined with the larger construction costs, roadway widening is typically one of the more expensive TSM&O strategies. However, it significantly improves capacity.

Costs – Capital - $$$ Operating - $

Complementary Strategies – Roadway Widening can be further supported by the following TSM&O strategies:

-Enhance bike/ped infrastructure
-Pedestrian Safety System
-Bicycle Alert System
-Dynamic Message Sign(s)
-Traffic Incident Management (TIM)
-Active Arterial Management (AAM)
-Event Management
-Work Zone Management
-Travel Demand Management (TDM)
-Predictive Traveler Information
-En-route Driver Information
-Route Guidance
-Innovative Intersection Designs
-Variable Speed Limit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Transit Traveler Information
-Fixed Route Transit
-Electronic Toll Collection
-Regional Payment System
-Freight Mobility

Conflicting Strategies – Widening may be impractical / impossible where physical, financial, or political constraints occur. In these instances, other TSM&O strategies should be considered. In addition, roadway widening may encourage higher travel speeds. As a result, roadway widening may conflict with traffic calming measures such as roadway diet, Complete Streets, etc.

Example Benefit-Cost Ratio – The Benefit-Cost Analysis for a hypothetical roadway widening, conducted using the TOPS-BC application, identified a BCR of 1.1 per lane added. The methodology and inputs used for the BCA are provided in the Transportation Systems Management and Operations Benefit Cost Analysis Compendium (FHWA, 2015).

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information – To be determined.

1.2.10 Signal Advanced Traffic Management System (ATMS)

General Description – Signal ATMS seeks to reduce traffic congestion in urban environments by improving the efficiency of existing infrastructure. Generally, Signal ATMS is operated out of the area's Traffic Management Center (TMC) and requires ITS infrastructure such as CCTVs, fiber optic cable, and traffic signal controllers. ATMS allows traffic engineers to fine-tune signal timing, react to traffic incidents more efficiently, and maneuver cameras to better determine traffic issues. All these components can help improve safety and the flow of traffic.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Signal ATMS may work well with the following strategies:

-Install Bluetooth
-Install CCTV
-Controller Upgrades
-Communications/Network Upgrades (fiber)
-Traffic Management Center (TMC)
-Adaptive Signal Control
-Traffic Signal Re-timing
-Traffic Incident Management (TIM)

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.umtri.umich.edu/our-focus/advanced-traffic-management-systems
http://www.townofcary.org/services-publications/traffic/advanced-traffic-management-system
http://www.miamidade.gov/publicworks/advanced-traffic.asp

1.2.11 Traffic Incident Management (TIM)

General Description – Incident Management supports the detection, verification, clearance and traffic management associated with incidents on freeways, expressways and arterials. This strategy uses CCTV, traffic sensors, telecommunications and centralized command to control a regional traffic management center. Incident management has a significant effect on the operational efficiency of roadways. Continued adoption of this strategy will be critical to the management of both recurring and nonrecurring congestion in the region.

With the onset of TSM&O initiatives promoting active arterial management and incident management on the arterials, this strategy has adopted/birthed some of the technologies and strategies discussed throughout this document. Incident management strategies have re-shaped the operations of state roadways over the past few decades; specifically, the freeway system. Incident management uses operators stationed in a RTMC or local TMC that identify nonrecurring active traffic incidents such as vehicle crashes, disabled vehicles and severe weather through the use of roadside detectors and camera surveillance. Upon detection of an incident, the operators are instructed to follow a pre-developed set of standard operating guidelines (SOG) to notify the appropriate first response agencies (i. e. Fire, Police, etc.). In addition, not only are the emergency first responders notified, but the traveling public is also notified via the ITS traveler information system (i.e. HAR, DMS, FL 511, etc.). The technologies and strategies utilized by these programs have drastically improved incident response practices and incident clearance times. Statewide, the average roadway clearance times on freeways have been cut almost in half since the inception of incident management. Overall, incident management has shown significant savings in terms of reducing unnecessary delay, idling, fuel consumption, automotive gas emissions and secondary crashes. Currently, incident management operations along Florida's freeways are recognized at the highest level throughout the nation. As stated earlier, up until just recently, these practices were limited to the state's freeways. However, with the advent of ICM, which recommends that all types of roadways work to balance traffic within a region, the desire to bring incident management to the arterial corridors is growing – hence the new AAM projects in FDOT District 1 currently underway and additional similar projects scheduled within the work program over the next five years.

Costs – Capital - $ Operating - $$

Complementary Strategies – Traffic Incident Management (TIM) works well with these other TSM&O strategies:

-Integrated Corridor Management (ICM)
-Event Management
-Work Zone Management
-Transit Signal Priority
-Adaptive Signal Control
-Traffic Signal Re-timing
-Queue Warning
-Dynamic Message Sign(s)
-En-Route Driver Information
-Pre-Trip Travel Information
-Predictive Traveler Information
-Route Guidance

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – The Benefit-Cost Analysis of the George NaviGator Traffic Incident Management System, conducted using the TOPS-BC application, identified a BCR of 4.4. The methodology and inputs used for the BCA are provided in the Transportation Systems Management and Operations Benefit Cost Analysis Compendium (FHWA, 2015).

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/eto_tim_pse/about/tim.htm
http://www.floridatim.com/

1.2.12 Traffic Management Center (TMC)

General Description – A Traffic Management Center (TMC) serves as the "mission control" for an area's major roadway network. Generally, operators working from the TMC monitor freeways, arterials, traffic signals, and intersections/interchanges by sensors, closed-circuit television (CCTV) feeds, and other technology deployed throughout the area. TMC operators can use the variety of information provided by this equipment, as well as other resources (first responders, customers, etc.), to ensure the roadway network is operating as safely and effectively as possible. Some responsibilities of TMC operators include: notifying road rangers or first responders of disabled vehicles, traffic incidents, or other activities; notifying the general public / media of travel conditions via traffic information resources (DMS, SunGuide, etc.); and performing signal re-timings and other operations as needed. A TMC is generally a great tool for improving a safety and efficiency for an area's roadway network;

however, it takes considerable funds to deploy (building construction costs) and additional funds to maintain operations. A TMC deployment should not take place without significant ITS infrastructure (sensors, controllers, CCTV, etc.) already on the ground. A Regional TMC (RTMC) can also be implemented, though it is generally deployed for major regional roadway projects, such as integrated corridor management, that span several jurisdictions.

Costs – Capital - $$$ Operating - $$

Complementary Strategies – A Traffic Management Center (TMC) may work well with or support the following TSM&O strategies:

-Install Bluetooth
-Install CCTV
-Communications/Network Upgrades (fiber)
-Controller upgrades
-Adaptive Signal Control
-Signal ATMS
-Traffic Signal Re-timing
-Traffic Incident Management
-Active Arterial Management (AAM)
-Integrated Corridor Management (ICM)
-Dynamic Message Signs
-Road Weather Information System (RWIS)
-Road Ranger Service Patrol
-En-Route Driver Information
-Pre-Trip Traveler Information
-Predictive Traveler Information
-Route Guidance
-Work Zone Management
-Event Management
-Dynamic Pricing
-Corridor Pricing
-Emergency Notification & Personal Security

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link – To be determined.

Additional Information –
https://mobility.tamu.edu/mip/strategies-pdfs/traffic-management/technical-summary/traffic-management-centers-4-pg.pdf

1.2.13 Traffic Signal Re-timing

General Description – Traffic signal re-timing is a basic TSM&O strategy that is widely and consistently implemented in some parts of FDOT District 1. Due to the ever-changing nature of traffic, signal timings must be periodically reviewed and updated to minimize delays to travelers. Re-timing is often the first step in improving operations at an existing signal. Traffic signal re-timing should take into account the level of pedestrian and bicycling activity at the intersection or corridor of interest. Depending on the signal technology at the intersection(s), re-timing may range from updating green phases to revising corridor-wide coordination.

Costs – Capital - $ Operating - $

Complementary Strategies – Traffic Signal Re-Timing can be further supported by the following TSM&O strategies:

-Enhance bike/ped infrastructure
-Pedestrian Safety System
-Bicycle Alert System
-Traffic Incident Management (TIM)
-Active Arterial Management (AAM)
-Event Management
-Work Zone Management
-Innovative Intersection Designs
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Transit Traveler Information
-Fixed Route Transit

Conflicting Strategies – Roundabouts will conflict with this strategy, as they are considered to be an alternative to signalized intersections.

Example Benefit-Cost Ratio – In Oakland County, Michigan, a two-phase project to retime 640 traffic signals resulted in BCRs of 175.00 for the first roadway and 55.00 for the second. A traffic light synchronization program in Texas yielded a 62.00 BCR. (from ITS Benefits, Costs, and Lessons Learned. 2017 FHWA JPO. FHWA-JPO-17-500) The Fuel-Efficient Traffic Signal Management (FETSIM) Program in California yielded a 58.00 BCR.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://nacto.org/docs/usdg/nchrp409_traffic_signal_retiming.pdf
http://www.spcregion.org/downloads/ops/Other%20Studies/BenefitsofRetimingTrafficSignals.pdf
https://www.ite.org/signal/index.asp

1.3 Strategies – Multimodal Improvements

Multimodal improvement strategies are intended to support and/or encourage alternative modes of transportation: Bicycle, Pedestrian, and Transit. The primary purpose for many of these strategies is improving the safety, comfort, or mobility for bicyclists, pedestrians, and transit users. A secondary effect for most of the strategies is providing additional incentive for single-occupant vehicle (SOV) users to switch to one of these alternative modes of transportation because of the added safety, convenience, or usefulness provided by these strategies.

1.3.1 Adaptive and Intelligent Streetlights

General Description – Adaptive and Intelligent Streetlight technology automatically adjusts the brightness of streetlights based on need, time of day, etc. This technology also includes sensors that can detect issues within the streetlight and relay that information to the local jurisdiction for maintenance or repair, instead of waiting for customers or mobile teams to identify and report the issue. These intelligent streetlights allow operators remote access to adjust the brightness and runtime of the LED bulbs based on various conditions (inclement weather, longer/shorter days, etc.). Adaptive and Intelligent Streetlight technology has the ability to improve brightness when appropriate, reduce maintenance costs, provided longer bulb life, and improve customer satisfaction.

Costs – Capital - $ Operating - $

Complementary Strategies – Adaptive and Intelligent Streetlights may work well with these TSM&O strategies:

-Roadway Diet
-Bicycle Alert System
-Pedestrian Safety Systems
-Enhance Bike/Ped Infrastructure
-Travel Demand Management (TDM)
-Innovative Intersection Designs
-Fixed Route Transit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Transit Traveler Information

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –

https://www.ge.com/reports/post/117014152735/fast-and-luminous-these-lights-are-so-bright/
https://icma.org/sites/default/files/Smart%20Solutions%20Technology%20Serving%20Communities%20E-Book.pdf
https://www.echelon.com/assets/blt339a50e1c88306c2/Navigant%20Research-Echelon%20Smart%20Street%20Lighting%20White%20Paper%20-%20Full%20Report.pdf

1.3.2 Autonomous Fixed Route Transit

General Description – Autonomous Fixed Route Transit is a relatively new technology. As of March 2018, there are no automated vehicles in revenue service. There are several pilots around the United States and the world, however. The primary feature of this strategy is an automated, driver-less transit vehicle operating along a fixed route. There are several challenges involved in the development and establishment of an automated transit service, including: fare collection, security and authority on-board (currently provided by the bus driver), the large upfront costs associated with developing the necessary digital and physical infrastructure, and the limitations of the current technology (operating speeds under 25mph). There are a number of questions still to be determined by Federal Transit Administration (FTA) and transit providers. Still, transportation practitioners across the industry are excited at the prospects of an autonomous transit service due to the expected benefits: improved safety from a reduction in crashes, improved travel time reliability and service availability, improved customer satisfaction, and operational efficiency.

Costs – Capital - $$$ Operating - $$$

Complementary Strategies – Autonomous Fixed Route Transit works well with these TSM&O strategies:

-Travel Demand Management (TDM)
-Predictive Traveler Information
-En-route Driver Information

-Queue Jump
-Express Bus / Limited Stop Bus
-Electric Fixed Route Transit
-Park and Ride Lots
-Dynamic Transit Capacity Assignment
-Dynamic Fare Reduction
-Adaptive Signal Control
-Communications/Network Upgrades (fiber)
-Install Bluetooth
-Transit Roadside Feature Upgrades
-Transfer Connection Protection
-Transit Traveler Information
-Transit Signal Priority
-Bus Rapid Transit
-Event Management
-Active Arterial Management (AAM)
-Regional Payment System
-Electronic Transit Ticketing
-Enhance bike/ped infrastructure
-Pedestrian Safety System
-Bicycle Alert System
-Updating Transit Routes

Conflicting Strategies – To be determined.
Example Benefit-Cost Ratio – To be determined.
Proven TSM&O Strategy Handout Link - To be determined.
Additional Information –
https://www.transit.dot.gov/automation-research

1.3.3 Bus Rapid Transit

General Description – Bus Rapid Transit (BRT) has been defined by the FTA as a 'rapid mode of transportation that can provide the quality of rail transit and the flexibility of buses.' BRT is an integrated system of facilities, equipment, services, and amenities that improves the speed, reliability, and identity of bus transit. BRT is essentially a rubber-tired light rail transit with greater operating flexibility and potentially lower costs.

Costs – Capital - $$$ Operating - +$

Complementary Strategies – Bus Rapid Transit works well with these TSM&O strategies, including:
-Travel Demand Management (TDM)
-Predictive Traveler Information
-En-route Driver Information
-Queue Jump
-Express Bus / Limited Stop Bus
-Park and Ride Lots
-Dynamic Transit Capacity Assignment
-Dynamic Fare Reduction
-Adaptive Signal Control
-Transfer Connection Protection
-Transit Traveler Information
-Transit Signal Priority

-Fixed Route Transit
-Event Management
-Active Arterial Management (AAM)
-Regional Payment System
-Electronic Transit Ticketing
-Enhance bike/ped infrastructure
-Pedestrian Safety System
-Bicycle Alert System

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.trb.org/Publications/Blurbs/158960.aspx

1.3.4 Complete Streets

General Description – Complete Streets are streets designed and operated to provide safety and support mobility for ALL users. The concept of Complete Streets encompasses many approaches to planning, designing, and operating roadways and rights of way with all users in mind to make the transportation network safer and more efficient.

Complete Streets approaches will vary based on community context. They may address a wide range of elements, such as sidewalks, bicycle lanes, bus lanes, public transportation stops, crossing opportunities, median islands, accessible pedestrian signals, curb extensions, modified vehicle travel lanes, streetscape, and landscape treatments. Complete Streets practices are intended to reduce motor vehicle crashes and risk to bicyclists and pedestrians. Alternative transportation modes, such as biking, walking, or transit, are encouraged through proper execution of Complete Streets concepts. Studies have also shown that walkable spaces, a common feature of Complete Streets, can provide positive health benefits to users, relating to physical activity.

Costs – Capital - $$ Operating - $

Complementary Strategies – Complete Streets may work well with or support these TSM&O strategies:
-Enhance bike/ped infrastructure
-Roadway Diet
-Bicycle Alert System
-Pedestrian Safety Systems
-Cycle Track
-Midblock Crossings
-Adaptive and Intelligent Streetlights
-Travel Demand Management (TDM)
-Innovative Intersection Designs
-Fixed Route Transit
-Transit Roadside Feature Upgrades
-Autonomous Fixed Route Transit
-Electric Fixed Route Transit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit

-Transit Traveler Information

Conflicting Strategies – Complete Streets focuses on improving mobility for all users and reducing motor vehicle crashes. This typically involves a roadway diet or repurposing of existing right-of-way to accommodate more bike/ped or transit infrastructure. For this reason, roadway widening generally conflicts with Complete Streets.

Example Benefit-Cost Ratio – The Concord Downtown Complete Streets Improvement Project identified a benefit/cost ratio of 3.41: 1 (3% discount rate). Identified benefits include: state of good repair (O&M cost savings), economic competitiveness, livability, sustainability, and safety. Their 2012 TIGER Grant application (http://www.concordnh.gov/DocumentCenter/View/1772) discusses the methodology and results of the Benefit/Cost Analysis in more detail.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.transportation.gov/mission/health/complete-streets
https://www.fhwa.dot.gov/publications/publicroads/10julaug/03.cfm
https://www.concordnh.gov/DocumentCenter/View/1790

1.3.5 Cycle Track

General Description – A cycle track is an exclusive bike facility that provides separation from both pedestrians and motor vehicles, creating a better user experience for bicyclists, and improving safety for all modes. Cycle tracks can be one-way or two-way and can be either raised alongside the road or given a protective barrier via bollards or on-street parking. If executed properly, cycle tracks should make bicyclists more comfortable due to their distance and protection from travel lanes. It also reduces the risk/fear of collisions with over-taking vehicles and "dooring."

Costs – Capital - $$ Operating - $

Complementary Strategies – A Cycle Track may work well with or support these TSM&O strategies:
-Enhance bike/ped infrastructure
-Roadway Diet
-Complete Streets
-Adaptive and Intelligent Streetlights
-Bicycle Alert System
-Pedestrian Safety Systems
-Midblock Crossings
-Adaptive and Intelligent Streetlights
-Travel Demand Management (TDM)
-Innovative Intersection Designs
-Fixed Route Transit
-Transit Roadside Feature Upgrades
-Autonomous Fixed Route Transit
-Electric Fixed Route Transit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Transit Traveler Information

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://nacto.org/publication/urban-bikeway-design-guide/cycle-tracks/

1.3.6 Dynamic Transit Capacity Assignment

General Description – Dynamic Transit Capacity Assignment is where data is collected regarding the performance of the transit fleet and real-time demand for transit. Information management systems are then used to optimize schedules and aid in the assignment of transit vehicles based on current transit demand. This enables the transit operator to reconfigure the assignment of vehicles and drivers to address the areas of the network with peak demand, while maximizing the number of passengers on each vehicle. While this would help regional transit operators to optimize the use of vehicles, reduce operating costs and maximize the user experience; the transit industry would need to stick to minimums and not exceed maximums in terms of number of buses in order to keep reliability dependable.

Costs – Capital - $ Operating - $

Complementary Strategies – Dynamic Transit Capacity Assignment works well with these TSM&O strategies, including:

-Travel Demand Management (TDM)
-Event Management
-Active Arterial Management (AAM)
-Predictive Traveler Information
-En-route Driver Information
-Queue Jump
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Dynamic Fare Reduction
-Transfer Connection Protection
-Transit Traveler Information
-Transit Signal Priority
-Fixed Route Transit
-Light Rail Transit
-Heavy Rail Transit
-Regional Payment System
-Electronic Transit Ticketing

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.trbappcon.org/2009conf/TRB2009papers/1803_2009_TRBApp_Fisher_Scherr_Dynamic_Transit_Assignment.pdf

1.3.7 Electric Fixed Route Transit

General Description – When upgrading to establishing a new electric fixed route transit service, there are a number of considerations to keep in mind. An electric bus exhibits several key benefits over standard buses powered by the internal combustion engine: less maintenance due to the mechanical components of the vehicle; less noise and pollution; and a cheap and renewable energy source. There are, however, several drawbacks that need to be considered as well, including: refuels more slowly (generally); a shorter range (approximately 200 miles per full charge) before recharging; additional buses needed in service to support the reduced range; charging stations needed; and the higher capital cost per bus compared to standard diesel counterparts.

Costs – Capital - $$$ Operating - $$

Complementary Strategies – Electric Fixed Route Transit works well with these TSM&O strategies:

-Travel Demand Management (TDM)
-Predictive Traveler Information
-En-route Driver Information
-Queue Jump
-Express Bus / Limited Stop Bus
-Park and Ride Lots
-Dynamic Transit Capacity Assignment
-Dynamic Fare Reduction
-Adaptive Signal Control
-Transfer Connection Protection
-Transit Roadside Feature Upgrades
-Transit Traveler Information
-Transit Signal Priority
-Bus Rapid Transit
-Event Management
-Active Arterial Management (AAM)
-Regional Payment System
-Electronic Transit Ticketing
-Enhance bike/ped infrastructure
-Pedestrian Safety System
-Bicycle Alert System
-Updating Transit Routes

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link – To be determined.

Additional Information –
https://www.gogreenmetro.com/374/Electric-Buses
https://www.transit.dot.gov/sites/fta.dot.gov/files/FTA_Report_No._0028.pdf
https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/FTA-CALSTART%20Low-No%20Webinar%20Jan%2024%202017.pdf

1.3.8 Enhance Bike/Ped Infrastructure

General Description – Enhancing the comfort and safety of pedestrians and bicyclists can provide affordable mobility, improve access to transit, and generally incentivize travelers away from single-occupant vehicles. There are several ways to enhance pedestrian and bicyclist infrastructure, including wider sidewalks, trails, median crossing islands, on-road and separated bicycling facilities, or systemwide improvements like wayfinding or bikesharing.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Enhance Bike/Ped Infrastructure may work well with these TSM&O strategies:

-Roadway Diet
-Bicycle Alert System
-Pedestrian Safety Systems
-Travel Demand Management (TDM)
-Innovative Intersection Designs
-Cycle Track
-Fixed Route Transit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Transit Traveler Information

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalks/
https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/separated_bikelane_pdg/page00.cfm
https://www.fhwa.dot.gov/environment/bicycle_pedestrian/funding/faq_bikeshare.cfm
https://nacto.org/publication/urban-bikeway-design-guide/bikeway-signing-marking/bike-route-wayfinding-signage-and-markings-system/
https://safety.fhwa.dot.gov/ped_bike/tools_solve/medians_brochure/

1.3.9 Express Bus / Limited Stop Bus

General Description – Express Bus / Limited Stop Bus caters to commuter travel and may take advantage of limited access facilities, HOT lanes, express lanes, and other strategies in order to provide reliable transportation from outlying communities to the central city. Generally, the Express Bus / Limited Stop Bus is supported by localized Fixed Transit Routes, Park and Ride Lots, and other strategies to provide "First Mile / Last Mile" connections to and from the Express Bus terminus points.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Express Bus / Limited Stop Bus works well with these TSM&O strategies:

-Travel Demand Management (TDM)
-Active Arterial Management (AAM)
-Integrated Corridor Management (ICM)
-Work Zone Management
-Event Management
-Predictive Traveler Information
-En-route Driver Information
-Queue Jump
-Dynamic HOV & Managed Lanes
-Dynamic Shoulder Lanes
-Park and Ride Lots

-Dynamic Transit Capacity Assignment
-Dynamic Fare Reduction
-Adaptive Signal Control
-Transfer Connection Protection
-Transit Traveler Information
-Transit Signal Priority
-Fixed Route Transit
-Bus Rapid Transit
-Regional Payment System
-Electronic Transit Ticketing
-Enhance bike/ped infrastructure
-Pedestrian Safety System
-Bicycle Alert System

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information – To be determined.

1.3.10 Fixed Route Transit

General Description – A Fixed Route Transit system includes any transit service in which vehicles run along an established path at predetermined times. The most common examples include trains, subways, and buses. For most transit agencies, bus routes are typically adjusted, dropped, or added every two to three months, depending on staff availability.

Costs – Capital - $$$ Operating - $$

Complementary Strategies – Fixed Route Transit works well with these TSM&O strategies:
-Travel Demand Management (TDM)
-Predictive Traveler Information
-En-route Driver Information
-Queue Jump
-Express Bus / Limited Stop Bus
-Park and Ride Lots
-Dynamic Transit Capacity Assignment
-Dynamic Fare Reduction
-Adaptive Signal Control
-Transfer Connection Protection
-Transit Traveler Information
-Transit Signal Priority
-Bus Rapid Transit
-Event Management
-Active Arterial Management (AAM)
-Regional Payment System
-Electronic Transit Ticketing
-Enhance bike/ped infrastructure
-Pedestrian Safety System
-Bicycle Alert System

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information – To be determined.

1.3.11 Midblock Crossing

General Description – Midblock crossings are installed near the midpoint of longer suburban/urban blocks. Generally, these longer blocks force pedestrians wanting to cross to either walk a substantial distance "out of the way" to use an existing crosswalk, or unsafely/illegally cross several lanes of traffic without any pavement markings, signs, or signals alerting drivers to potential pedestrians. Midblock crossings, if executed properly, offer a more convenient method for crossing a roadway. Midblock crossings should have proper markings, signage and/or pedestrian signals to alert drivers. Refuge islands can be paired with midblock-crossings of major roadways to improve pedestrian safety and comfort, requiring them to only cross one direction of traffic at a time. Traffic calming measures can be implemented on the roadway to further improve safety and comfort for pedestrians using the midblock crossing.

Costs – Capital - $$ Operating - $

Complementary Strategies – A Midblock Crossing may work well with these TSM&O strategies:
-Roadway Diet
-Bicycle Alert System
-Pedestrian Safety Systems
-Cycle Track
-Enhance bike/ped infrastructure
-Travel Demand Management (TDM)
-Innovative Intersection Designs
-Fixed Route Transit
-Adaptive and Intelligent Streetlights
-Dynamic Message Sign
-Electric Fixed Route Transit
-Autonomous Fixed Route Transit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Transit Traveler Information

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.fhwa.dot.gov/publications/research/safety/pedbike/05085/chapt12.cfm

Utilizing the methodology above, each strategy was assessed to outline is applicability.

1.3.12 On-Demand Transit

General Description – On-Demand Transit, or personalized public transit in simplified terms, occurs when vehicles do not follow fixed routes and passenger trips are generated by reservations from passengers to the transit operator who then dispatches a vehicle. The transit operator will make use of information management systems to attempt to optimize the number of passengers picked up on each trip. Passengers may use telephone, web-based or smart phone applications to make reservations and requests for travel. This strategy is particularly relevant to passengers that are not able to use conventional transit systems, such as elderly travelers heading to medical appointments. Private services such as SuperShuttle and Uber can be considered as on-demand transportation services, both of which are available nationwide. This strategy could be useful for off-peak transit services in the region. While transit operators already operate paratransit services, these could be extended to wider application. Many agencies within the region can see great potential for the "first/last mile" within the transit system and is generally favored as a plausible strategy.

Costs – Capital - $$$ Operating - $

Complementary Strategies – Transit Traveler Information works well with these TSM&O strategies, including:

-Travel Demand Management (TDM)
-Predictive Traveler Information
-En-route Driver Information
-Queue Jump
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Transit Traveler Information
-Dynamic Transit Capacity Assignment
-Dynamic Fare Reduction
-Transfer Connection Protection
-Transit Signal Priority
-Regional Payment System
-Electronic Transit Ticketing

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.trb.org/Publications/Blurbs/163788.aspx
http://www.trb.org/Publications/Blurbs/162701.aspx

1.3.13 Park and Ride Lots

General Description – Park and Ride Lots encourage commuters to drive their vehicle (SOV or HOV) from their trip origin to train or bus stations, where they may park their car and ride public transportation to their destination. The goal of Park and Ride Lots is to reduce traffic congestion by encouraging the use of public transportation. Providing for "First Mile" connections via the user's vehicle, Park and Ride Lots incentivize commuters to use public transportation for the bulk of their commute.

Costs – Capital - $$$ Operating - $

Complementary Strategies – Express Bus / Limited Stop Bus works well with these TSM&O strategies:

-Travel Demand Management (TDM)
-Active Arterial Management (AAM)
-Integrated Corridor Management (ICM)
-Work Zone Management
-Event Management
-Predictive Traveler Information
-En-route Driver Information
-Queue Jump
-Dynamic HOV & Managed Lanes
-Dynamic Shoulder Lanes
-Park and Ride Lots
-Dynamic Transit Capacity Assignment
-Dynamic Fare Reduction
-Adaptive Signal Control
-Transfer Connection Protection
-Transit Traveler Information
-Transit Signal Priority
-Fixed Route Transit
-Bus Rapid Transit
-Heavy Rail Transit
-Light Rail Transit
-Event Management
-Active Arterial Management (AAM)
-Regional Payment System
-Electronic Transit Ticketing
-Enhance bike/ped infrastructure
-Pedestrian Safety System
-Bicycle Alert System

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.virginiadot.org/travel/resources/parkAndRide/Final_PR_Best_Practices_021113.pdf
http://wordpress.cnhrpc.org/wp-content/uploads/2015/10/NH-Park-and-Ride-Toolkit-092315.pdf
http://atrf.info/papers/2015/files/ATRF2015_Resubmission_128.pdf

1.3.14 Queue Jump

General Description – Queue Jumping uses separate lanes (for example, a right turn lane) and signals (similar to designated bus lanes) to allow only a bus to proceed through the intersection, thus "jumping" past other vehicles. This would be a transit-specific strategy to support on-time arrivals and reduce route travel time delay.

Costs – Capital - $$$ Operating - $

Complementary Strategies – Queue Jump works well with these TSM&O strategies:
-Travel Demand Management (TDM)
-Predictive Traveler Information
-En-route Driver Information

-Fixed Route Transit
-Express Bus / Limited Stop Bus
-Park and Ride Lots
-Dynamic Transit Capacity Assignment
-Dynamic Fare Reduction
-Adaptive Signal Control
-Transfer Connection Protection
-Transit Roadside Feature Upgrades
-Transit Traveler Information
-Transit Signal Priority
-Bus Rapid Transit
-Event Management
-Active Arterial Management (AAM)
-Regional Payment System
-Electronic Transit Ticketing
-Enhance bike/ped infrastructure
-Pedestrian Safety System
-Bicycle Alert System
-Extend Turn Lanes*

*Extending the turn lane may be necessary to accommodate a Queue Jump. However, if a right-turn lane extension is needed to alleviate right-turn lane queues spilling into thru-lane traffic, then a bus will require a different lane for its Queue Jump maneuver.

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://nacto.org/publication/transit-street-design-guide/intersections/intersection-design/queue-jump-lanes/
https://pdfs.semanticscholar.org/9766/875c2804d6c7128fb90c283f668b5b624c1b.pdf

1.3.15 Transfer Connection Protection

General Description – Transfer Connection Protection helps to bring transit operations together as a single system by recognizing the need for travelers to make connections between routes. Travelers can request protection for their connection either using a smart phone or using onboard equipment on a personal automobile or a transit vehicle. Fleet information systems are then used to ensure that if the initial service is running late, that any subsequent services have an option (for a fee) to be delayed to allow the travelers to make the connection successfully.

Costs – Capital - $$ Operating - $

Complementary Strategies – Transfer Connection Protection works well with these TSM&O strategies, including:
-Travel Demand Management (TDM)
-Event Management
-Integrated Corridor Management (ICM)
-Active Arterial Management (AAM)
-Predictive Traveler Information
-En-route Driver Information

-Queue Jump
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Dynamic Transit Capacity Assignment
-Dynamic Fare Reduction
-Transit Traveler Information
-Transit Signal Priority
-Fixed Route Transit
-Light Rail Transit
-Heavy Rail Transit
-Regional Payment System
-Electronic Transit Ticketing

Conflicting Strategies – Some agency stakeholders may consider it not be feasible to have an entire bus waiting for a single person. Caution should be exercised when considering whether to implement this strategy.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.rtams.org/reportLibrary/100.pdf

1.3.16 Transit Roadside Feature Upgrades

General Description – Upgrading transit roadside features can provide a positive experience to transit users. Upgraded roadside features may also improve ridership, particularly for "transit choice" riders who generally choose between transit and other modes of transportation based on convenience and cost. Amenities and features may include, but are not limited to: covered shelters, shelters with cooling/heating, seating, lighting, static/dynamic information systems, waste receptacles, and special features for people with disabilities (railings, bathrooms, signage, etc.).

Costs – Capital - $$ Operating - $

Complementary Strategies – Transit Roadside Feature Upgrades may work well with or support the following TSM&O strategies:
-Fixed Route Transit
-Electric Fixed Route Transit
-Autonomous Fixed Route Transit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Queue Jump
-Transit Signal Priority
-Complete Streets
-Enhance bike/ped infrastructure
-Transit Traveler Information
-Travel Demand Management (TDM)
-Adaptive and Intelligent Streetlights
-Updating Transit Routes

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://safety.fhwa.dot.gov/ped_bike/ped_transit/ped_transguide/ch1.cfm
https://safety.fhwa.dot.gov/ped_bike/ped_transit/ped_transguide/ch2.cfm
https://safety.fhwa.dot.gov/ped_bike/ped_transit/ped_transguide/ch3.cfm
https://safety.fhwa.dot.gov/ped_bike/ped_transit/ped_transguide/ch4.cfm

1.3.17 Transit Signal Priority

General Description – Transit Signal Priority (TSP) was developed to improve schedule adherence for transit agencies. TSP slightly modifies the existing timing plan at an intersection by "stealing" green time from movements with lower demand to allow qualified transit busses to pass through the intersection. TSP may extend or reduce the green time for the approach of the bus using the extra time taken from a conflicting movement. Additional sensors are installed at traffic signals that sense the presence of transit vehicles. These transit vehicles are given priority to pass through the signalized intersection. Such systems can also take a count of the number of people on board the transit vehicle and the current schedule status of the transit vehicle before deciding if priority should be granted. Some systems require the installation of an in-vehicle unit on the transit vehicle.

Much like Florida's Adaptive Signal Control system, the local region has also implemented TSP. This strategy should not be confused with Traffic Signal Preemption, which is a system that allows the normal operations of traffic signals to be interrupted and altered, typically to accommodate an approaching emergency vehicle, to help reduce emergency response times and improve traffic safety at the intersection. TSP is similar, but is focused on the transit side, while pre-emption is focused on first responders within the transportation system. Overall, TSP increases the attractiveness of transit to regional travelers. Wide-scale adoption of this strategy can increase trip time reliability for transit vehicles and the passengers on that mode choice. This influences travelers' decision-making with respect to mode of travel. It is also noted that sometimes TSP cannot fix certain corridors – at the end of the day, sometimes there are just "slow routes" that may take longer than usual every time unless bus density is increased.

TSP may also impose a negative effect to the traffic signal system as a whole; when TSP "steals" the green movement seconds from another phase, it alters the overall signal timing as the system takes a few minutes to get back to normal operations. Generally speaking, the positive benefits stemming from TSP do outweigh the negative.

Costs – Capital - $$ Operating - $

Complementary Strategies – Transit Signal Priority works well with these other TSM&O strategies:
-Integrated Corridor Management (ICM)
-Event Management
-Work Zone Management
-Travel Demand Management (TDM)
-Adaptive Signal Control
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Fixed Route Transit
-Park and Ride Lots
-Queue Jump
-Transit Traveler Information

-Regional Payment System
-Electronic Transit Ticketing

Conflicting Strategies – Roundabouts will conflict with this strategy, as they are considered to be an alternative to signalized intersections.

Example Benefit-Cost Ratio – The Benefit-Cost Analysis of Portland Tri-Met's Transit Signal Priority project, conducted using the TOPS-BC application, identified a BCR of 1.78. Also, another BCA of Transit Signal Priority was conducted for the Los Angeles DOT / MTA advanced Traffic Signal Priority system. The TOPS-BC application estimated a BCR of 10.09 The methodology and inputs used for the BCA are provided in the Transportation Systems Management and Operations Benefit Cost Analysis Compendium (FHWA, 2015).

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/publications/fhwahop14032/ch8.htm
https://ops.fhwa.dot.gov/publications/fhwahop08024/chapter9.htm#9.2
http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.477.1656&rep=rep1&type=pdf

1.3.18 Transit Traveler Information

General Description – Similar to Traveler Information, Transit Traveler Information's goal is to inform the public, specifically the transit schedule and updates. Equipment on board the transit vehicle enables travelers to gain access to information regarding the current transit stop, upcoming transit stops and real-time transit schedule information. The system can also be extended to provide traveler information at bus stops and for pre-trip through the use of kiosks or web-based delivery systems. This strategy also increases the attractiveness of transit use and could influence the modal split in favor of transit within the region. Studies have shown users use transit more frequently when real-time information is available. There are a variety of technological options available to collect this transit information, including Automatic Vehicle Location (AVL) and Automatic Passenger Counter (APC).

Costs – Capital - $$ Operating - $$

Complementary Strategies – Transit Traveler Information works well with these TSM&O strategies, including:
-Travel Demand Management (TDM)
-Predictive Traveler Information
-En-route Driver Information
-Queue Jump
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Dynamic Transit Capacity Assignment
-Dynamic Fare Reduction
-Transfer Connection Protection
-Transit Signal Priority
-Fixed Route Transit
-Light Rail Transit
-Heavy Rail Transit
-Regional Payment System
-Electronic Transit Ticketing

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://onebusaway.org/
http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_45.pdf
http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_92.pdf
http://www.trb.org/main/blurbs/159906.aspx
http://www.trb.org/main/blurbs/158961.aspx
https://www.nctr.usf.edu/pdf/77803.pdf
https://www.itsbenefits.its.dot.gov/ITS/benecost.nsf/ID/6567C935EF9C3B08852578B60077380F?OpenDocument&Query=Home

1.3.19 Update Transit Routes

General Description – Updating a transit agency's service routes may include: route adjustments; schedule adjustments; new routes or buses to serve demand; and route elimination. Transit route updates may lead to improved customer satisfaction, higher ridership, better service for the transportation-disadvantaged, and more efficient operations. The Federal Transit Administration (FTA) does not have route update requirements in place for agencies receiving federal funds; however, the FTA does require that all updates are fair and equitable, and do not disproportionately impact minority and low-income populations, in accordance with Title VI.

Costs – Capital - $ Operating - $

Complementary Strategies – Updating Transit Routes may work well with or support the following TSM&O strategies:

-Fixed Route Transit
-Electric Fixed Route Transit
-Autonomous Fixed Route Transit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Queue Jump
-Regional Payment System
-Dynamic Overflow Transit Parking
-Dynamic Transit Capacity Assignment
-Transit Traveler Information
-Travel Demand Management (TDM)
-Predictive Traveler Information
-Pre-Trip Travel Information
-Transit Signal Priority
-Transit Roadside Feature Upgrades
-Transfer Connection Protection
-Electronic Transit Ticketing
-Dynamic Fare Reduction

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.transit.dot.gov/regulations-and-guidance/fta-circulars/title-vi-requirements-and-guidelines-federal-transit

1.4 Strategies – Freight Support

Freight support strategies are focused on improving the movement of goods through the regional transportation network and providing additional support systems for freight drivers.

1.4.1 Automated Roadside Safety Inspection

General Description – Automated Roadside Safety Inspection makes use of data from the commercial vehicle electronic clearance applications and enables more selective and rapid inspections of freight vehicles and goods. Sensors and diagnostic equipment are used to check vehicle systems and driver requirements. For instance, automated inspection equipment can be implemented to remotely test commercial trucks for faulty equipment, such as non-functioning brakes.

Although there are no current implementations identified so far, this strategy could potentially reduce operating costs for trucking companies while reducing the resources required for inspection. Weigh-In-Motion is another technology for determining the weight of a commercial vehicle without requiring it to stop on a scale – an automated inspection technique that is used and the beginning to a more comprehensive Automated Roadside Safety Inspection approach. There are currently 10 Weigh-In-Motion stations in Florida.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Automated Roadside Safety Inspection works well with these other TSM&O strategies:

-Commercial Vehicle Administration Process
-Commercial Vehicle Electronic Clearance
-Freight Mobility
-Hazardous Materials Security & Incident Response
-On-board Safety and Security Monitoring

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.irdinc.com/public/uploads/downloads/1509636040_Automation_Technologies_CVO_Screening_ITSWC_17.pdf

1.4.2 Commercial Vehicle Administration Process

General Description – Commercial Vehicle Administrative Processes is an information management system used to streamline the processes through which carriers purchase credentials. Processes consist of all activities and transactions that must take place in order for commercial vehicles to legally operate on the nation's roadways. This application also allows carriers to electronically report vehicle registration, carrier operating authority, fuel tax registration, permitting and mileage reporting. FDOT is implementing this strategy as a part of their commercial vehicle information systems and networks program.

Costs – Capital - $ Operating - $

Complementary Strategies – Commercial Vehicle Administration Process works well with these other TSM&O strategies:

-Automated Roadside Safety Inspection
-Commercial Vehicle Electronic Clearance
-Freight Mobility
-Hazardous Materials Security & Incident Response
-On-board Safety and Security Monitoring

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – The Commercial Vehicle Information Systems and Network (CVISN) program, implemented by the FMCSA, provided for electronic credentialing, safety information exchange, electronic screening, Smart Roadside, and Driver Information Sharing. FHWA determined that the CVISN ranged from a 1.9 to a 7.5 BCR, depending on system configuration, level of deployment, and crash avoidance benefits gained.

FHWA further determined that just the electronic credentialing of the CVISN program yielded a 2.6 BCR nationally. (from ITS Benefits, Costs, and Lessons Learned. 2017 FHWA JPO. FHWA-JPO-17-500)

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.fhwa.dot.gov/publications/research/operations/its/jpo99037/fotadmin.pdf

1.4.3 Commercial Vehicle Electronic Clearance

General Description – Pre-screened truck drivers are entitled to equip their vehicles with an electronic transponder. This allows enforcement personnel to automatically check safety, credentials, size and weight of the vehicle prior to inspection site locations. This strategy reduces operating costs for truck companies while reducing the resources required for enforcement. Given the strategic importance of freight movement within the state of Florida, the strategy would be relevant in assisting more cost-effective freight operations. A commercial vehicle electronic clearance program known as Pre-Pass is currently available at more than 300 facilities in 30 states.

Costs – Capital - $ Operating - $

Complementary Strategies – Commercial Vehicle Electronic Clearance works well with these other TSM&O strategies:

-Automated Roadside Safety Inspection
-Commercial Vehicle Administration Process
-Freight Mobility
-Hazardous Materials Security & Incident Response
-On-board Safety and Security Monitoring

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – The Commercial Vehicle Information Systems and Network (CVISN) program, implemented by the FMCSA, provided for electronic credentialing, safety information exchange, electronic screening, Smart Roadside, and Driver Information Sharing. FHWA determined that the CVISN ranged from a 1.9 to a 7.5 BCR, depending on system configuration, level of deployment, and crash avoidance benefits gained.

FHWA further determined that just the electronic credentialing of the CVISN program yielded a 2.6 BCR nationally. (from ITS Benefits, Costs, and Lessons Learned. 2017 FHWA JPO. FHWA-JPO-17-500)

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ntl.bts.gov/lib/24000/24900/24974/Ch7.pdf
http://www.fdot.gov/traffic/traf_incident/Projects_CVO/CVISN.shtm

1.4.4 Freight Mobility

General Description – Freight Mobility connects drivers, dispatchers and intermodal transportation providers to enable them to take advantage of real-time traffic information, vehicle and load location, in order to optimize operations.
FRATIS, or Freight Advanced Traveler Information Systems, ties into freight mobility. It consists of three applications that can provide operational solutions for moving vast quantities of goods through highly urbanized areas. FRATIS is currently in the development phase of three applications by the FHWA and the ITS Joint Program Office:
-Freight Real-Time Traveler Information with Performance Measures – Enhances traveler information systems to address specific freight needs and increase their use and effectiveness;
-Drayage Optimization – Optimizes drayage operations so that load movements are coordinated among freight facilities – maximizes productive moves and seeks to eliminate unproductive ones;
-Freight Dynamic Route Guidance – Utilizes real-time traveler information to provide best route options between freight facilities for carriers.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Freight Mobility works well with these other TSM&O strategies:
-Automated Roadside Safety Inspection
-Commercial Vehicle Administration Process
-Commercial Vehicle Electronic Clearance
-Dynamic Message Sign(s)
-Integrated Corridor Management (ICM)
-Active Arterial Management (AAM)
-Hazardous Materials Security & Incident Response
-On-board Safety and Security Monitoring

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ntl.bts.gov/lib/54000/54100/54104/12-065.pdf
https://ntl.bts.gov/lib/57000/57000/57031/FHWA-JPO-16-225.pdf
https://www.its.dot.gov/research_archives/dma/bundle/fratis_plan.htm

1.4.5 Freight Parking

General Description – Similar to general parking management efforts, freight traffic on freeways is another opportunity to use parking management. This system would inform truck drivers of available parking spaces in rest areas. Information management systems are also used to make the acquisition of a freight parking permit more efficient and effective and to provide guidance to truckers on suitable parking locations and the availability of freight parking slots. In addition to garage parking, commercial truck parking has become a concern throughout Florida due to the increasing number of trucks on the interstates, as the number of truck parking areas has not increased to keep up with the demand. This causes many truck drivers to park along the interstate near rest areas or on/off ramps. These trucks then become potential hazards for drivers who may drift out of their lane and collide with the parked truck. Transportation officials are exploring ways to inform truck drivers of the availability of parking spaces at rest areas so that they will have this information prior to entering the rest area and will have the ability to seek parking at nearby truck stops or other areas in the event that there is limited available space.

Costs – Capital - $$ Operating - $

Complementary Strategies – Freight Parking works well with these other TSM&O strategies:
-Dynamic Message Sign(s)
-Freight Mobility
-Predictive Traveler Information
-En-route Driver Information
-Dynamic Routing
-Route Guidance

Conflicting Strategies –

Example Benefit-Cost Ratio – The FHWA determined that a Regional Truck Parking Information Management System (TPIMS), deployed across Interstate rest areas in 8 Midwest states, yielded a 4.27 BCR. The primary benefits outlined in the report were safety, travel time, and environmental. (from ITS Benefits, Costs, and Lessons Learned. 2017 FHWA JPO. FHWA-JPO-17-500)

Proven TSM&O Strategy Handout Link –

Additional Information –
https://ops.fhwa.dot.gov/freight/documents/cmvrptcgr/index.htm#app
https://ops.fhwa.dot.gov/freight/infrastructure/truck_parking/

1.5 Strategies – Automated / Connected Vehicle Support Improvements

Automated and Connected Vehicle technologies are expected to cause a paradigm shift in the transportation sector. The strategies described below are intended to support and leverage the paradigm-altering technologies for the benefit of transportation users and practitioners.

1.5.1 Automated Vehicle Operation

General Description – Automated Vehicle Operation, or Autonomous Vehicles, enables vehicles to be operated autonomously with no human intervention. The possibilities would be endless and would enable autonomous demand actuated transportation services using a fleet of autonomous vehicles.

Transit operations of busses could be done autonomously; saving labor costs. Safety is the primary driving factor for implementing such a strategy. Every major vehicle manufacturer with a presence in the US market is currently working on an autonomous vehicle program, as well as Tesla, Apple and

Google. In addition, an autonomous vehicle testbed is being established on a Tampa Hillsborough County Expressway Authority toll road. Although this will be driven by the automotive manufacturers, the potential impact of autonomous vehicles, safety, efficiency and user experience make this a strategy that should be monitored closely by transportation agencies. Suggested costs are associated with the investments necessary to prepare roadway infrastructure for Vehicle to Infrastructure (V2I) communications ("connected vehicle") and operate & maintain the new communications equipment.

Costs – Capital - $$$ Operating - $$$

Complementary Strategies – The following strategies may support Automated Vehicle technologies:
-Adaptive Signal Control
-Communications/Network upgrades (fiber)
-Install Bluetooth
-Install CCTV
-Controller Upgrades
-Signal ATMS
-Advanced Intersection Detection
-Traffic Management Center (TMC)
-Integrated Corridor Management (ICM)
-Data Management - Big Data
-Data Management - Transportation Data Analytics
-Performance Measurement
-Road Weather Information System (RWIS)
-Signal Phase and Timing (SPaT)
-Traffic Signal Preemption
-Regional Payment System

Conflicting Strategies – To be determined.
Example Benefit-Cost Ratio – To be determined.
Proven TSM&O Strategy Handout Link – To be determined.
Additional Information –
https://ops.fhwa.dot.gov/regulationpolicy/avpolicyactivities/index.htm

1.5.2 Communications/Network Upgrades (Fiber)

General Description – Fiber optic cable comes with several benefits over standard copper wiring for ITS infrastructure: extremely high bandwidth, data security, resistance to electromagnetic interference, lightweight and smaller size, and low costs compared to copper. As ITS infrastructure improves, information and data will increase dramatically. Upgrading current communications infrastructure to fiber optic will improve the flow of data. This means more CCTVs, Bluetooth, and other devices can be incorporated into the roadway network, allowing for improved operations and data collection.

Costs – Capital - $$ Operating - $
Complementary Strategies – Communications/Network Upgrades (Fiber) support these strategies:
-Adaptive Signal Control
-Install Bluetooth
-Install CCTV
-Controller Upgrades
-Signal ATMS
-Advanced Intersection Detection
-Traffic Management Center (TMC)
-Integrated Corridor Management (ICM)

-Data Management - Big Data
-Data Management - Transportation Data Analytics
-Performance Measurement
-Road Weather Information System (RWIS)
-Signal Phase and Timing (SPaT)
-Traffic Signal Preemption

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.fdot.gov/design/Training/DesignExpo/2015/presentations/FiberDesignforTrafficSignalsandITSProjectsforDesigners-MikeLubin.pdf

1.5.3 Connected Vehicles

General Description – A "Connected Vehicle" is a vehicle that uses any number of different communication technologies to communicate with the driver, other vehicles (Vehicle-to-Vehicle [V2V]), roadside infrastructure (Vehicle-to-Infrastructure [V2I]), and other devices (Vehicle-to-Everything [V2X]). Connected Vehicles produce, distribute, and receive large quantities of data in order to provide the driver or automated driving system (ADS) more information with which to use while operating a motor vehicle. V2V communications occur between vehicles, meaning the public investments required to support such communications are minimal. However, V2I communications will require considerable investments from public agencies to provide the infrastructure necessary to support such communications. V2I requires roadside units (RSU) to be able to communicate to the vehicle's on-board unit (OBU).

The V2V, V2I, and V2X communications improve the operational capabilities of the "connected vehicle," providing such useful information as: a disabled vehicle up ahead blocking a lane; congestion and reduced speeds up ahead; blind spot alerts; and pedestrians nearby. This information allows drivers or automated systems to adjust their speed, route, and general operation of the vehicle in a more efficient manner. In addition to operational improvements, V2I communications also provide a large source of real-time data that can be used by transportation agencies to improve their roadway network, measure performance, and allocate resources more effectively.

NOTE: "Connected Vehicle" only refers to a vehicle's ability to communicate to the driver and/or its surroundings.

Costs – Capital - $ Operating - $

Complementary Strategies – The following strategies may support Connected Vehicle technologies:
-Adaptive Signal Control
-Communications/Network upgrades (fiber)
-Install Bluetooth
-Install CCTV
-Controller Upgrades
-Signal ATMS
-Advanced Intersection Detection
-Traffic Management Center (TMC)
-Integrated Corridor Management (ICM)
-Data Management - Big Data

-Data Management - Transportation Data Analytics
-Performance Measurement
-Road Weather Information System (RWIS)
-Signal Phase and Timing (SPaT)
-Traffic Signal Preemption
-Regional Payment System

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://autocaat.org/Technologies/Automated_and_Connected_Vehicles/
https://www.its.dot.gov/pilots/
https://www.its.dot.gov/v2i/

1.5.4 Connected Vehicles – In-Vehicle Information

General Description – In-vehicle Information involves the delivery of information to drivers using Connected Vehicle technologies. The Connected Vehicle technologies can either be dedicated by short range communications between the vehicle and the roadside or wide-area cellular wireless technologies. The information content delivered to the driver is likely to come from private sector information providers working in cooperation with automotive suppliers. In-vehicle information allows different messages to individual drivers and enables drivers to have access to quality information to enable decisions regarding traffic condition, routes and other service availabilities.

Costs – Capital - $ Operating - $

Complementary Strategies – The following strategies may support Connected Vehicle technologies:
-Adaptive Signal Control
-Communications/Network upgrades (fiber)
-Install Bluetooth
-Install CCTV
-Controller Upgrades
-Signal ATMS
-Advanced Intersection Detection
-Traffic Management Center (TMC)
-Integrated Corridor Management (ICM)
-Data Management - Big Data
-Data Management - Transportation Data Analytics
-Performance Measurement
-Road Weather Information System (RWIS)
-Signal Phase and Timing (SPaT)
-Traffic Signal Preemption
-Regional Payment System
Conflicting Strategies – To be determined.
Example Benefit-Cost Ratio – To be determined.
Proven TSM&O Strategy Handout Link - To be determined.
Additional Information – To be determined.

1.5.5 Connected Vehicles – Probe Vehicle Data

General Description – Probe Vehicle Data makes use of Connected Vehicle technology to extract data from the carrier network and make it available to a central location. The data can range from instantaneous vehicle speed, vehicle location and vehicle identification to extremely detailed information regarding the performance of the engine, the vehicle and the driver.

Costs – Capital - $ Operating - $

Complementary Strategies – The following strategies may support Connected Vehicle technologies:
-Adaptive Signal Control
-Communications/Network upgrades (fiber)
-Install Bluetooth
-Install CCTV
-Controller Upgrades
-Signal ATMS
-Advanced Intersection Detection
-Traffic Management Center (TMC)
-Integrated Corridor Management (ICM)
-Data Management - Big Data
-Data Management - Transportation Data Analytics
-Performance Measurement
-Road Weather Information System (RWIS)
-Signal Phase and Timing (SPaT)
-Traffic Signal Preemption
-Regional Payment System

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information – To be determined.

Utilizing the methodology above, each strategy was assessed to outline is applicability.

1.5.6 Controller Upgrades

General Description – Upgrading an existing signal controller to an Advanced Transportation Controller (ATC) will allow transportation practitioners to pursue more advanced traffic management efforts. ATC's are required for certain projects such as Active Arterial Management (AAM), connected vehicle communications, and other activities. Controller upgrades are a key component in establishing some of the more advanced TSM&O efforts listed in this Strategy Guide.

Costs – Capital - $$ Operating - $

Complementary Strategies – Controller upgrades work well with or support these strategies:
-Adaptive Signal Control
-Install Bluetooth
-Install CCTV
-Communications/Network Upgrades (Fiber)
-Signal ATMS
-Advanced Intersection Detection
-Traffic Management Center (TMC)

-Integrated Corridor Management (ICM)
-Data Management - Big Data
-Data Management - Transportation Data Analytics
-Performance Measurement
-Road Weather Information System (RWIS)
-Signal Phase and Timing (SPaT)
-Traffic Signal Preemption

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.ite.org/standards/ATCController/
https://www.ite.org/standards/atc/index.asp
http://www.westernstatesforum.org/Documents/2013/presentations/ODOT_Spencer_FINAL_ATC_Standards.pdf

1.5.7 Install Bluetooth

General Description – Bluetooth readers provide point-to-point travel time information reading vehicle transponders and matching them at the different collection points to calculate a travel time. Bluetooth devices, such as smartphones and many newer vehicles, have a unique media access control (MAC) address which is transmitted short distances. In order to calculate travel time using Bluetooth, roadside Bluetooth readers are implemented at strategic locations along the corridor for which travel times are to be determined. The system works by having an initial Bluetooth reader pick up the MAC address and then a second Bluetooth reader farther along the corridor identify the same MAC address.

This information is then processed to calculate the travel time. Bluetooth readers can communicate with their central software using either cellular or Ethernet configurations. The Bluetooth readers can be deployed anywhere along the corridor but are often placed at existing signalized locations and connected to an Ethernet port on the Ethernet switch in the traffic signal cabinets for data transfer. Another option could be through independent cellular and solar powered locations, which are typically used for mid-block locations or remote intersections. The FDOT's Approved Products List (APL) currently has three types of Bluetooth readers/vendors; BlueTOAD, BlueMAC, and Iteris. Since Bluetooth technology has become more widely deployed in recent years, the cost of implementation for field devices is relatively low for the amount of useful data they provide. A disadvantage is that the Bluetooth devices which are being read can be turned off by the owner, making them impossible to read. Another disadvantage is the range of the Bluetooth readers can be limited, leading to missed potential data points. These disadvantages contribute to the low sample size Bluetooth readers collect. Previously, Bluetooth readers were not able to detect Bluetooth devices which had active connections to other Bluetooth devices (i.e., cell phone connected to vehicle), but now they can. Because of this advancement in Bluetooth reader technology, the match percentage is now typically about 15 percent of total vehicles passing the Bluetooth reader.

Costs – Capital - $$ Operating - $

Complementary Strategies – Bluetooth installation works well with or supports these strategies:
-Adaptive Signal Control
-Communications/Network Upgrades (Fiber)
-Install CCTV

-Controller Upgrades
-Signal ATMS
-Advanced Intersection Detection
-Traffic Management Center (TMC)
-Integrated Corridor Management (ICM)
-Data Management - Big Data
-Data Management - Transportation Data Analytics
-Performance Measurement
-Road Weather Information System (RWIS)
-Signal Phase and Timing (SPaT)
-Traffic Signal Preemption (Emergency Vehicles)

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/publications/fhwahop13029/ch2.htm
https://ops.fhwa.dot.gov/wz/p2p/pmwkshop053013/shaw/shaw.htm
http://roads.maryland.gov/OPR_Research/MD-12-SP909B4D-Bluetooth-Traffic-Detectors_Report.pdf

1.5.8 Signal Phase and Timing (SPaT)

General Description – Signal Phase and Timing (SPaT) is provided via dedicated short-range communications (DSRC) to appropriately equipped vehicles and/or applications with information relating to the approaching signal's phase and timing to next phase. For example, a motorist is approaching a major four-way intersection: the RSU relays information to the vehicle letting the driver know that the signal will change from red to green in 10 seconds; the computer then either directs the user to apply an appropriate speed or applies the speed automatically, limiting safety hazards while improving the fuel efficiency of the vehicle. Deploying this kind of technology will support safer and more efficient movements in connected vehicles.

Costs – Capital - $ Operating - $

Complementary Strategies – Signal Phase and Timing (SPaT) works well with these strategies in place:
-Communications/Network Upgrades
-Controller Upgrades
-Signal ATMS

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://arxiv.org/pdf/1710.05394
https://transportationops.org/sites/transops/files/Resource_SPaT_Implementation_Guidance%20_Ver_1.0_Dec_21_2016.pdf

1.5.9 Traffic Signal Preemption (Emergency Vehicles)

General Description – As defined by the 2003 MUTCD, Traffic Signal Preemption is "the transfer of normal operation of a traffic control signal to a special control mode of operation." Preemptive control is designed and operated to give the most important classes of vehicles the right-of-way at and through a signal. This right-of-way is usually achieved via a green signal on the approach of the vehicle requesting preemption. Preemptive is different from signal priority, which alters the existing signal operations to shorten or extend phase time settings to allow a priority vehicle to pass through an intersection. Some of the benefits associated with preemption include: improved response time/travel times for emergency vehicles; improved safety and reliability for vehicles receiving preemption right-of-way; and improved safety and clarity of right-of-way for other roadway users.

Costs – Capital - $$ Operating - $

Complementary Strategies – Traffic Signal Preemption works well with these other TSM&O strategies:

-Integrated Corridor Management (ICM)
-Active Arterial Management (AAM)
-Traffic Incident Management (TIM)
-Dynamic Message Sign(s)
-Emergency Vehicle Management
-Disaster Response & Evacuation
-Hazardous Materials Security & Incident Response

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/publications/fhwahop08024/chapter9.htm#9.1

1.5.10 Vision Enhancement for Crash Avoidance

General Description – Vision Enhancement for Crash Avoidance employs night vision and heads-up displays installed in advance to improve driver vision by technological enhancement. This strategy within connected vehicles technology is specifically appealing to rural areas, where wild animals can venture into roadways and cause crashes. Applied within urban or downtown areas; pedestrians can better be identified in the evening.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Vision Enhancement may work well with these strategies:

-Connected vehicle technologies
-Install CCTV
-Install Bluetooth
-Dynamic Message Sign(s)
-Communications/Network Upgrades (fiber)

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –

https://www.extremetech.com/extreme/193402-what-is-night-vision-how-does-it-work-and-do-i-really-need-it-in-my-next-car
http://ir.uiowa.edu/cgi/viewcontent.cgi?article=1112&context=drivingassessment

1.6 Strategies – Dynamic Strategies

The following strategies allow traffic operators to apply corrective transportation measures based on real-time information and traffic data. These strategies are intended to improve throughput and/or to re-route users away from potential hazards such as a disabled vehicle.

1.6.1 Dynamic HOV & Managed Lanes

General Description – Dynamic HOV & Managed Lanes is principally a "freeway within a freeway" where a set of lanes within the freeway are separated from the general-purpose lanes and are managed using a combination of tools and techniques (pricing, vehicle eligibility, and access control) in order to sustain optimal conditions. Typically implemented in areas of high congestion, Managed Lanes have been proven to provide enhanced travel time reliability and provide incentives to carpool or use transit along the corridors in which they are installed. Examples of Managed Lanes include HOV lanes, value priced lanes, or high occupancy toll (HOT) lanes. Managed Lanes solutions allow for transportation system user's "choice". This strategy involves dynamically changing the qualifications for driving in a HOV or Managed Lane(s). HOV lanes (also known as car pool lanes or diamond lanes) are restricted traffic lanes reserved at peak travel times or longer for exclusive use of vehicles with a driver and one or more passengers, including carpools, vanpools and transit buses. The normal minimum occupancy level is two or three occupants.

Many agencies exempt other vehicles, including motorcycles, charter buses, emergency and law enforcement vehicles, low emission vehicles, and/or single-occupancy vehicles from paying a toll. In an Active Transportation and Demand Management (ATDM) approach, the HOV lane qualifications are dynamically changed based on real-time or anticipated conditions on both the HOV and general-purpose lanes. Qualifications that can potentially be dynamically adjusted include the number of occupants (e.g., from two to three occupants), the hours of operation, and the exemptions (e.g., change from typical HOV operation to buses only). Alternatively, the HOV restrictions could be dynamically removed, allowing general use of the previously Managed Lane.

Costs – Capital - $$$ Operating - $$$

Complementary Strategies – Dynamic HOV & Managed Lanes work well with these other TSM&O strategies:

-Integrated Corridor Management (ICM)
-Dynamic Message Sign(s)
-Variable Speed Limit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Electronic Toll Collection
-Regional Payment System
-Travel Demand Management (TDM)
-Dynamic Pricing
-Corridor Pricing
-Predictive Traveler Information
-Pre-trip Travel Information
-Route Guidance

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – The Benefit-Cost Analysis of FDOT District 6's I-95 Express Lanes project, conducted using the TOPS-BC application, identified a BCR of 6.97. The methodology and inputs used for the BCA are provided in the Transportation Systems Management and Operations Benefit Cost Analysis Compendium (FHWA, 2015).

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/freewaymgmt/hov.htm
https://ops.fhwa.dot.gov/freewaymgmt/managed_lanes.htm

Utilizing the methodology above, each strategy was assessed to outline is applicability.

1.6.2 Dynamic Junction Control

General Description – Dynamic Junction Control is primarily a freeway and expressway application where lane assignments are controlled and dynamically assigned according to traffic conditions. Sensors installed in the ramps and mainline are used to determine traffic conditions and algorithms are used to assign lanes appropriately. For example, an inside right lane on the mainline could be closed in order to facilitate merging vehicles from an on-ramp. A free-flowing condition on the outside left lane from the on-ramp would be created to eliminate the merged weave, allowing for traffic to vacate the arterials more quickly and efficiently get cars onto the mainline during applicable time periods. For off-ramp locations, this may consist of assigning lanes dynamically either for through movements, shared through-exit movements, or exit-only.

For on-ramp locations, this may involve a dynamic lane reduction on the mainline upstream of a high-volume entrance ramp or might involve extended use of a shoulder lane as an acceleration lane for a two-lane entrance ramp which culminates in a lane drop.

Costs – Capital - $$$ Operating - $$

Complementary Strategies – Dynamic Junction Control works well with these other TSM&O strategies:
- -Integrated Corridor Management (ICM)
- -Dynamic Lane Use Control
- -Dynamic Merge Control
- -Dynamic Message Sign(s)
- -Predictive Traveler Information
- -Pre-trip Travel Information
- -Route Guidance

Conflicting Strategies – Dynamic Junction Control may not work well with Adaptive Ramp Metering, as both strategies are intended to relieve mainline congestion issues through ramp access. Literature regarding the combination of these two strategies is not currently available.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/publications/fhwahop14019/fhwahop14019.pdf

1.6.3 Dynamic Lane Reversal

General Description – Dynamic Lane Reversal considers an imbalance between directional flows during the morning peak hours and evening peak hours. Therefore, lanes are dynamically reassigned using overhead variable message signs, maximizing the available capacity to the dominant traffic flow direction. This is typically considered a freeway and expressway application and has the ability to maximize available capacity and better match the travel demand. However, for grade separated arterials, this strategy is also viable.

Typically, about half of the relevant stakeholders favor this strategy and see probable benefits, while others do not have the existing infrastructure or the need for such an application.

Costs – Capital - $$$ Operating - $$$

Complementary Strategies – Dynamic Lane Reversal works well with these other TSM&O strategies:
-Integrated Corridor Management (ICM)
-Dynamic HOV & Managed Lanes
-Dynamic Lane Use Control
-Dynamic Message Sign(s)
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Electronic Toll Collection
-Regional Payment System
-Dynamic Pricing
-Corridor Pricing
-Travel Demand Management (TDM)
-Predictive Traveler Information
-Pre-trip Travel Information
-Route Guidance

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/publications/fhwahop14019/ch5.htm
https://ops.fhwa.dot.gov/freewaymgmt/publications/frwy_mgmt_handbook/chapter8_01.htm

1.6.4 Dynamic Lane Use Control

General Description – Dynamic Lane Use Control makes use of overhead variable message signs that are lane specific. During an incident, certain lanes can be opened or closed depending on the location of an incident. Approaching traffic can also be slowed down in increments well in advance of an incident and/or directed to change lanes. This strategy has the ability to maximize available capacity and better match the travel demand. This application would ultimately inform travelers making them aware of an irregular occurrence ahead of time in order to eliminate secondary crashes. This may be a plausible application and some of our region's stakeholders have seen some merit in implementing it.

Costs – Capital - $$$ Operating - $$

Complementary Strategies – Dynamic Lane Use Control works well with these other TSM&O strategies:
-Integrated Corridor Management (ICM)

-Dynamic Message Sign(s)
-Work Zone Management
-Traffic Incident Management (TIM)
-Queue Warning System
-Predictive Traveler Information
-Pre-trip Travel Information
-Route Guidance

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/atdm/approaches/atm.htm

1.6.5 Dynamic Merge Control

General Description – Dynamic Merge Control, also known as dynamic late merger or dynamic early merge, is a technique that makes use of dynamic message signs or lane control signs approaching a merge point. The signs show advisory messages that encourage motorists to display direct and cooperative merging behaviors. It is typically applied on a part-time basis during congested conditions. This strategy allows the driver to be informed ahead of time and eliminate last minute weave conditions.

Improving merging behavior will have a significant influence on intersection capacity and could be used to improve the effectiveness of traffic management on the region's freeways and arterials. Areas without significant weaving may not benefit from this application, but it could be used in instances when a six-lane roadway section goes down to four.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Dynamic Merge Control works well with these other TSM&O strategies:
-Dynamic Message Sign(s)
-Work Zone Management
-Event Management
-Integrated Corridor Management (ICM)
-Traffic Incident Management (TIM)
-Queue Warning System
-Predictive Traveler Information
-Pre-trip Travel Information
-Route Guidance

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://mobility.tamu.edu/mip/strategies-pdfs/active-traffic/technical-summary/Dynamic-Merge-Control-4-Pg.pdf
https://ops.fhwa.dot.gov/wz/workshops/accessible/McCoy.htm

1.6.6 Dynamic Overflow Transit Parking

General Description – Dynamic Overflow Transit Parking is a favored strategy among transit agencies and cities where these services are provided. Sensors are used to monitor the availability of parking around transit facilities and park-and-ride locations. When the sensors indicate that parking is nearing capacity, dynamic message signs and other information delivery techniques are used to guide drivers to overflow parking locations. This strategy could improve the attractiveness of public transit to regional travelers by making it easier to find a parking space convenient to transit facilities. This would be particularly relevant to the SunRail project (which is wide reaching within the region). Parking facilities for these additional stops could incorporate dynamic message signs to inform the traveling public of available parking and when parking has been filled and offer other viable options.

Costs – Capital - $$ Operating - $

Complementary Strategies – Dynamic Overflow Transit Parking works well with these other TSM&O strategies:
-Dynamic Message Sign(s)
-Dynamic Parking Guidance and Reservation
-Dynamic Priced Parking
-Travel Demand Management (TDM)
-Route Guidance

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/atdm/approaches/apm.htm

1.6.7 Dynamic Routing

General Description – Dynamic Routing makes use of roadside variable message signs to direct traffic around an incident on the mainline of freeways and arterials. Dynamic Routing can also redirect motorists to less congested facilities. Traffic sensors along the highway can also be used to detect prevailing traffic conditions on the mainline and also in diversion routing. An algorithm can be used, or manual operator intervention, to dynamically change routing instructions based on congestion levels. Dynamic routing can also be achieved through the use of in-vehicle information systems; in specific cases where individual drivers can be given different re-routing instructions. Typically, the private sector would provide the in-vehicle equipment and the information content to be delivered to the driver. Examples of this include WAZE and recent versions of Google maps with traffic condition information.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Dynamic Routing works well with these other TSM&O strategies:
-Dynamic Message Sign(s)
-Work Zone Management
-Event Management
-Integrated Corridor Management (ICM)
-Traffic Incident Management (TIM)
-Queue Warning System
-Predictive Traveler Information
-En-route Driver Information

-Route Guidance

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://mobility.tamu.edu/mip/strategies-pdfs/active-traffic/executive-summary/dynamic-rerouting-1-pg.pdf

1.6.8 Dynamic Shoulder Lanes (Part-Time Shoulder Use)

General Description – Dynamic Shoulder Lanes, also known as Hard Shoulder Running (HSR), consist of sensors in the highway continuously monitoring traffic conditions to determine when the shoulders should be brought into operation. This provides the ability for a highway to act as a high-speed, higher capacity facility, with the shoulder used as a running lane. Implementation of this strategy may also require Variable Speed Limit, since the dynamic shoulder lane is usually at a slightly lower speed to keep within safety standards. Dynamic Shoulder Lanes are also known as "hard shoulder running" or temporary shoulder use.

Costs – Capital - $$$ Operating - $

Complementary Strategies – Dynamic Shoulder Lanes work well with these other TSM&O strategies:

-Dynamic Message Sign(s)
-Work Zone Management
-Integrated Corridor Management (ICM)
-Traffic Incident Management (TIM)
-Queue Warning System
-Predictive Traveler Information
-Route Guidance

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – The I-35W South project established in the Minneapolis-St. Paul area included high-occupancy toll (HOT) lanes, 2 new auxiliary lanes, Priced Dynamic Should Lane (PDSL), and ATM signing and strategies. The MnDOT identified a BCR of 6.0 for the project as a whole. (https://www.itsbenefits.its.dot.gov/ITS/benecost.nsf/ID/FDC8084ED7FACBC485257CA70071C641?OpenDocument&Query=Home)

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/publications/fhwahop15023/fhwahop15023.pdf
https://ops.fhwa.dot.gov/publications/fhwahop10023/chap4.htm

1.6.9 Variable Speed Limit

General Description – Variable Speed Limit, or Speed Harmonization, alerts drivers to imminent traffic congestion and provides a dynamic speed limit to slow down vehicles approaching the congestion. Sensors along the roadway detect when congestion or weather conditions exceed pre-determined thresholds and the system automatically reduces the speed limit to slow traffic and postpone the onset of congestion. The goal of Variable Speed Limit is to preemptively reduce travel speeds, which allows smooth traffic flow and avoids stop-and-go conditions. As congestion dissipates, speed limits may return to normal. Variable Speed Limit can also be used when weather leads to adverse driving conditions. Speed limits are reduced to encourage drivers to slow down during adverse weather conditions, improving safety. Once driving conditions normalize, speed limits are returned to normal.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Variable Speed Limit works well with these other TSM&O strategies:

-Dynamic Message Sign(s)
-Integrated Corridor Management (ICM)
-Traffic Incident Management (TIM)
-Active Arterial Management (AAM)
-Event Management
-Work Zone Management
-Retroreflective Signal Back Plates
-Innovative Intersection Designs

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/publications/fhwahop17003/index.htm
https://mobility.tamu.edu/mip/strategies-pdfs/active-traffic/technical-summary/Variable-Speed-Limit-4-Pg.pdf

1.7 Strategies – Travel Demand Management

Travel Demand Management strategies are intended to encourage and incentivize the use of alternative modes of transportation. This is usually carried out by either improving the convenience and/or mobility of those alternative modes, or by dis-incentivizing single-occupant vehicle (SOV) use through various pricing strategies.

1.7.1 Corridor Pricing

General Description – Electronic toll collection and dynamic pricing can also be extended to cover other modes of transportation along the corridor. In addition to tolls being varied by time of day or by prevailing traffic conditions, transit fares could also be varied, and parking fees could be varied in order to conduct demand management. This tactic provides the ability to create a balanced approach to operations and management of corridor facilities across multiple modes. It also helps to ensure that the users or travelers get the maximum value for their money by supporting optimized transportation operations. No current implementations are identified so far and additionally, nearly 1/3 of participants did not view it as a viable option at this point with so many other agreeable options (dynamic pricing). On the other hand, some stakeholders do acknowledge this strategy in their Master Plans and Long-Range Transportation Plans.

Corridor Pricing is similar to demand pricing, though instead of a focus on a given geographic area, this approach is concerned with multimodal congestion pricing strategies along a specific facility.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Corridor Pricing works well with these other TSM&O strategies:

- Integrated Corridor Management (ICM)
- Active Arterial Management (AAM)
- Travel Demand Management (TDM)
- Dynamic Message Sign(s)
- Variable Speed Limit
- Dynamic HOV & Managed Lanes
- Dynamic Shoulder Lanes
- Dynamic Routing
- Dynamic Lane Reversal
- Fixed Route Transit
- Express Bus / Limited Stop Bus
- Bus Rapid Transit
- Regional Payment System
- Park and Ride Lots
- Dynamic Parking Guidance and Reservation
- Dynamic Overflow Transit Parking
- Dynamic Priced Parking
- Electronic Toll Collection
- Dynamic Pricing
- Predictive Traveler Information
- Pre-trip Travel Information
- Route Guidance

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/publications/fhwahop09015/cp_prim7_05.htm

1.7.2 Demand Pricing

General Description – Another form of electronic toll collection is Demand Pricing, or congestion/cordon pricing. This is a fee or tax paid by users to enter a restricted area, usually within a city center, as a part of a demand management strategy to relieve congestion within that area. Travelers would simply pay a fee if they reach within a certain radius of the area of restriction. In most cases, the objective of this strategy is to relieve congestion within the restricted area; not only for traffic, but for parking as well. Whereas dynamic pricing (variable tolls) is generally concerned with existing toll facilities, demand pricing is more concerned with congestion management in a geographic area (e.g., CBD, event location, etc.).

This strategy could be used to deter drivers from entering metropolitan areas during major events or during peak hours of the day. It would encourage users to park and ride into these restricted areas – by effectively getting travelers to ride into the controlled area, rail systems and transit can ultimately benefit. Demand Pricing can be found in London, Singapore, and Stockholm. There is much validity in this strategy due to the nature of it discouraging high levels of traffic and promoting transit services a truly integrated multi-modal system.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Demand Pricing work well with these other TSM&O strategies:

-Active Arterial Management (AAM)
-Travel Demand Management (TDM)
-Dynamic Message Sign(s)
-Variable Speed Limit
-Fixed Route Transit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Regional Payment System
-Park and Ride Lots
-Dynamic Parking Guidance and Reservation
-Dynamic Overflow Transit Parking
-Dynamic Priced Parking
-Electronic Toll Collection
-Predictive Traveler Information
-Pre-trip Travel Information
-Route Guidance

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – The Seattle Metropolitan area found that over a 30-year period, its systemwide variable tolling system could exceed $28 billion in benefits, resulting in a 6.00 BCR. (from ITS Benefits, Costs, and Lessons Learned. 2017 FHWA JPO. FHWA-JPO-17-500)

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.sfcta.org/transportation-planning-and-studies/congestion-management/mobility-access-and-pricing-study-home
https://ops.fhwa.dot.gov/congestionpricing/strategies/involving_tolls/zone_based.htm

1.7.3 Dynamically Priced Parking

General Description – Dynamically Priced Parking is very much how it sounds. It makes use of smart parking meter technology and communications between parking meters in a central back office where, based upon parking garage capacity, parking rates are varied according to the demand for parking. Typically, the rates will be varied to achieve an occupancy rate of between 60% and 80% (which is regarded as optimum) to service parking demand, while minimizing the time taken to find a space. It should be noted that this tool can have a dual effect on downtown parking. In the first instance, it becomes easier to find a parking space and to maximize the utilization of parking spaces. In the second instance, this strategy will support zeroing out of parking meters when the occupant leaves, requiring the next occupant to pay the full price. This can have a significant impact on parking revenue.

Costs – Capital - $ Operating - $

Complementary Strategies – Dynamically Priced Parking works well with these other TSM&O strategies:
-Dynamic Message Sign(s)
-Dynamic Parking Guidance and Reservation
-Dynamic Overflow Transit Parking
-Travel Demand Management (TDM)
-Route Guidance

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.iea.org/media/workshops/2016/behaviour/Session_2_Ng.pdf
http://www.nyc.gov/html/dot/html/motorist/parksmart.shtml

1.7.4 Dynamic Fare Reduction

General Description – Dynamic Fare Reduction utilizes sensors to monitor traffic and transportation conditions along the corridors. In times of high congestion for private vehicle traffic, the transit fares along the corridors are reduced to encourage a switch from private vehicles to transit. Traveler information systems communicate this fair change to the traveling public. Passenger counters and other sensors are used to establish the occupancy of transit vehicles to ensure that sufficient spare capacity exists to accommodate the anticipated shift. As part of an ICM implementation, this strategy would make transit more attractive along regional corridors. It would also provide transit operators with the flexibility to adjust vehicle assignments to optimize operations and costs. This strategy is noteworthy but in instances where counties and MPOs drive the cost of fares, it would need to be considered by those institutions before a definitive decision is made whether to implement this strategy.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Dynamic Fare Reduction works well with these TSM&O strategies, including:

-Travel Demand Management (TDM)
-Event Management
-Work Zone Management
-Integrated Corridor Management (ICM)
-Active Arterial Management (AAM)
-Predictive Traveler Information
-En-route Driver Information
-Queue Jump
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Dynamic Transit Capacity Assignment
-Transfer Connection Protection
-Transit Traveler Information
-Transit Signal Priority
-Fixed Route Transit
-Light Rail Transit
-Heavy Rail Transit
-Regional Payment System
-Electronic Transit Ticketing

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –

https://ops.fhwa.dot.gov/atdm/approaches/adm.htm

1.7.5 Dynamic Pricing

General Description – Through electronic toll collection technologies, Dynamic Pricing (or variable tolls) takes this concept one step further by enabling the use of dynamic pricing on toll roads in the region. Pricing can vary dynamically based on time of day or sensors can be used to establish prevailing traffic conditions to drive the variation in tolls. In most cases, the objective of this strategy is to maintain the target level of service on the toll road. For instance, if traffic is moving slowly during Peak PM hours, tolling authorities may reduce pricing to encourage the use of an Express Lane (See the previous Managed Lanes Section). However, if the capacity of Express Lanes exceeds the intended use and speeds begin to drop, pricing is driven up to deter travelers from entering the Express Lanes. Dynamic Pricing provides an additional demand management tool that helps with operational efficiency and preserving the customer experience. Several major cities in the United States implement dynamic pricing through the use of Express Lanes or Managed Lanes: Seattle, Atlanta, Houston and Miami. The I-4 Ultimate PPP project, currently under construction with anticipated completion in 2021, will have Express Lanes that will dynamically change pricing. This strategy is ultimately a congestion management strategy first and a revenue generation strategy second.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Dynamic Pricing work well with these other TSM&O strategies:

-Integrated Corridor Management (ICM)
-Dynamic Message Sign(s)
-Variable Speed Limit
-Dynamic HOV & Managed Lanes
-Dynamic Shoulder Lanes
-Dynamic Routing
-Dynamic Lane Reversal
-Fixed Route Transit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Regional Payment System
-Park and Ride Lots
-Travel Demand Management (TDM)
-Electronic Toll Collection
-Corridor Pricing
-Predictive Traveler Information
-Pre-trip Travel Information
-Route Guidance

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – The Seattle Metropolitan area found that over a 30-year period, its systemwide variable tolling system could exceed $28 billion in benefits, resulting in a 6.00 BCR. (from ITS Benefits, Costs, and Lessons Learned. 2017 FHWA JPO. FHWA-JPO-17-500)

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/congestionpricing/faq/index.htm#faq_05
https://ops.fhwa.dot.gov/publications/fhwahop13007/pmlg7_0.htm

1.7.6 Electronic Toll Collection

General Description – Regional toll road users can pay for tolls without the use of cash and without the need to stop at a toll plaza. Electronic toll collection system users establish a prepaid account with the relevant toll road operator and have a specially designed transponder sticker installed on the windshield of the vehicle. Vehicles can then pass through Express Lanes at toll plaza's obviating the need to stop. The prepaid account is linked to a credit card and automatic transfers are made by the back office. Alternatively, users can visit a customer service location and add cash to the prepaid account. Electronic toll collection has been implemented extensively in the region through the EPass and SunPass systems on both the Central Florida Expressway (CFX) Authority and Florida's Turnpike Enterprise.

Costs – Capital - $$$ Operating - $$

Complementary Strategies – Electronic Toll Collection work well with these other TSM&O strategies:

-Integrated Corridor Management (ICM)
-Dynamic Message Sign(s)
-Variable Speed Limit
-Dynamic HOV & Managed Lanes
-Dynamic Shoulder Lanes
-Dynamic Routing
-Dynamic Lane Reversal
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Regional Payment System
-Travel Demand Management (TDM)
-Dynamic Pricing
-Corridor Pricing
-Predictive Traveler Information
-Pre-trip Travel Information
-Route Guidance

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://mobility.tamu.edu/mip/strategies-pdfs/traffic-management/technical-summary/Electronic-Toll-Systems-4-Pg.pdf

1.7.7 Electronic Transit Ticketing

General Description – Electronic Transit Ticketing enables transit travelers to pay for transit tickets without cash. The transit tickets, used for rails and buses, can be based on a case-by-case basis, weekly, monthly or even annually. Travelers are able to pay using a special smart card, credit card or smart phone. Electronic transit ticketing would provide travelers in the area with a higher level of convenience and customer service. Regionally, stakeholders identify the use of this strategy; electronic transit ticketing is a more efficient method of ticket entry, processing and marketing for companies in the railways, flight and other transport and even within entertainment industries.

Other areas of the United States have implemented this strategy, most notably the Metro System in Houston, Texas.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Electronic Transit Ticketing works well with these TSM&O strategies, including:

-Travel Demand Management (TDM)
-Integrated Corridor Management (ICM)
-Active Arterial Management (AAM)
-Predictive Traveler Information
-En-route Driver Information
-Queue Jump
-Park and Ride Lots
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Transit Traveler Information
-Dynamic Transit Capacity Assignment
-Dynamic Fare Reduction
-Transfer Connection Protection
-Transit Signal Priority
-Regional Payment System
-Electronic Transit Ticketing

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/publications/fhwahop16023/ch3.htm
https://www.bostonfed.org/-/media/Documents/PaymentStrategies/commuting-gets-a-little-easier-with-transit-mobile-payments.pdf
https://ops.fhwa.dot.gov/publications/fhwahop16023/ch4.htm
http://www.state.nj.us/transportation/refdata/research/reports/FHWA-NJ-2015-003.pdf
http://www.nj.gov/transportation/refdata/research/reports/FHWA-NJ-2017-010.pdf

1.7.8 Emissions Testing and Mitigation

General Description – Emissions Testing and Mitigation is truly about traffic and the emissions expelled from idling vehicles. There are emissions sensors to determine traffic conditions and emissions levels in the vicinity of roads and highways. Based on this data, algorithms are used to re-route traffic, change traffic signal timings and assist in distributing emissions. These systems can also identify high emitting vehicles and provide information to fleet operators to enable them to tune the fleet.

Emissions and fuel consumption go hand in hand and can be used to measure the effects of traffic, particularly on arterials where acceleration and deceleration are more variable – providing the region with a more effective arterial traffic management system. Pinellas County in Florida has implemented air quality management as part of their ATMS.

Costs – Capital - $$ Operating - $

Complementary Strategies – Emissions Testing and Mitigation works well with these TSM&O strategies, including:

-Dynamic Message Sign(s)
-Event Management
-Work Zone Management
-Travel Demand Management (TDM)
-Traffic Incident Management (TIM)
-Predictive Traveler Information
-En-route Driver Information
-Route Guidance
-Dynamic Pricing
-Corridor Pricing
-Demand Pricing
-Variable Speed Limit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Queue Jump
-Transit Traveler Information
-Fixed Route Transit
-Electronic Toll Collection
-Regional Payment System
-Freight Mobility

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information – http://www.epa.illinois.gov/topics/air-quality/mobile-sources/vehicle-emissions-testing/index

1.7.9 Regional Payment System

General Description – A Regional Payment System enables regional travelers to pay for transit tickets, tolls and parking fees without the use of cash. The system is an integrated, interoperable electronic fare payment system that can be utilized by all modes at all times; making it easier and convenient for travelers to use. Transportation agencies benefit from simplified transactions, streamlined revenue collection, improved efficiency and lower transaction costs. Electronic payment devices such as smart cards or smart phone applications enable travelers to pay for a range of transportation services. The electronic payment services are managed by a central back office that manages the transactions and also handles clearance to ensure that the service provider receives the appropriate fee. Further research is needed to extend these systems across all modes and address interoperability. SunPass/EPASS is only implemented in a limited capacity (toll systems and parking payments) so there is much to consider expanding this strategy further into a seamless regional payment system.

Costs – Capital - $$$ Operating - $$

Complementary Strategies – Regional Payment System works well with these TSM&O strategies, including:

-Travel Demand Management (TDM)

-Integrated Corridor Management (ICM)
-Active Arterial Management (AAM)
-Predictive Traveler Information
-En-route Driver Information
-Queue Jump
-Park and Ride Lots
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Transit Traveler Information
-Dynamic Transit Capacity Assignment
-Dynamic Fare Reduction
-Transfer Connection Protection
-Transit Signal Priority
-Electronic Transit Ticketing

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.trb.org/main/blurbs/175863.aspx
https://ntl.bts.gov/lib/jpodocs/repts_te/14073_files/sec_2_6.htm

1.7.10 Travel Demand Management

General Description – Travel Demand Management encompasses a range of techniques designed to influence traveler behavior by either reducing the demand for travel or spreading the demand in space and time. Travel demand management techniques include congestion pricing, ridesharing, development of transit alternatives, promotion of non-motorized transportation such as cycling and pedestrian activities, telecommuting and land use management. In most major US urban areas, this is usually performed under the auspices of the MPO. In order to accommodate future growth and transportation demand, it will be necessary to consider travel demand management strategies in addition to capital investment programs. This tactic is thoroughly supported among the take holders, since these agencies are able to influence the choices of the travelling public.

Mode choices normally overlooked may be advertised in such a way that those options truly are viable options. Bike Share and/or Car Share Programs would also be included in this strategy.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Travel Demand Management (TDM) works well with these other TSM&O strategies, including:
-Dynamic Message Sign(s)
-Event Management
-Work Zone Management
-Traffic Incident Management (TIM)
-Predictive Traveler Information
-Pre-Trip Travel Information
-En-route Driver Information
-Transit Traveler Information

-Route Guidance
-Variable Speed Limit
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Queue Jump
-Fixed Route Transit
-Regional Payment System
-Freight Mobility

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/tdm/index.htm
https://mobilitylab.org/about-us/what-is-tdm/
http://www.vtpi.org/tdm/
http://www.cmap.illinois.gov/documents/10180/37082/TDM_StrategyAnalysis_20090318final.pdf/fc34c2e0-1eec-4acd-a2f8-e4c01a9a215d

1.7.11 Dynamic Ridesharing (D-Ride)

General Description – Dynamic Ridesharing makes use of information management systems to precisely match the supply of rides to the demand for rides. This enables travelers who wish to ride share to gain access to information on the possibilities. Dynamic Ridesharing helps with the challenge of providing cost-effective transit in major US cities. By increasing vehicle occupancy, more highway capacity can be utilized, and by minimizing the number of duplicate trips being made by single occupancy vehicles, demand can be managed. This could be of particular relevance during the construction period for the I-4 Ultimate project. There are numerous examples of ridesharing systems supported by the public sector across major cities in the USA. These include the commuter project in San Francisco, the Los Angeles smart traveler project, the Bellevue smart traveler project in Washington State and the Sacramento area real-time ridesharing matching project. There is also significant private sector activity in this area, and currently, the most prominent example of this is UBER and LYFT.

Costs – Capital - $ Operating - $

Complementary Strategies – Dynamic Ridesharing works well with these other TSM&O strategies:
-Pre-Trip Travel Information
-Event Management
-Work Zone Management
-Travel Demand Management (TDM)
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Queue Jump
-Transit Traveler Information
-Fixed Route Transit
-Regional Payment System
-Electronic Transit Ticketing

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://dynamicridesharing.org/
https://ridesharechoices.scripts.mit.edu/home/wp-content/papers/AMEY_Thesis_Final.pdf
https://ops.fhwa.dot.gov/congestionpricing/value_pricing/pubs_reports/projectreports/sb_sride_dynshare/index.htm

1.8 Strategies – Emergency Management

Emergency Management strategies are intended to improve evacuations in the event of natural disasters or improve emergency response to major incidents.

1.8.1 Disaster Response and Evacuation

General Description – Disaster Response and Evacuation uses ITS to enhance the ability of the surface transportation system to respond to disasters. The user service provides enhanced access to the scene for incident response personnel and resources via smart phones or in-vehicle instrumentation. It provides better information about the transportation system within the vicinity of the disaster and provides more efficient and safer evacuations for the general public, if needed. In addition, the transportation system includes a wealth of trained professionals and resources that constitute a portion of the disaster response. The use of this technology through this lens is to prioritize, allocate and track these personnel and resources; providing a more effective response to disasters. Not only would these responses be more efficient, ITS solutions to disaster response and evacuation would help minimize confusion to the traveling public during a stressful event such as a hurricane evacuation.

There are no current implementations known, but Florida deals with an abundance of natural disasters due to hurricanes and tornados. Hurricane evacuations alone take an enormous of amount of preparation and coordination between multiple agencies, let alone adding a transportation network moving people to safety. Stakeholders are on board with this application due to Florida's disasters and truly, to have a fully ICM approach, this tactic must be included because this region must address these concerns.

Costs – Capital - $ Operating - $

Complementary Strategies – Disaster Response and Evacuation works well with these other TSM&O strategies:

-Integrated Corridor Management (ICM)
-Dynamic Message Sign(s)
-Traffic Signal Preemption (Emergency Vehicles)
-Emergency Vehicle Management

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.fdot.gov/EmergencyManagement/documents.shtm

1.8.2 Emergency Notification & Personal Security

General Description – Emergency Notification and Personal Security enables travelers to notify appropriate response personnel regarding the need for assistance due to emergency or non-emergency situations. Notifications can be initiated manually or automatically based on data. This strategy also includes threat alerts to secure areas and wide-area alerts to inform the public in the case of an emergency. This application is particularly appealing due to the number of visitors that come to Florida's Gulf Coast. They have very little or no knowledge of the area and therefore during emergencies may miss out on critical moments just trying to find a hospital.

Instead, this ITS application can notify the correct authorities to respond more quickly. Another benefit is the use of this for severe weather alerts due to Florida's subjection to hurricanes and other natural elements. Again, this could also be used for transit as well. Agencies could have supportive roles, tied to the network and able to alert the proper authorities when incidents do occur.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Emergency Notification & Personal Security works well with these other TSM&O strategies:

-Integrated Corridor Management (ICM)
-Dynamic Message Sign(s)
-Emergency Vehicle Management

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://trid.trb.org/view.aspx?id=715079

1.8.3 Emergency Vehicle Management

General Description – Emergency Vehicle Management reduces the response time to incidents for emergency responders by making use of automated vehicle location and computer-aided dispatching technologies. Unlike Opticom, where signals pick up sensors from emergency vehicles and turn lights green to allow those vehicles to move through intersections easily (i.e. move the affected signals "out of step"), this application would open a certain corridor or pathway to the incident by turning the entire pathway green. Therefore, emergency vehicles can flow relatively seamlessly to an incident. This has been implemented by a large number of fire, police and ambulance services across the country. This strategy would form part of an overall incident management program for the region; which is a goal for the area. Some agencies in the region already have an incident management coalition and the activities of this group could be reinforced by emergency vehicle management systems that improve the efficiency of emergency management services in vehicle dispatch. It should be noted that the software driving this application is fairly expensive.

Costs – Capital - $$ Operating - $

Complementary Strategies – Emergency Vehicle Management works well with these other TSM&O strategies:

-Automated Vehicle Location (AVL)
-Integrated Corridor Management (ICM)
-Traffic Incident Management (TIM)

-Traffic Management Center (TMC)
-Traffic Signal Preemption (Emergency Vehicles)
-Adaptive Signal Control
-Road Ranger Service Patrol
-Emergency Notification & Personal Security
-Hazardous Materials Security & Incident Response
-Disaster Response & Evacuation

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information – To be determined.

1.8.4 Hazardous Materials Security & Incident Response

General Description – Hazardous Materials Security and Incident Response is established and managed using a centralized hazardous materials database, which tracks sensitive security hazardous materials shipments. If a freight truck is involved in an incident, emergency personnel can be notified prior to arrival at the scene that hazardous materials, or "HAZMAT" for short, are involved and the appropriate safety measures can be done prior to exposure. In the past, first responders would show up to an accident, find out hazardous materials were involved and notify the correct personnel to assist in containment of those substances – sometimes exposing first responders to dangerous supplies. HAZMAT Security and Incident Response supports a more effective incident management when hazardous materials are involved and given the level of freight movement across the State of Florida, this strategy has great relevance to the FDOT District 1 area. The question remains as to who would maintain this database. The Hazardous Materials Information Resource System (HMIRS) is a Department of Defense (DOD) automated system developed and maintained by the Defense Logistics Agency.

HMIRS is the central repository for Material Safety Data Sheets (MSDS) for the United States government military services and civil agencies. It also contains value-added information input by the service/agency focal points. If the Department of Defense has already implemented this application, the demarcation points would need to be clearly defined. Overall, this strategy is favorable (due to the advancement of safety precautions).

Costs – Capital - $ Operating - $

Complementary Strategies – Hazardous Materials Security & Incident Response works well with these other TSM&O strategies:
-Automated Roadside Safety Inspection
-Commercial Vehicle Administration Process
-Commercial Vehicle Electronic Clearance
-Dynamic Message Sign(s)
-Integrated Corridor Management (ICM)
-Active Arterial Management (AAM)
-Dynamic Routing
-Hazardous Materials Security & Incident Response
-On-board Safety and Security Monitoring
-Pre-trip Travel Information
-Route Guidance

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.faa.gov/about/office_org/headquarters_offices/ash/ash_programs/hazmat/
https://hazmatonline.phmsa.dot.gov/services/publication_documents/Enhanced_Security_02_22_12%201.pdf

1.9 Strategies – Information and Data Management

The strategies described below are concerned with collecting, storing and analyzing data, and with disseminating information to transportation practitioners and users.

1.9.1 Archived Data

General Description – Archiving data is the process of moving data that is no longer actively used to a separate storage device for long-term retention. This data may be older information, but it is still important to a particular agency and could be used for future reference. Additionally, there are regulatory compliance laws regarding the retention of this information. This strategy recognizes the value of data that can be generated by ITS. In particular, data from transportation operations can be brought to a centralized location and used for performance management that can then be repurposed for future planning. Data is likely to be generated by multiple sources, including freeway management, traffic signal control, transit ticketing and electronic toll collection systems, among others. This strategy takes a look at the best way for data to be stored, named, shared, disseminated and easily accessible.

The volume of data transportation agencies see, store and have available within the region is growing in leaps and bounds. Advances in data science help to reduce the cost of data storage and management. The region is also continuing to conduct performance measures, discussed later in this section, on transportation initiatives and develop results-driven investment programs. The use of data to show performance measurements and return-investments is an important element when it comes to determining and funding for future initiatives.

Costs – Capital - $ Operating - $

Complementary Strategies – Archived Data works well with these other TSM&O strategies:
-Data Management - Big Data
-Data Management - Transportation Data Analytics
-Performance Measurement

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.fdot.gov/planning/statistics/symposium/2014/BigDataTransport.pdf
http://www.cflsmartroads.com/projects/design/tsp/Regional_integrated_corridor_mgmt/FDOT%20Production%20Big%20Data%20Platform.pdf

1.9.2 Asset Management

General Description – ITS systems are comprised of a complex network of fiber optic cables, electrical cables, wireless communications, and an array of field devices. This strategy is a central location, or database, where assets are recorded and managed; basically, a way to inventory an entire transportation system and be able to track where this equipment is installed and maintained. Keeping track of the constantly changing system, whether it is expansion, maintenance, and/or upgrades is imperative. An asset management database tool would help manage the overall ITS system. This database would help operate and maintain ITS deployments throughout the region. Furthermore, there is the idea of sharing resources regionally, where applicable, to cut down on costs.

Asset Management has been brought up as potentially serving as a shared resource; for example, one regional asset management database is agreed upon and administrative positions help to maintain this database. Field crews can call up this resource, let them know what equipment has been installed, maintained or removed and this database keeper can input the information – serving as record keeper and a Quality Control process combined.

Costs – Capital - $ Operating - $

Complementary Strategies – Asset Management supports these TSM&O strategies:
-Integrated Corridor Management (ICM)
-Active Arterial Management (AAM)
-Traffic Incident Management (TIM)
-Event Management
-Work Zone Management

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.fdot.gov/planning/TAMP/TAMP-2015.pdf

1.9.3 Data Management – Big Data

General Description – Big Data makes use of data analytics where techniques have been developed beyond transportation to handle the emerging big data sets that transportation systems generate. The strategy involves a data platform technology to bring together multiple disparate data sets into a common format and location. This also involves the use of discovery tools to understand patterns and trends from within the data and develop new analytics for performance management and results driven investment programs. Planners and engineers in Florida have observed that the application of Big Data techniques through the implementation of a Big Data Solution Center will yield substantial value to transportation planning and operations in the region. High-performance big data analytics, such as text mining, have the potential to generate significant value from data, providing answers and delivering a competitive advantage to decision-makers. Even information gathered from social media, electronic articles and third-party vendors are open sources of readily available information, and also maintain databases of user related information that can be accessed in real-time. The information that can be derived from big data holds the power to revolutionize traffic operations and transportation planning. It holds the potential for the future adoption of scientific approaches to traffic engineering and transportation management. The importance of accurate, reliable data in transportation analyses is paramount to sound decisions in planning, designing, operating, and maintaining the transportation system.

Costs – Capital - $ Operating - $

Complementary Strategies – Data Management - Big Data works well with these other TSM&O strategies:

-Archived Data
-Data Management - Transportation Data Analytics
-Performance Measurement

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.fdot.gov/planning/statistics/symposium/2014/BigDataTransport.pdf
http://www.cflsmartroads.com/projects/design/tsp/Regional_integrated_corridor_mgmt/FDOT%20Production%20Big%20Data%20Platform.pdf

1.9.4 Data Management – Transportation Data Analytics

General Description – Transportation Data Analytics can be used to guide effective operations and planning within FDOT District 1. The University of Maryland has provided the use of a "Regional Integrated Transportation Information System (RITIS)" - an automated data sharing, dissemination, and archiving system that includes many performance measure, dashboard, and visual analytics tools that help agencies to gain situational awareness, measure performance, and communicate information between agencies and to the public.

FDOT already sends their data to RITIS or other data gathering platforms. Between this already implemented strategy and the pilot Big Data initiative, data will receive the focus needed from multiple agencies in order to produce performance measures that quantitatively define how ITS benefits a region.

Costs – Capital - $ Operating - $

Complementary Strategies – Data Management - Transportation Data Analytics works well with these other TSM&O strategies:

-Archived Data
-Data Management - Big Data
-Performance Measurement

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.fdot.gov/planning/statistics/symposium/2014/BigDataTransport.pdf
http://www.cflsmartroads.com/projects/design/tsp/Regional_integrated_corridor_mgmt/FDOT%20Production%20Big%20Data%20Platform.pdf

1.9.5 Dynamic Message Signs

General Description – Dynamic Message Signs are electronic signs on the highway that provide drivers with real-time traffic alerts. Operated by staff at a Traffic Management Center (TMC), Dynamic Message Signs are effective at introducing new, pertinent information to drivers as they travel along arterials and freeways. Information provided include detour information, stop-and-go traffic, lane closures, estimated travel time to specific interchanges, parking information, etc. As Dynamic Message Signs provide on-the-fly information, they are required equipment for most dynamic traffic management strategies.

Costs – Capital - $$ Operating - $

Complementary Strategies – Dynamic Message Signs are supplemental to the following strategies:

-Dynamic Merge Control
-Dynamic Junction Control
-Dynamic Lane Reversal
-Dynamic HOV & Managed Lanes
-Dynamic Shoulder Lanes
-Queue Warning System
-Dynamic Routing
-Integrated Corridor Management (ICM)
-Traffic Incident Management (TIM)
-Dynamic Pricing
-Freight Mobility
-Emergency Notification
-Event Management
-Work Zone Management

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/travelinfo/dms/signs.htm

1.9.6 Dynamic Parking Guidance and Reservation

General Description – Dynamic Parking Guidance and Reservation is a good strategy when it comes to downtowns or special events that will fill parking garages to capacity, creating traffic on arterials. Sensors in both off-street and on-street parking slots are used to determine if a slot is available or occupied. This information is transmitted to a central back office, which then transmits the information to motorists looking for a parking space. The information to the motorist could then be delivered via dynamic message signs, to parking structures, or through the use of in-vehicle information technologies or smart phones.

A more advanced meshed version of dynamic parking reservation would also enable motorists to make advance reservation of parking spaces for an additional fee. Motorists can also be offered guidance to navigate to available slots.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Dynamic Parking Guidance and Reservation works well with these other TSM&O strategies:

-Dynamic Message Sign(s)
-Dynamic Overflow Transit Parking
-Dynamic Priced Parking
-Travel Demand Management (TDM)

-Route Guidance

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://trrjournalonline.trb.org/doi/pdf/10.3141/2324-09
https://www.hindawi.com/journals/jat/2017/9452506/abs/

1.9.7 Dynamic Wayfinding

General Description – Dynamic Wayfinding uses smart phone technology that displays icons and information in an easily understood format which can be superimposed on the smart phone screen, enabling the user to access information regarding service possibilities in the locale or to be provided with navigation instructions to get to a specific destination. This technology is typically used in large convention centers, hotels and hospitals, where the strategy truly optimizes user experience. FDOT District 1 can mirror this strategy through a transportation lens by providing data for other route guidance and navigation strategies to provide a comprehensive end-to-end solution to guide and support travelers from original origin to final destination.

Costs – Capital - $ Operating - $

Complementary Strategies – Dynamic Wayfinding works well with these other TSM&O strategies:
-Pre-Trip Travel Information
-Event Management
-Work Zone Management
-Travel Demand Management (TDM)
-Integrated Corridor Management (ICM)
-Express Bus / Limited Stop Bus
-Bus Rapid Transit
-Park and Ride Lots
-Queue Jump
-Transit Traveler Information
-Fixed Route Transit
-Regional Payment System
-Electronic Transit Ticketing

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/atdm/approaches/adm_table/index.htm

1.9.8 En-Route Driver Information

General Description – Smart phones or in-vehicle information systems are used to provide driver information during the course of the journey, known as En Route Driver Information. Roadside dynamic message signs can also provide en route driver information on a more limited basis. The driver information is based on data from multiple sources fused together into a central database. This data is packaged into meaningful information and delivered to drivers. There is significant private sector involvement in the delivery of information to drivers in vehicles and this forms part of the Connected Vehicle program. Similar to pre-trip traveler information, en route driver information is being provided within the context of 511 system deployments with private sector entities, including WAZE and Google who also provide this via smart phones on a nationwide basis. Delivering quality traveler information en route allows drivers to improve decision making. This would optimize the use of the transportation network, making the best use of current transportation capacity in the region.

Costs – Capital - $$ Operating - $$

Complementary Strategies – En-Route Driver Information works well with these other TSM&O strategies:

-Dynamic Message Sign(s)
-Pre-Trip Travel Information
-Predictive Traveler Information
-Queue Warning System
-Traffic Incident Management (TIM)
-Event Management
-Work Zone Management
-Travel Demand Management (TDM)
-Transit Traveler Information

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.fhwa.dot.gov/publications/research/operations/its/98031/devtravel.pdf
https://www.fhwa.dot.gov/publications/research/operations/its/jpo99038/fotatis.pdf

1.9.9 Performance Measurement

General Description – Performance Management, or Performance Measurement, is an important strategy that is heavily associated with system reporting. This strategy employs sensors to collect data regarding transportation system performance and reports back to a back-office system to analyze performance, create reports and analytics. Performance measures are highly associated with ICM and AAM Programs due to the real-time nature of system management and the ability to report on effective or ineffective transportation management plans. The development of these measurements generally includes:

1. Data Collection
2. Development of Baseline Plans
3. Establishment of Performance Measures
4. Establishment of Initial Performance Targets
5. Use of Real-Time Data Inputs (Travel Time, Incident Reports, Weather, Volumes, Freight, parking, Numbers of Devices, etc.)
6. Reporting and Analysis

It is important to note the last step in this process, Reporting and Analysis. Agencies create reports daily, weekly and monthly to report on how the transportation system is working and how effective transportation management has been performed. Some items these reports portray may include:

1. System Benefits
2. System Health (ITS and Signal System)

3. Corridor Travel Time Reliability Measures
Once these items are captured over a certain period of time, it is important to analyze these performance measures/reports both quantitatively and qualitatively.

Costs – Capital - $ Operating - $

Complementary Strategies – Performance Measurement works well with these other TSM&O strategies:

-Archived Data
-Data Management - Big Data
-Data Management - Transportation Data Analytics

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.fdot.gov/planning/statistics/symposium/2014/BigDataTransport.pdf
http://www.cflsmartroads.com/projects/design/tsp/Regional_integrated_corridor_mgmt/FDOT%20Production%20Big%20Data%20Platform.pdf

1.9.10 Predictive Traveler Information

General Description – Predictive Traveler Information uses data from multiple sources that has been fused together to create a comprehensive picture of current traffic conditions. A special purpose algorithm is then applied to make short-term predictions regarding future traffic conditions. This information is supplied to drivers through a variety of information delivery techniques including roadside dynamic message signs, mobile applications and in-vehicle information systems. This strategy improves the effectiveness of traveler information by informing drivers of conditions they are likely to encounter further along the highway, providing time for diversion and behavior adaptation. The extra time bought by these predictions may also improve the performance of incident management systems. This strategy has been implemented by the land transport authority in Singapore using a specially developed algorithm from IBM. The application of this strategy would include historical data and all stakeholders would be directly impacted, due to each agency disseminating travel time data to the RTMC and third-party applications and receiving traffic volumes and other data to aid in the operation of their respected region.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Predictive Traveler Information works well with these other TSM&O strategies:

-Dynamic Message Sign(s)
-Pre-Trip Travel Information
-Traffic Incident Management (TIM)
-Event Management
-Work Zone Management
-Travel Demand Management (TDM)
-Transit Traveler Information

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://ops.fhwa.dot.gov/publications/fhwahop15029/chap3.htm
http://www.fdot.gov/research/completed_proj/summary_te/fdot_bc355_03.pdf
https://ntl.bts.gov/lib/61000/61100/61164/FHWA-JPO-17-481.pdf

1.9.11 Pre-Trip Travel Information

General Description – Pre-Trip Travel Information utilizes data from multiple sources, used together, to create a comprehensive picture of current traffic conditions. A range of information delivery techniques is then used to deliver information to regional travelers. In this particular instance, smart phones, interactive voice response and web-based systems are used to provide information before travel. According to FHWA, pre-trip traveler information is being provided within the context of 511 system deployments in more than 30 states. In addition, third parties already provide this service to some level. Florida already offers traveler information support via the 511 system, where users can hear travel information for specific routes or even receive phone, text or e-mail alerts about incidents.

Delivering quality traveler information at the pre-trip stage allows maximum flexibility in terms of travel choice of route, mode and timing of the journey. This significantly improves traveler decision-making, making the best use of current transportation capacity in the region.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Pre-Trip Travel Information works well with these other TSM&O strategies:
-Dynamic Message Sign(s)
-Predictive Traveler Information
-Traffic Incident Management (TIM)
-Event Management
-Work Zone Management
-Travel Demand Management (TDM)
-Transit Traveler Information

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
http://www.itsoverview.its.dot.gov/Options.asp?System=TI&SubSystem=PTI&Tech=Pre-Trip
http://www.itsoverview.its.dot.gov/Options.asp?System=TI&SubSystem=PTI&Tech=511
http://www.itscosts.its.dot.gov/ITS/benecost.nsf/SingleLink?OpenForm&Tax=Intelligent+Transportation+Systems+Traveler+Information+Pre-Trip+Information+Kiosks&Location=Cost

1.9.12 Route Guidance

General Description – Smart phones and in-vehicle information systems are used to provide turn by turn driving directions to enable drivers to get from origin to destination. Guidance is based on a centralized navigation database, digital maps and often takes into account current and prevailing traffic conditions. This is already being provided through Google and presently, many cars come standard with navigation systems. Maintaining and improving traveler information is important to all the FDOT District 1 stakeholders because the more informed the traveling public is, the less delay occurs, and the more traffic continuously flows. Many of the region's stakeholders are willing to pump data to and from their own TMC or databases to aid in the transportation of information to end users.

Costs – Capital - $$ Operating - $$

Complementary Strategies – Route Guidance works well with these other TSM&O strategies:
-Dynamic Message Sign(s)
-Pre-Trip Travel Information
-Predictive Traveler Information
-En-Route Driver Information
-Queue Warning System
-Traffic Incident Management (TIM)
-Event Management
-Work Zone Management
-Travel Demand Management (TDM)
-Transit Traveler Information

Conflicting Strategies – To be determined.

Example Benefit-Cost Ratio – To be determined.

Proven TSM&O Strategy Handout Link - To be determined.

Additional Information –
https://www.fhwa.dot.gov/publications/research/safety/96145/sec1.cfm

2

Issues, Symptoms, and Considerations

This chapter provides a brief explanation of the various transportation issues, symptoms, and other considerations that can be addressed using TSM&O strategies. These issues are separated into the following categories:

- Safety Issues
- Capacity Issues
- Multimodal Considerations

2.1 Safety Issues

The following issues pertain to safety.

2.1.1 Bike/Ped Close Proximity to Heavy or High-Speed Traffic

This issue relates to facilities where bicyclists and/or pedestrians are forced to travel very close to heavy-volume or high-speed traffic. A lack of bicycle/pedestrian infrastructure along such facilities may further discourage alternative modes of transportation along the corridor.

2.1.2 Driveway Issues

Conflicts and/or congestion may occur when driveways are either too narrow, too wide, or too numerous. When driveways are too narrow, drivers may have a difficult time properly navigating the ingress, which may create conflict points on travel lanes if they cannot make the turn quickly enough. However, when driveways are too wide, they may result in excessive pedestrian and cyclist exposure to vehicles. When there are too many driveways providing access to the same location, there may be an increased number of conflict points both along the corridor and within the location itself. The excessive number of driveways may also cause congestion along the corridor resulting from the additional ingress/egress points for vehicles.

2.1.3 High Crash Rate – Vehicle (angle)

High crash rates between two vehicles at an angle usually occur at intersections and other major conflict points along a roadway where vehicles are traveling in opposing directions. These types of crashes can be more severe given the opposing forces of the two vehicles.

2.1.4 High Crash Rate – Vehicle (bike/ped)

High crash rates between a vehicle and a bicyclist/pedestrian may occur at locations with limited or inadequate bicyclist/pedestrian infrastructure or near excessively wide driveways. Poor intersection design may also lead to vehicular conflicts with bicyclists and pedestrians.

2.1.5 High Crash Rate – Vehicle (head on)

High crash rates between two head-on vehicles may occur due to wrong-way driving, passing on undivided roadways, unfamiliar routes (e.g., detours), and other issues. Head-on collisions, especially those at high speeds, are generally understood to be the most severe type of traffic accident, due to the opposing forces of the two vehicles.

2.1.6 High Crash Rate – Vehicle (rear end)

Rear-end collisions often occur near congestion, intersections, work zones, or driveways. Though these crashes are generally not as serious as other types of crashes, they can still be dangerous and do contribute to additional traffic issues and congestion.

2.1.7 High Crash Rate – Vehicle (side-swipe)

Side-swipe collisions generally occur as a result of vehicles merging / changing lanes, or vehicles passing another vehicle. The initial accident may not be too severe, but it can cause secondary crashes for one or both vehicles with railing, a median, or other vehicles.

2.1.8 High Crash Rate – Vehicle (passing)

High crash rates with passing vehicles generally occur along undivided rural roadways. These types of crashes typically result from aggressive driving, blind curves / hills, speeding, and poor visibility.

2.1.9 Obstructed Motorist View

Obstructed motorist views, especially those occurring at high speeds, can be a safety hazard. Obstructions can include, but are not limited to: blind curves, vegetation/trees, large hills, etc. These obstructed views can impede motorists' ability to identify important details on the roadway, such as traffic signal cues, signing and pavement markings, disabled vehicles, congestion ahead, etc.

2.1.10 Railway / Roadway Conflicts

Highway-rail conflicts can be extremely dangerous for motorists, bicyclists, and pedestrians. From 2005 to 2009, 436 highway-rail grade crossing incidents occurred in Florida.[1] Approximately 31% of those incidents were at multiple-incident locations. For those at-grade crossings that indicate multiple incidents, the FDOT, local agency, and partner railroad entity should consider all options for improving safety at the location, up to and including elimination of the at-grade crossing, where feasible.

2.1.11 School Bus Stops

School bus stop locations are a consideration for additional safety improvements due to the added (young) pedestrian traffic in the area.

2.1.12 School Zones

School zones are a consideration for additional safety and mobility improvements due to the added pedestrian, bicycle, and motor vehicle traffic in the surrounding area. The confluence of these modes of transportation, coupled with younger transportation users, suggests a need for supportive safety and mobility improvements

2.1.13 Speeding – Excessive (less than 10% over speed limit)

Speed limits are intended to keep motor vehicles at safe travel speeds given a roadway's geometric and physical characteristics. Motorists speeding excessively (between 1% and 10% over the speed limit) may be putting themselves and/or nearby transportation users at an unnecessary risk. Where feasible, improvements should be considered that may reduce excessive speeding along a given roadway.

2.1.14 Speeding – Reckless (more than 10% over speed limit)

Speed limits are intended to keep motor vehicles at safe travel speeds given a roadway's geometric and physical characteristics. Motorists speeding recklessly (more than 10% over the speed limit) may be putting themselves and/or nearby transportation users at an unnecessary risk. Reckless speeding reduces the motorist's control over their vehicle, exacerbates mistakes made while handling their vehicle (e.g., distracted driving, overcorrecting, etc.), and reduces their ability to react to changing travel conditions. Where feasible, improvements should be considered that may reduce reckless speeding along a given roadway.

2.2 Capacity Issues

The following issues pertain to capacity, congestion, and travel time.

2.2.1 Heavy Directional Split

A heavy directional split is a large directional traffic imbalance that occurs during peak hours. For example, during the morning peak hour there is a large commuter contingent traveling from suburban residential areas into the central business district (CBD). Conversely, during the afternoon peak hour there is a large contingent of commuters traveling from the CBD back to their suburban residential area.

[1] Florida Department of Transportation (2011). Highway-Rail Grade Crossing Safety Action Plan. https://safety.fhwa.dot.gov/hsip/xings/docs/fl-sap.pdf

This commuting pattern results in a disproportionate use of the roadway during specific times of day, exacerbating congestion during those periods. FHWA has identified the 60/40 directional split as a commonly used threshold for the level of imbalance needed to warrant reversible flow facilities.[2]

2.2.2 Large Queues

The Highway Capacity Manual (HCM) defines a Queue as: "A line of vehicles, bicycles, or persons waiting to be served by the system in which the flow rate from the front of the queue determines the average speed within the queue. Slowly moving vehicles or people joining the rear of the queue are usually considered part of the queue. The internal queue dynamics can involve starts and stops. A faster-moving line of vehicles is often referred to as a moving queue or a platoon." Queues can occur on highways and on freeways.

Large queues in travel lanes or turning lanes can inhibit traffic flow, potentially leading to congestion and increased rear-end crashes.

2.2.3 Over Capacity (moderate v/C = 1.01-1.10)

The Volume to Capacity ratio (v/C) for a facility is the ratio of observed traffic volume to the predetermined capacity of the facility. Facilities with a v/C ratio between 0.85 and 0.95 are classified as *Near Capacity*, while facilities measuring from 0.95 to 1.00 are considered *At Capacity*. Any facility with a v/C higher than 1.0 is considered *Over Capacity*.

A v/C ratio higher than 1.0 indicates the facility cannot provide smooth traffic flows because the demand (volume) exceeds available supply (capacity). This leads to congestion. A wide range of TSM&O strategies can return moderately over-capacity facilities to acceptable levels.

2.2.4 Over Capacity (excessive v/C = 1.10+)

The Volume to Capacity ratio (v/C) for a facility is the ratio of observed traffic volume to the predetermined capacity of the facility. Facilities with a v/C ratio between 0.85 and 0.95 are classified as Near Capacity, while facilities measuring from 0.95 to 1.00 are considered At Capacity. Any facility with a v/C higher than 1.0 is considered Over Capacity.

A v/C ratio higher than 1.0 indicates the facility cannot provide smooth traffic flows because the demand (volume) exceeds available supply (capacity). This leads to congestion. A wide range of TSM&O strategies can return moderately over-capacity facilities to acceptable levels. However, facilities exhibiting a v/C ratio greater than 1.10 may require more capital-intensive strategies, such as roadway widening, a new roadway, or a package of TSM&O strategies, to bring a facility's v/C ratio to more acceptable levels.

2.2.5 Travel Time Reliability Issues

A prevailing consideration for transportation practitioners is the notion of travel time reliability (TTR). A variety of metrics are used in determining TTR: average travel time, travel time index (TTI), planning time index (PTI), buffer index, and percentile travel time (generally 80th percentile or higher). The most common method for determining reliability is the ratio of 95th percentile to average travel time, conducted across a predetermined time period (generally one year). If there is wide variability in these ratios, the corridor can be described as *unreliable*.

---

[2] Federal Highway Administration (2011). Managed Lane Chapter for the Freeway Management and Operations Handbook. https://ops.fhwa.dot.gov/freewaymgmt/publications/frwy_mgmt_handbook/revision/jan2011/mgdlaneschp8/sec8.htm

The reason reliability is such a concern for practitioners is that it directly affects the end user. A roadway experiencing travel time reliability issues means a motorist cannot reasonably account for the time it will take to reach their destination, leading to uncertainty for the user, who may arrive too early or too late for their appointment, job, or other event. Improving a roadway's travel time reliability may improve the quality of life for users who must frequently use that roadway by providing certainty, potentially freeing up additional time for leisure or work activities, and reducing stress incurred from unexpected travel delays. Also, a commuter may be more accepting of travel delays if they are expected and the delays generally follow the same duration as previous commutes.

2.2.6 Large Scale Events / Unusual Attractors

Large scale events and other attractors produce abnormal demands on the surrounding transportation network. Typical events include, but are not limited to: concerts, sporting events, festivals, etc. These types of events occur infrequently but may overwhelm the transportation network if not properly planned for.

2.2.7 Queuing onto Limited Access Roadways

Providing the correct amount of access from arterials to freeways, and vice versa, can be a delicate balance. When access is disproportionate, queues may result near the interchange, either at the off-ramp (motorists attempting to exit the freeway) or at the on-ramp (motorists attempting to enter the freeway). If long enough, these queues may back up into travel or thru lanes, resulting in congestion and safety issues.

2.2.8 Poor Signal Timing

FHWA has identified outdated or poor traffic signal timing as a primary contributor to traffic delay on urban arterials.[3] If a traffic signal or series of traffic signals have not been timed recently, the cycles may not account for changes in population, commuting, work zones, or developments that affect travel patterns. This will likely lead to inefficient traffic signal cycles for the intersection's various approaches.

2.2.9 High Seasonal Factors

Certain areas or regions experience predictable changes in demand volumes as a result of seasonal changes in population and location attractors. A common example of this in Florida is the influx of "snowbirds" during Fall and Winter. Snowbirds live in the north during warm months (Spring and Summer) but travel to warmer climates such as Florida during the colder months to avoid the extreme cold.

Another example could be schools, which have a predetermined schedule for the school year that will alter traffic patterns based on time of year. Transportation practitioners need to account for these changes in demand volume.

2.2.10 Unusual Weekly Demand Volumes (Atypical Weekday/Weekend split)

There are some areas, particularly in Florida, that may experience abnormal demand volumes, such as greater demand during weekends and less demand during weekdays. This could be the result of certain attractors such as major beaches, other recreational parks, or tourist locations. Transportation

[3] FHWA (2008). Traffic Signal Timing Manual. https://ops.fhwa.dot.gov/publications/fhwahop08024/chapter1.htm

practitioners must be able to account for these unusual demand volumes when developing strategies and improvements for the region.

2.2.11 Constrained Right-of-Way / Facility

A constrained corridor cannot be widened beyond its current state. A corridor may be constrained if there is minimal right-of-way available to support a widening. Similarly, a lack of political will and/or funding may also distinguish a facility as constrained. Transportation practitioners will have to consider other options beyond the standard roadway widening to improve traffic conditions on a constrained corridor.

2.3 Multimodal Considerations

The following are considerations for alternative modes of transportation, as well as for freight movement.

2.3.1 First Mile / Last Mile Issues

"First Mile / Last Mile" is a commonly used term to describe the intermediate trips from a transit customer's origin to the transit hub, and from the final transit hub to the user's destination. Issues arise when transit users experience difficulties getting to a transit hub. Examples may include: pedestrians unable to walk to a bus stop due to unsafe conditions caused by lack of or inadequate pedestrian infrastructure; or motorists unable to find convenient parking near a bus stop. First Mile / Last Mile issues make transit use difficult for "captive riders" (users with limited transportation options beyond transit) and make transit use untenable for "choice riders" (users with multiple options for travel). Alleviating First Mile / Last Mile issues will improve the transit service and may lead to increased ridership.

2.3.2 Heavy Single-Occupant Vehicle (SOV) Use

The advent of the personal automobile and resultant suburbanization of many regions throughout the country were two of the primary factors that propagated the mass use of single-occupant vehicles (SOV). Heavy SOV use impacts the transportation network in several key areas: increased congestion, increased vehicle miles traveled (VMT) on roadway infrastructure (more frequent repairs needed), increased emissions, increased number of traffic accidents, and reduced transit use.

2.3.3 Heavy Truck Traffic Volumes

One of the primary goals established in the Florida Transportation Plan (FTP) is *Efficient and Reliable Mobility for People and Freight*. It may be practical and expedient to provide additional support infrastructure for roadways that experience significant truck traffic volumes. If there is a large contingent of truck traffic along a major thoroughfare, the facility may need more frequent maintenance and repair. Similarly, infrastructure that supports freight movements while improving safety for truck drivers and other roadway users will directly speak to one of the prime directives of the FTP.

2.3.4 Major Truck Routes

One of the primary goals established in the Florida Transportation Plan (FTP) is Efficient and Reliable Mobility for People and Freight. It may be practical and expedient to provide additional support infrastructure for roadways that are designated as major truck routes. If there is a large contingent of truck traffic along a major thoroughfare, the facility may need more frequent maintenance and repair. Similarly, infrastructure that supports freight movements along these routes while improving safety for truck drivers and other roadway users will directly speak to one of the prime directives of the FTP.

2.3.5 Poor Passenger Load Factor – Transit

Passenger load factor is the ratio of passenger-miles travelled to vehicle revenue miles travelled. This ratio is a commonly used indicator for showing how well (or poorly) a transportation agency is performing. A poor passenger load factor indicates a given route is not supporting a large enough userbase, and may need to be adjusted, updated, or eliminated. However, transportation practitioners must understand the context surrounding the route(s) in question. The route(s) in question may provide other benefits such as serving a transportation-disadvantaged community or providing access to a vital public resource.

2.3.6 Poor Trip Planning / Trip Connectivity

Many transit users require multiple connections and routes to get to their desired location. It can be a difficult task to plan out a trip using public transit. Many transit agencies have now developed trip planning tools either on their website, on a mobile app, or both. These tools simplify the process for users wishing to use public transportation, providing a better customer experience and potentially improving ridership as a result.

When trip planning tools are unavailable or inadequate, it can be difficult for users to plan their routes and use the transit service effectively.

Trip connectivity is tied to several components: access to desirable destinations; timely, reliable routes; reliable connection routes (if applicable), and shorter wait times. When either of these components falter, trip connectivity becomes poor, leading to poor customer experience.

2.3.7 Public Transit Delays (Low On-time Arrival Percentage)

Public transit delays reduce reliability for users. This may adversely affect the quality of life for transit users and/or lead to reduced transit use. There are a variety of potential root cause(s) for these delays including, but not limited to: inadequate number of buses serving the route; too many stops along the route; poor signal timing/coordination; excessive congestion; route inefficiencies; and other issues.

2.3.8 "Superstop" / Users Changing Modes of Transportation

A major need identified in the region is improving the modal split of the transportation network, moving away from SOV dominance. A "Superstop" acts as a major hub for public transit and is a primary location for connecting routes and users wishing to change their mode of transportation. Supporting multimodal measures such as the Superstop will contribute to additional multimodal travel.

2.4 Other Considerations

The following considerations do not fit into the previously described categories of safety, capacity, or multimodal considerations.

2.4.1 Emissions / Idling

Air quality is a key concern for state DOTs and local agencies. A significant portion of air quality impacts are caused by greenhouse gas emissions (GHG) stemming from motor vehicles. One of the primary objectives identified in the 2060 Florida Transportation Plan is planning and developing transportation systems to improve air quality and reduce GHG emissions. Emissions and idling issues are compounded by heavy single-occupant vehicle use in many areas within Florida.

2.4.2 Evacuation Route Designation

Facilities that are designated as evacuation routes will feature prominently in the event of a natural or man-made disaster. These evacuation routes may be overwhelmed by the large volumes of residents and visitors evacuating from an endangered area. Where feasible, practitioners should seek to improve evacuation routes to safely accommodate more volume in the event of a disaster.

2.4.3 Freight Parking Over-Utilized

Commercial truck parking has become a concern throughout Florida due to the increasing number of trucks on freeways. Despite the increase in trucks, there has not been a proportionate increase in available freight parking. This may lead to over-utilized freight parking. If parking is unavailable for truck drivers, they may inadvertently violate the Federal Motor Carrier Safety Administration's (FMCSA) hours-of-service regulations, which include an 11-hour daily driving limit. It is important to keep freight parking properly balanced and available for truck drivers to ensure the safe and efficient movement of freight throughout the roadway system.

2.4.4 Freight Parking Under-Utilized

Commercial truck parking has become a concern throughout Florida due to the increasing number of trucks on freeways. There may be locations where freight parking is currently under-utilized. This may result from drivers not being properly informed about the amenity, the parking may be too close to a major freight hub or another parking area, or the parking is located alongside a roadway facility that no longer serves large volumes of truck traffic.

It is important to keep freight parking properly balanced and available for truck drivers to ensure the safe and efficient movement of freight throughout the roadway system.

2.4.5 Parking Issues

Parking availability, especially for the central business district (CBD), is a major concern for transportation practitioners. Parking may be under-utilized during weekday afternoons, over-utilized at night, overwhelmed during weekends and events, or any combination thereof. Parking may also be a problem near transit hubs, where commuters supplement their transit use with first-mile SOV trips.

It may be difficult to solve these parking issues by simply providing more parking spaces. Transportation practitioners will likely need to identify alternative strategies for alleviating or minimizing these issues.

3

Additional Resources

This chapter provides additional resources for transportation practitioners to use in determining appropriate TSM&O strategies for a given situation. Resources include reference materials and other available applications.

3.1 Reference Materials

3.1.1 FHWA TSM&O Resource Page

This page provides additional links and descriptions for transportation practitioners interested in TSM&O strategies and program planning.

https://ops.fhwa.dot.gov/plan4ops/focus_areas/integrating/transportation_sys.htm

3.1.2 TSM&O Benefit-Cost Analysis Compendium

This document was created as a companion guide to the Tool for Operations Benefit Cost Analysis (TOPS-BC) application (discussed in Section 4.2). The compendium provides general information and benefit-cost analysis (BCA) information for various TSM&O strategies.

https://ops.fhwa.dot.gov/publications/fhwahop14032/ch1.htm#11

3.1.3 FDOT TSM&O 2017 Strategic Plan

The Florida Department of Transportation TSM&O 2017 Strategic Plan establishes the vision, mission, goals, objectives, and priority focus areas for TSM&O practices within the State. In support of these objectives, the Strategic Plan also provides specific, measurable, achievable, relevant, and time-bound (SMART) action plans to be accomplished over the next five years.

http://www.fdot.gov/traffic/Doc_Library/PDF/2017%20TSM&O%20Strat%20Plan%20Aug%2024%202017%20FINAL.pdf

3.1.4 Planning for TSM&O Guidebook

The Planning for TSM&O Guidebook was developed as a national guidance document for local, regional, and state agencies to use as a guide in the establishment of their own TSM&O program.

http://www.cflsmartroads.com/docs/Planning%20for%20TSMO%20Guidebook%20-%20FINAL.pdf

3.2 Other Applications and Tools

3.2.1 Tool for Operations Benefit Cost Analysis (TOPS-BC)

The Tool for Operations Benefit Cost Analysis (TOPS-BC) is an excel-based application that provides transportation practitioners a TSM&O-focused benefit-cost tool for determining appropriate strategies for a given situation. The TOPS-BC application includes a large inventory of standard ITS equipment and their associated costs. This inventory database, along with other benefits and costs established for several TSM&O strategies, supports the benefit-cost analysis performed by the application. If the user prefers to use other costs and benefits, the application allows them to input those numbers alongside most of the defaults provided. FHWA has released the User's Manual as well as the TSM&O Benefit-Cost Analysis Compendium to support TOPS-BC users. As with most BCA tools, the more reliable the data, the more reliable the results.

https://ops.fhwa.dot.gov/plan4ops/topsbctool/index.htm