Evaluation of Arterial Corridor Improvements and Traffic Management Plans in Florida

Project BDV31-977-44

FINAL REPORT

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UNITS CONVERSION PAGE

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
		LENGTH		
In	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
mi	miles	1.61	kilometers	km
		VOLUME		
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	metric ton	Mg

TECHNICAL REPORT DOCUMENTATION PAGE

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16. Abstract

The main goal of adaptive signal control technologies (ASCT) is to minimize the travel time experienced by travelers and to reduce the number of stops through arterial corridors. This project conducted an independent assessment of an ASCT system in Mayport, FL, and compared operating conditions when the system was “Off” to when the system was “On” to determine its effectiveness.

The mobility benefits of the ASCT implementation were assessed by comparing performance measures of time of the day (TOD) plans versus ASCT through field data collection. Two critical intersections were identified within the corridor, and performance measures such as corridor travel time, intersection delay, major and minor street queues, turning movement, etc. were collected. The changes in performance measures were used to report the effectiveness of ASCT.

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EXECUTIVE SUMMARY

The main goal of adaptive signal control technologies (ASCT) is to minimize the travel time experienced by travelers and to reduce the number of stops through arterial corridors. This project conducted an independent assessment of an ASCT system in Jacksonville, FL, and compared operating conditions when the system was "Off" to when the system was "On" to determine its effectiveness.

The study corridor was the Mayport Road-Atlantic Boulevard in Duval County, and it extends from Wonderwood Drive to Seminole Road. The northern end of the corridor leads to a private roadway which provides access to Mayport Naval Station. The ASCT system has been implemented along Mayport Road (which runs north-south) and Atlantic Boulevard (which runs east-west). These two arterials carry high levels of commuter traffic to Mayport Naval Station, Kathryn Abbey Hannah Park, and Neptune Beach. In total, the corridor spans 4.1 miles with 14 signalized and 5 unsignalized intersections.

The InSync adaptive signal control system was implemented along this corridor in March 2019. Three types of traffic data were collected when the system was "Off" and when the system was "On": travel times, and turning movements and queue lengths at two critical intersections. Floating car runs were conducted with the UFTI instrumented vehicle to collect vehicle travel times during three time periods: AM peak (7-9 AM), off-peak (11-1 PM) and PM peak (3-5 PM). Turning movement counts and queue lengths were collected manually at the two critical intersections (Wonderwood Drive and SR-A1A).

Based on the data obtained, five performance measures were estimated for the "Off" and "On" study periods: link/route travel time, delay at intersections, queue length (at critical intersections), queue-to-lane storage ratio (at critical intersections), and passenger car equivalent (PCE) flows (at critical intersections). For each performance measure, a comparison between the "Off" and "On" data was conducted, and the following were concluded:

- ASCT implementation resulted in an overall decrease in travel time in both directions (21.2% for the SB, and 4.4% for the NB). Conditions improved significantly for the SB direction, while the NB direction remained relatively unchanged. This could be because the NB had already been optimized with the previous actuated-coordinated system (only one intersection showed noticeable delay with the previous system).
- For the SB, delay significantly decreased in the Mazama, Plaza, and Fairway Villas Dr intersections. For the NB, only Fairway Villas Dr had noticeable delay in the previous system, and its delay was reduced with the ASCT.
- Average queue length at SR-A1A was significantly reduced, while there were longer SB queues at Wonderwood intersection after the ASCT implementation. However, once past this intersection, vehicles traveling southbound would experience minimal delays for the remainder of the corridor. Hence this could be due to the ASCT deliberately forming platoons to optimize coordination.

- The traffic patterns follow naval station hours. Especially at Wonderwood Drive, the EBL and NBT movements had higher volumes in the AM as vehicles arrived at the naval station. The SB right and SB through movements had higher volumes in the PM as vehicles departed. The off-peak traffic followed typical lunch-hour patterns, with similar SB and NB demands.
- Except for the SB through movement at SR-A1A, the traffic throughput either marginally improved or remained the same. Hence, when queues and throughput are considered together, we can conclude that a similar amount of vehicles were served by the ASCT with significantly lower delays and travel times.

It can be concluded that the ASCT implementation on this corridor showed clear improvement in nearly all traffic operational measures.

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1. INTRODUCTION

The primary objective of implementing signal control traffic adaptive systems is to minimize travel time delay and to decrease the number of stops for vehicles traveling along signalized arterials. The Florida Department of Transportation (FDOT) intends to implement adaptive signal control technologies (ASCT) pilot projects at several locations in the state and is interested in evaluating under what conditions these are most effective. This evaluation is based on a comparison of traffic operational quality before and after ASCT implementation.

1.1. Background and Objectives

This project evaluated the effectiveness of an ASCT system based on a comparison of operations when the system was “On” to when the system was “Off”. The research team coordinated its work with the FDOT District 2 contractor (HNTB) in order to supplement the field data collection.

The objective of this project was to evaluate traffic operations following the implementation of ASCT along the Mayport Road-Atlantic Boulevard corridor in Duval County from Wonderwood Drive to Seminole Road.

1.2. Project Overview

In Task 1 of this project, the research team conducted a literature review and an overview of industry practice on regional traffic operations programs (RTOPs). The document provided an overview of recommendations for developing and maintaining an RTOPs and for performance measures used in evaluating other regional programs. Following the completion of that task, the scope of the project was revised, and thus, some of the components of the literature review are not directly related to the completed project. University of Florida Transportation Institute (UFTI, 2019) conducted an evaluation of an ASCT system between 2014 and 2019. Since revision, this project followed similar objectives and goals as FDOT Project BDV32-977-05. Thus the literature review provides a summary of best practices for ASCT implementation identified through the literature review of that project.

Due to delays and changes in the original implementation plan, as well as changes in the scope of this project, the data collection was conducted with the ASCT system “On” first and “Off” later. This document provides the “Off” and “On” field data collected along the Mayport Road-Atlantic Boulevard corridor, Duval County, from Wonderwood Drive to Seminole Road, as well as a comparison of the respective traffic operational performance measures.

The InSync ASCT has been implemented along Mayport Road (which runs north-south) and Atlantic Boulevard (which runs east-west). The northern end of the Mayport Road corridor leads to a private road into a naval station. The main arterials which intersect this corridor are Wonderwood Drive and SR-A1A (both of these run east-west). These two arterials carry high levels of commuter traffic to the Mayport Naval Station, Kathryn Abbey Hannah Park, and Neptune Beach. The intersections of these arterials with Mayport Road were selected in consultation with FDOT District 2 staff as the two critical intersections of this corridor. In total, the study corridor spans 4.1 miles in length with 14 signalized and 5 unsignalized intersections.

The InSync adaptive signal control system was implemented along this corridor in March 2019. Three types of traffic data were collected when the system was "Off" and when the system was "On": travel times, and turning movements and queue lengths at two critical intersections. Floating car runs were conducted with the UFTI instrumented vehicle to collect vehicle travel times during three time periods – AM peak (7-9AM), off-peak (11-1 PM) and PM peak (3-5 PM). Turning movement counts and queue lengths were collected manually at the two critical intersections (Wonderwood Drive and SR-A1A).

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The remainder of this report provides detailed information on the corridor, followed by the "Off" and "On" data and the comparison for each performance measure. The last chapter provides conclusions and recommendations for this study.

1.3. Corridor Information

Figure 1.1 provides a schematic of the Mayport Road, Duval County Corridor.

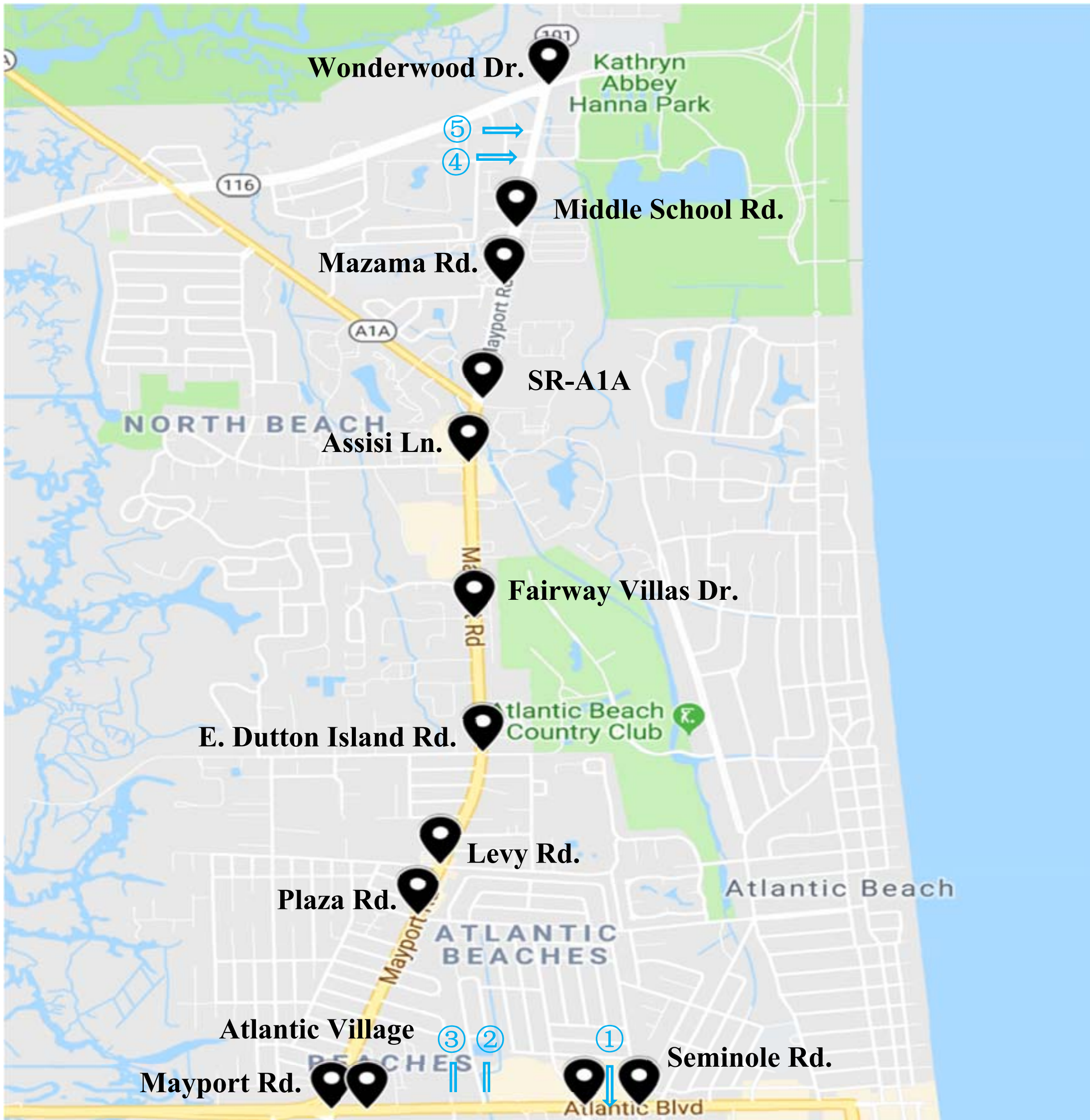


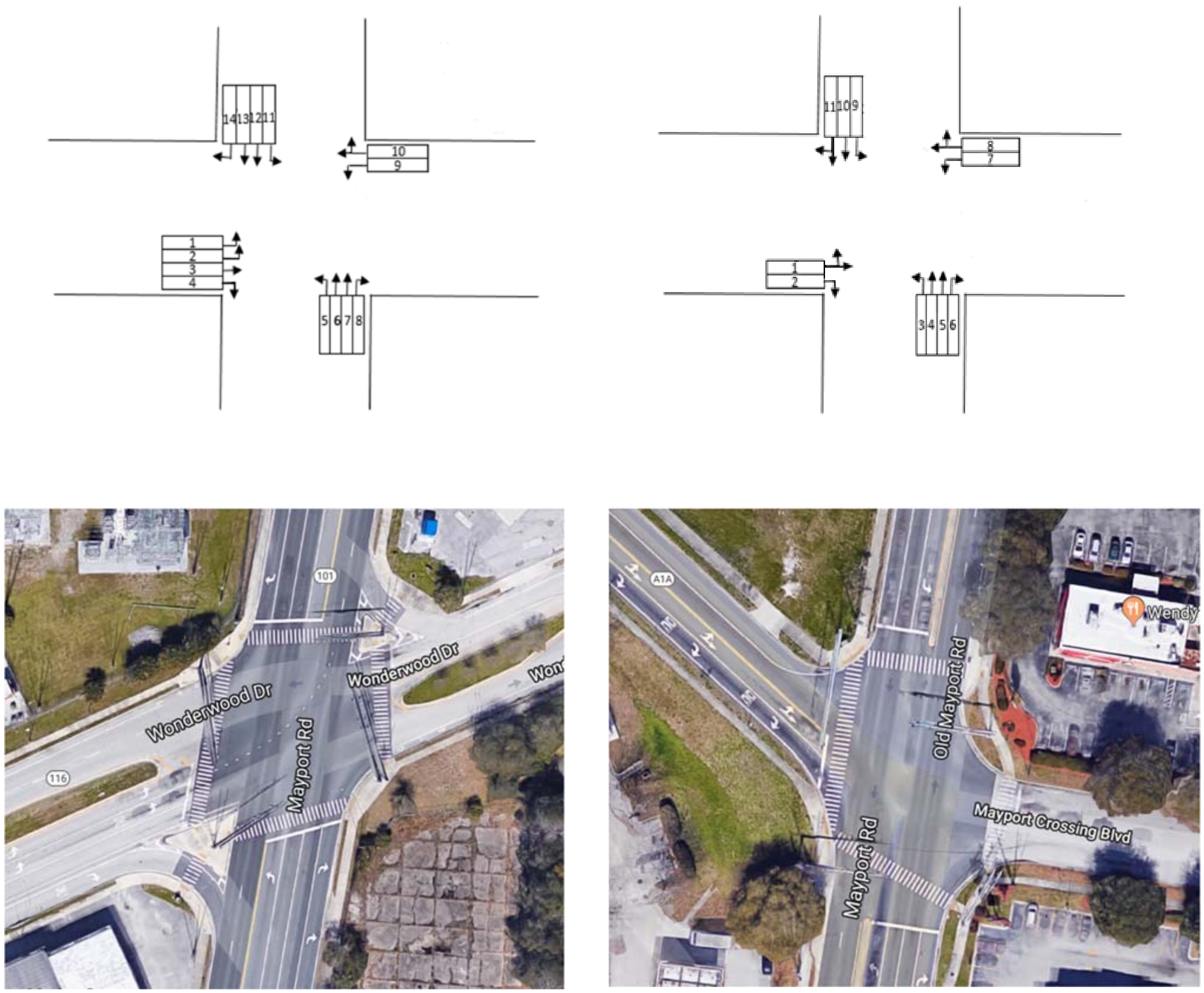
Figure 1.1 Schematic of Mayport Road-Atlantic Blvd Corridor, Duval County

The signalized intersections are marked in black while the unsignalized intersections are marked in blue. The unsignalized intersections are: 1. Sailfish Dr, 2. Aquatic Dr, 3. Atlantic Ct, 4. Pioneer Dr, 5.Renault Dr.

Table 1 lists the intersections along the corridor. The adjacent land use consists of a variety of businesses and public entities, including parks, restaurants, banks, residential areas, a middle school, and a country club. Commuting and recreational traffic, originating from downtown Jacksonville and I-295, heading toward the Mayport Naval Station and Kathryn Abbey Hanna Park, is carried by Wonderwood Drive toward the northeastern end of this corridor. Traffic along SR-A1A includes commuter and recreational traffic which enters the study corridor in the southeast direction. These traffic streams cross the corridor through two main intersections (Wonderwood Drive and SR-A1A), which were selected by the FDOT District 2 as the critical intersections for this corridor. For the analysis of the two critical intersections, detailed turning movement and queue counts were collected. Figure 1.2 provides the lane configuration of the two critical intersections.

Table 1.1 List of Intersections along Mayport Road-Atlantic Blvd Corridor

	Intersection	**No. of Unsignalized Intersections**	**Distance (mi)**
1	**Wonderwood Dr.**	-	-
2	Middle School Rd.	1	0.45
3	Mazama Rd.	0	0.17
4	**SR-A1A**	0	0.38
5	Assisi Ln.	0	0.19
6	Fairway Villas Dr.	0	0.48
7	E. Dutton Island Rd.	0	0.43
8	Levy Rd.	1	0.37
9	Plaza Rd.	0	0.17
10	Mayport Rd. N	0	0.64
11	Mayport Rd. S	0	0.64
12	Atlantic Village	2	0.27
13	Penman Rd.	0	0.32
14	Seminole Rd.	1	0.19



(a) Mayport Rd. & Wonderwood Dr.

(b) Mayport Rd. & SR-A1A

Figure 1.2 Lane Configuration Schematic and Overview Aerial Photo of Critical Intersections

1.4. Performance Measures

Five performance measures were evaluated: Link/Route Travel Time, Delay at Intersections, Number of Stops, Queue Length (critical intersections), Queue-to-Lane Storage Ratio (critical intersections), and PCE Flows (critical intersections). For each performance measure, a comparison between the "Off" and "On" conditions is conducted and the results of the differences (calculated as "On data" – "Off data") are presented.

In the next chapter literature review of the Regional traffic operations programs (RTOP) is presented.

2. LITERATURE REVIEW AND INDUSTRY PRACTICE ON REGIONAL TRAFFIC OPERATIONS PROGRAMS (RTOP)

2.1. Introduction

The main objectives of this project are to independently evaluate the implementation and management of advanced signal control along two corridors in Florida. This chapter reviews the literature identified related to the development and implementation of Regional traffic operations programs (RTOP) that have been utilized in other regions. It examines the functionality and management of such programs as well as the performance measures used to evaluate them.

The Federal Highway Administration (FHWA) defines the Regional Traffic Operations Program (RTOP) "as a component of a broader program which makes the case to achieve safe, reliable, and secure transportation" (FHWA, 2009). FHWA emphasizes regional collaboration among agencies to accomplish these goals. Alternatively, the Georgia Department of Transportation defines it as "a signal timing program with the goal of improving traffic flow and reducing vehicle emissions through improved signal timing on select corridors (http://www.dot.ga.gov/DS/SafetyOperation/RTOP, GDOT, 2011). The Georgia RTOP also assists local jurisdictions to quickly find and repair problems.

Generally, the purpose of the RTOP is to provide partner agencies a formal framework to discuss issues, plan for improvements, and share experiences. Agencies that use a common framework for establishing expectations, goals, and managing resources will gain success both individually and region-wide (FHWA, 2009).

FHWA suggests that an RTOP first creates a Regional Concept of Transportation (RCTO), which is a management tool used to help in planning and implementing management and operating strategies in a collaborative and sustained manner (FHWA, 2009). An RTCO will build support and funding necessary to have a successful program. Furthermore, developing a RTCO helps agencies and stakeholders think of what the program should be and look like in the future (3 to 5 years), and what needs to be accomplished to reach that mark. The foundation for creating an RTCO is the development of "smart objectives", as described in figure 2.1.

The remainder of the memorandum is organized as follows: The next section presents an overview of recommendations for developing and maintaining an RTOP according to the Federal Highway Administration. Section 3 presents selected case studies for RTOP and related programs in the literature, while section 4 discusses performance measures that have been used in other regional programs. The last section summarizes our findings and provides a preliminary list of recommended measures for evaluating RTOPs.

Specific: It provides sufficient specificity to guide formulation of viable approaches to achieving the operations objective without dictating the approach.

Measurable: It is measurable in terms that are meaningful to the partners and users. Tracking progress against the operations objective provides feedback that enables the partners to assess the effectiveness of their actions. An operations objective is chosen that is measurable within the partners' means.

Agreed: Necessary for the development and implementation of the RCTO, partners come to a consensus on a common operations objective.

Realistic: The participants are reasonably confident that they can achieve this operations objective within resource limitations and institutional demands. Because this cannot be fully evaluated until the approach of the RCTO is defined, the partners may need to iteratively adjust the operations objective once the approach of the RCTO is determined.

Time-bound: Partners specify when the operations objective will be achieved. This promotes efficiency and accountability.

Figure 2.1 Criteria for How to Make Smart Objectives

2.2. FHWA's Recommendations for Developing RTOPs

The FHWA has created a step-by-step framework for developing RTOPs, which is shown in Figure 2.2 (FHWA, 2009). The framework emphasizes the continuous nature of RTOPs and is based on the complexity of the system and the required operations strategies (FHWA, 2009). For instance, for larger complex networks, it is best to go through every step in detail to ensure that all problems, strategies, and improvements are discussed. For a system that is small, some steps can be omitted (for example the selection of strategies if there is only one option.) The steps shown in Figure 2.2 are grouped into 4 stages: getting started, decision making, implementation, and continuous improvement. Although the steps are listed in sequential order, the framework is cyclical because a significant amount of iteration is required.

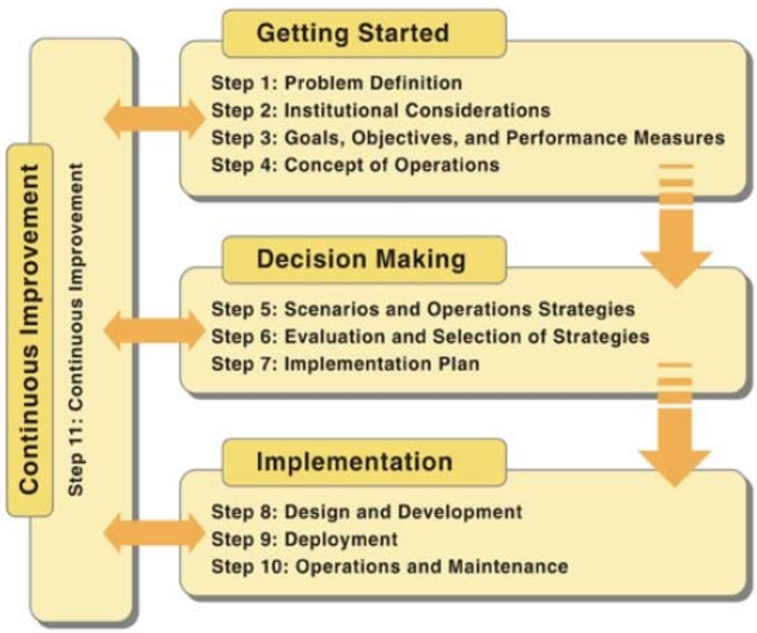


Figure 2.2 Framework for a Regional Traffic Operation Program (RTOP) according to FHWA (FHWA, 2009)

The first step in FHWA's framework is to define the problem. What could be a problem to one party, may not be the same problem to another, so it is best to discuss and agree on the extent and severity of the problem to focus on. The problem should be defined beginning at the regional level. Once a problem is agreed upon, goals, objectives, and performance measures must be identified. It is emphasized that goals and objectives should be defined considering the problem identified. According to the FHWA guide, the goals should be broad statements, the objectives should be specific statements on what will be achieved, and performance measures should be specific measurements used to evaluate the objectives and goals.

Performance measure(s) chosen must be related to the user perspective (for example, travel time.) Once these steps are complete, a concept of operations document must be prepared. This document should include goals and objective(s), as well as a description of initial conditions of the system, operating practices and policies, and system capabilities (FHWA, 2009). Once the preliminary steps have been discussed and completed, then stakeholders and other participating parties can start making decisions. FHWA recommends that the first decision is to select suitable scenarios and the respective operations strategies. According to FHWA, scenarios are related to the overarching goals of the program. For example, a scenario, may consist of reducing delay on the main line. For that scenario, one strategy could be to implement an adaptive traffic signal control on major corridors. Strategies suggested at the regional level include reporting and responding to complaints, adaptive signal control implementation, and consistency in signal timing practices (FHWA, 2009). Once identified, the strategies are evaluated and suitable ones selected for implementation. The last step in the decision-making stage is the development of an implementation plan that outlines actions required. The implementation plan can be a document that summarizes the problems, goals, objectives, performance measures, and the selected strategies for several scenarios. It is good practice to describe in detail operation strategies as these will help build a plan for the remainder of the project.

The implementation plan will translate the selected strategies into a project plan. At this stage, the actual traffic signal settings in the timing plan would be determined, individual(s) responsible to authorize the plan will be identified, and details on how the plan should implemented should be agreed upon (FHWA, 2009). FHWA emphasizes that the most important part of the process is what comes next: operations and maintenance. It is important that the people activating and operating the system have a clear understanding of their part of the program and during various scenarios. It is also important to be able to confirm whether the system working at maximum efficiency and reliability.

The last stage involves continuous monitoring and improvement of the system as needed. Although continuous improvement is the last step in the four-stage process, it never stops. The system must constantly be evaluated to ensure the performance of the system matches the goals and objectives of the project. FHWA describes several elements that are key for successfully maintaining an RTOP. The first key element to a sustainable program is leadership. The report emphasizes that a leadership role can begin with a single person, but can grow into becoming an organization. The example provided in the FHWA report is the Puget Sound Regional Council (PSRC), in Washington State, which illustrates how a program can benefit from regional collaboration. Another example offered is the Pima Association of Governments (PAG) in Tucson, Arizona, which is leading the way for agencies to work collectively and implement Intelligent Transportation Systems. Evaluation is the next element that needs to be considered, including examining what works, what doesn’t work, and what can be improved. One of several resources that regional programs can use to measure their signal operations and effectiveness is the Institute of Transportation of Engineers (ITE) traffic signal self-assessment (ITE, 2011) and the Traffic Signal Audit Guide (ITE, 2007).

The report recommends incorporating training programs into the RTOP, because training provides many benefits to the agency as well as the employees and other staff members. Training programs should not be limited to engineers, but should include maintenance staff. The last two key elements discussed in maintaining a sustainable RTOP are funding mechanisms and public involvement and outreach. Applications for regional, state, or federal funds are given higher priority when several agencies join together. When there is cooperation between neighboring agencies, there is generally improved maintenance because funding is available and distributed to projects that are beneficial to an entire region. Lastly, keeping the public or the users involved throughout the process is very important because the public can provide detailed feedback on system performance. The Denver Regional Council of Government (DRCOG) and Puget Sound Regional Council (PSRC) programs are mentioned as two good examples on how public outreach is used effectively. Both made communication with the public a priority and aimed to keep the decision makers and/or the public involved by extending an invitation to regular meetings.

2.3. Case Studies Identified in the Literature

A few examples of RTOPs were identified in the literature. The section will highlight three RTOPs and will also discuss regional traffic signal programs implemented around the country. Table 2.1 summarizes the programs reviewed along with their key characteristics. The following paragraphs describe each of these programs in more detail.

2.3.1. Georgia Department of Transportation (GDOT)

Georgia's RTOP is a signal timing program with the goal of improving traffic flow and reducing vehicle emissions through signal timing. The program was implemented in the Atlanta area, and it accounts for 50% of the lane miles and 75% of the congestion in the state of Georgia. GDOT discovered that several programs had to be improved: (a) routine maintenance of equipment – budget for routine maintenance of signals is insufficient, (b) active management of signals – agencies don't have staff dedicated to active management, and (c) cross-jurisdictional coordination – inconsistencies in operating plans across jurisdictional boundaries. According to GDOT, after program implementation, the number of stops along the major street was significantly reduced. The reduction in the number of stops lowers the vehicle emissions, which ultimately improves air quality. However, flow on the major street after implementation, may not be non-stop due to unexpected events such as construction, traffic crash, or pedestrian crossings.

2.3.2. Denver Regional Council of Government (DRSOG)

In Denver, Colorado, the DRSOG is one of the first Metropolitan Planning Organizations (MPOs) to begin or conduct this type of program. DRSOG has been working on this program along with

Colorado Department of Transportation (CDOT), local governments to coordinate signals on major roadways in the region. A total of 328 signals had to be retimed on travel corridors in the metro area. Travel time for motorists was reduced by more than 9000 hours in 2013, ultimately reducing fuel consumption by 1128 pounds/day. Denver's RTOP has improved the traffic signal timing and coordination plans, and their system capabilities by providing equipment and installing communication links.

2.3.3. Mid-America Regional Council (MARC)

The RTOP for the Kansas City, Missouri area is a program that aims to build strong regional community through interagency coordination, cooperation, planning, and leadership for the greater part of Kansas. To improve system performance, different measures such as travel speed, travel delay, and network congestion was used to improve the reliability and performance of the regional system. MARC found that the travel speeds have been increasing along the study area, congestion levels have been greatly decreasing after peaking in 2003, and travel delay has been decreasing compared to the other local areas. According to MARC, the region is moving in the right direction since performance measures analyzed in the report are showing improvements.

Table 2.1 Model Examples of Regional Traffic Operation Programs in the U.S.

Name	Purpose	Number of Signals	Management	Staffing	Maintenance Cost	Performance Measures	Results/ Achievement
Atlanta, GA – Georgia Department of Transportation	Improving traffic flow and reducing emission through improved timing	816	RTOP manager, consulting team	Program manager, corridor manager, agencies	Installation cost – $8.5 million in traffic signals	Throughput, number of stops	Manage to get 95% vehicle detection devices operational, 95% pedestrian detection devices operational, 70% of equipment malfunctions reported by RTOP team
Denver, CO – Denver Regional Council of Governments	Reducing traffic congestion and improving air quality	860	DRCOG, CDOT, and local governments	Local governments	N/A	Travel time	In 2013, reduced travel time by more than 9,000 hours and reduced fuel consumption by 4,700 gallons per day

Name	Purpose	Number of Signals	Management	Staffing	Maintenance Cost	Performance Measures	Results/ Achievement
Kansas City, MO – Mid-America Regional Council	"Operation Green Light" – monitors and manages the existing transportation system through safe and efficient traffic signal operations to reduce travel time, fuel consumption, and air pollution	684	MARC, KDOT, FHWA, MODOT	22 cities – including Fairway, KS, Kansas City, MO, and 20 more	In 2013, $490,000 for system maintenance and improvement	Travel time	In a day, 20 hours saved in travel time, 5,800 fewer stops
Puget Sound, WA –Puget Sound Regional Council	Regional Traffic Operations Committee – collaborative and coordinated approach to regional traffic operations, investments, and practices	N/A	Corridor lead agency, partner agency, WSDOT	Staffed by management	N/A	Travel time	Active traffic management at the arterial and freeway levels
Reno and Las Vegas, NV – Nevada Regional Transportation Commission	Improve traffic operations at the regional level	350	Washoe County, NDOT, City of Reno	Engineering consultants	N/A	Delay	Reduction in overall stops and travel delays

Name	Purpose	Number of Signals	Management	Staffing	Maintenance Cost	Performance Measures	Results/ Achievement
Orange, CA – Orange County Transportation Authority	Keeps people moving by reducing freeway congestion and improving safety and efficiency on local roads	500	Orange County Transportation Authority	Local agencies	$1,057,996 annually	Number of stops, travel time, delays	Vehicle received more green lights

2.4. Performance Measures

In summary, RTOPs use performance measures to measure progress in order to evaluate whether a given strategy is working. They also use them to identify the need for more funding (for example, in establishing the importance of specific devices used in monitoring) or to prioritize network improvements. According to Table 2.1, there are many ways to measure regional traffic signals operation performance including:

- Throughput
- Number of stops
- Travel time
- Delay

Performance measures can also be more informative than quantitative. For example using complaints as a measure may provide qualitative information. For example, signal timings are only changed when there are complaints on a specific intersection or corridor. The literature indicates that agencies sometimes use the number of calls for complaints as a performance measure. However, this should not be the main or only performance measure the region utilizes, as it does not address issues not globally perceived by the public (such as overall network efficiency.) The following are two examples of how performance measures are identified and used in other RTOPs.

Maryland State Highway Administration (SHA) – The agency set yearly goals for the number of retimed traffic signals and corridors. The program focused on mobility across the transportation system that allowed them to concentrate on reducing delays on state arterials, reducing fuel consumption and emissions, throughput, and to evaluate crash histories throughout the entire region. SHA sets an annual goal of re-timing 400 intersections to reduce delay. According to SHA (FHWA, 2009), this goal cannot always be met since the percent of delay reduction will have diminishing returns as signals and corridors are continuously retimed. A future goal of theirs is to collect data on select corridors each year to prioritize resource allocation to areas of significant growth.

Regional Transportation Commission (RTC) of Washoe County, Nevada – This agency utilized a website to ask for feedback and publicize information about their projects. The website gives citizens the opportunity to report a problem, complaint, and issue. When a complaint is recorded, staff members take time to discuss the concern with the citizen. During the discussion, the staff member will ask the citizen if he/she is willing to assist in data collection (some agencies provide a GPS unit and have them travel with it during a period of time). Following the data collection, the data is analyzed and reviewed with the citizen. In the end, if the complaint is valid, the citizen is praised for bringing it to the agency's attention.

Using complaints as a performance measure provides opportunities to engage citizens, educate them, and have them be a part of the solution.

Performance measure can be categorized into two groups: mobility and system reliability - most RTOPs that have been researched utilize mobility because it aligns more with their goals and purpose. For example, many of the programs studied purpose is to minimize traffic congestion, reduce gas emissions, or decrease the travel time that corresponds to the performance measures of travel time, number of stops, or delay. System reliability, on the other hand, focus on equipment performances such as vehicle and pedestrian detectors. Georgia's RTOP incorporates these performances measures in their monthly progress reports in where the overall status of the devices are summarized. In fact, most of devices status in their corridor exceeds the monthly goal of having 95% of the vehicle or pedestrian devices operational.

Regarding performance measurement for maintenance, RTOPS tend to utilize such measures often to identify the need for increased funding. The most important part is finding a performance measure(s) that is within the agency's budget, including equipment and staff. For example, an agency with limited resources will not plan to have a corridor with vehicle detections such as detector loops, if they cannot provide for every intersection along the corridor. There are other ways an agency can measure operational performance. SHA created a model for maintaining their operations, which ultimately focuses on mobility as its performance measure across the system.

2.5. Evaluation of Adaptive Signal Control Technology (ASCT)

In a parallel study (FDOT BDV32 977-05), the research team conducted a literature review regarding ASCT systems. The following is a summary of best practices identified:

- Robust communication and adaptability of controllers to any new adaptive signal control systems are both important factors in the effectiveness and functionality of any system.
- Functioning and maintenance of detectors is key from the operating agency's perspective.
- Transition from emergency events to regular patterns should be studied; any pre-emptive events during data collection would be useful in this regard.
- Since there are problems sometimes during pre- and post- congested periods, collecting off-peak and queue data is necessary to evaluate the effectiveness of the system.
- Infrastructure, such as communication cables, controllers and detection should be thoroughly tested before the data collection.
- The old systems must be re-calibrated and coordinated for the "before" data collection, so that the benefits derived can be measured more accurately.
- "With/without" evaluation instead of a "before/after" approach must also be considered.
- Whenever available, high resolution signal timing and detector data should be used and whenever necessary, simulation tools should be employed for rigorous

evaluation of the system. Phase splits and other controller information can be useful in evaluating the access equity of the intersections.

- Travel demand can, and typically does change between before and after studies due to a variety of reasons such as site development and seasonal changes. This variability is often mitigated by collecting data on the same days of the week and within a given season.

Additional information regarding this study is provided in its final report, completed in August, 2019.

2.6. Conclusions and Recommendations

2.6.1. Conclusions

Based on the literature, there are not many RTOPs in operation. Atlanta, Denver, and Kansas City are great examples of successful RTOP applications. The key to a successful program is continuous collaboration between partnering parties and agencies working towards common goals and objectives. Without collaboration and commitment between all stakeholders involved, the regional program will not be successful. FHWA recommends a four-stage framework: getting started, decision making, implementation, and continuous improvement. The four-stage framework includes steps that are crucial for developing an RTOP, such as defining the problem, evaluating and selecting strategies, implementing a plan, operating and maintaining the system, and continually improving the system.

Furthermore, the selection of suitable performance measures is important, particularly with respect to alignment with the goals and objectives of the project. It is also important that the performance measures are within the budget. Staff that will be assisting with the management of the system, and equipment being utilized should also be included in the budget. There are cases of RTOPs that have proven to be successful, such as the Georgia Department of Transportation, which can be used as a model when constructing a new program. GDOT's regional program uses both mobility and reliability performance measurements to assess how well the program is working compared to other programs. However, there isn't a best program. As we can see from the literature, many regional programs are built differently, and all are successful in their own way.

2.6.2. Recommendations

Based on the literature review, we recommend the following performance measures as suitable in evaluating RTOP programs:

- Mobility
  - Throughput
  - Travel time
  - Queue Length

    - Intersection Delay
- User Complaints
    - Number of complaints at a given area or corridor
- Equipment Reliability
    - Vehicle Detectors
    - Other equipment failures

The performance measures recommended here are commonly used in other regional programs. Similarly to the Regional Transportation in Georgia, both mobility and reliability measurements are recommended.

3. ROUTE TRAVEL TIME

The average travel time (min) along the route was measured using a floating car. During the "Off" data collection, we conducted 6 runs for the SB direction and 5 runs for the NB direction. During the "On" data collection, for the first day, we were able to perform 5 runs for each time period, with the second day yielding 6 runs for the AM peak period and 5 runs for the off-peak and PM peak periods. Table 3.1 provides the route travel time for the "Off" data collection, while Table 3.2 depicts travel time for the "On" data collection. The travel time comparison is presented in Table 3.3.

3.1. "Off" Study (April 9-10, 2019)

Table 3.1 Route Travel Time (min)

Route TT (min)	AM Peak	Off-Peak	PM Peak	Average	Peak Hours Average
Mayport Rd, SB	11.00	13.20	14.60	**12.93**	**12.80**
Mayport Rd, NB	7.98	9.68	9.18	**8.95**	**8.58**

3.2. "On" Study (March 19-20, 2019)

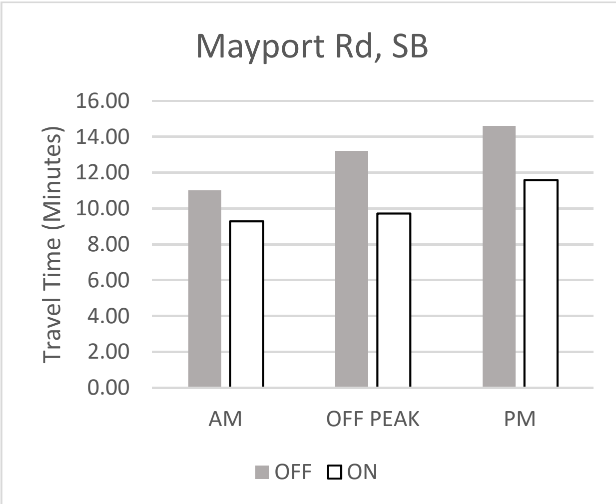
Table 3.2 Route Travel Time (min)

Route TT (min)	AM Peak	Off-Peak	PM Peak	Average	Average (Peak hours)
Mayport Rd, SB	9.30	9.70	11.60	**10.20**	**10.45**
Mayport Rd, NB	8.03	8.63	9.01	**8.56**	**8.52**

3.3. Comparison of "Off" and "On" Travel Times

Table 3.3 Change in Percentage of Route Travel Time ("On" – "Off")

Route TT (min)	AM Peak	Off-Peak	PM Peak	Average	Average (Peak hours)
Mayport Rd, SB	-1.70 (-15.45%)	-3.48 (-26.49%)	-3.00 (20.55%)	**-2.73 (-21.18%)**	**-2.35(-18.36%)**
Mayport Rd, NB	0.05 (0.63%)	-1.05 (-10.85%)	-0.17 (-1.85%)	**-0.39 (-4.37%)**	**-0.06(-0.70%)**



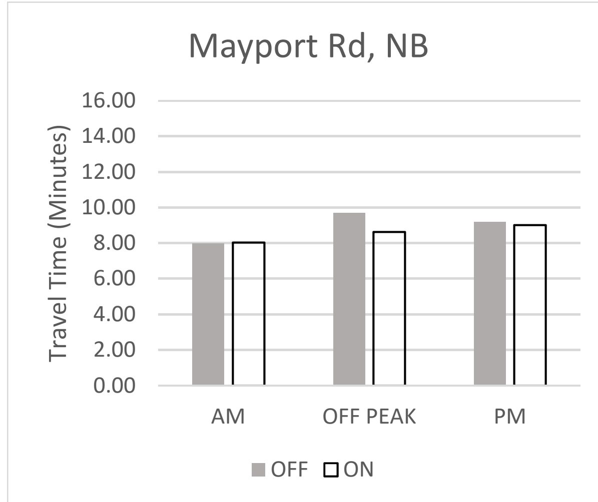


Figure 3.1 Travel Times along Mayport Road., Duval County

3.4. Discussion

The following can be concluded from the comparison of travel times:

- Overall, there was a reduction in travel time for both the SB and NB direction, with a 21.18% and 4.37% decrease respectively. The SB direction experienced a significant decrease ($p<0.05$) in travel time for all approaches. The NB experienced slight decreases in travel time, mostly because there was minimal delay along the corridor prior to system implementation.
- The greatest reduction in travel time occurs during the off-peak period for the SB movement (26.49% or 3.48 min).
- The improvement in the SB direction during the PM peak is significant ($p<0.05$) as it had the highest travel time during both “Off” and “On” studies.

4. DELAY

Delay (sec) at each intersection along the corridor was also obtained using the floating car measurements.

4.1. "Off" Study (April 9-10, 2019)

Table 4.1 and Figure 4.1 provide the delay obtained per intersection for the SB direction. Figure 4.1 graphically depicts the delay at each intersection for the SB movement. The delay for Mazama Road, Fairway Villas Drive, and Plaza Road, had the highest levels of delay, with Plaza Road experiencing the highest PM peak delay and Fairway Villas Drive the highest off-peak delay. Low levels of delay were observed for several intersections in the SB direction.

Table 4.1 Delay (s) for Each Intersection Through Movement along the SB Direction – "Off" Study

Delay at Intersections (sec)	AM Peak	Off-Peak	PM Peak
Wonderwood Dr.	**19.00**	**0.00**	**0.00**
Middle School Rd.	5.58	0.33	0.00
Mazama Rd.	9.58	9.92	98.92
SR-A1A	**2.50**	**36.33**	**25.83**
Assisi Ln	5.00	0.92	0.00
Fairway Villas Dr.	1.17	136.25	31.42
E Dutton Island Dr.	3.67	0.00	3.50
Levy Rd.	4.75	0.00	0.00
Plaza Rd.	55.92	99.33	137.67
Mayport Rd N	58.33	0.00	0.00
Mayport Rd S	6.42	0.00	0.00
Atlantic Village	5.92	18.08	15.75
Penman Rd.	12.08	9.58	14.00
Seminole Rd.	11.92	0.00	0.00

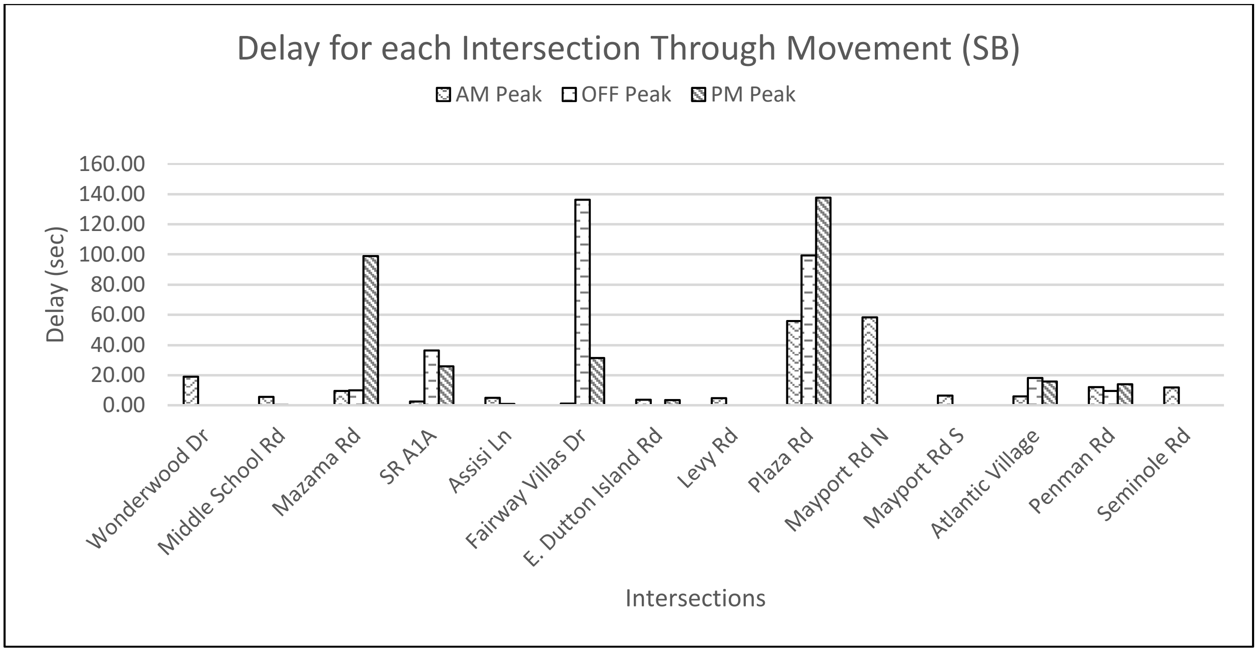


Figure 4.1 Delay (sec) for Each Intersection Through Movement along the SB Direction – "Off" Study

Table 4.2 and Figure 4.2 show the delays obtained per intersection for the NB direction. Figure 4.2 illustrates the delay at each intersection for the NB movement. The intersection delay in the NB direction is highest during the off-peak at the Fairway Villas Drive intersection. The highest delay for the two critical intersections, Wonderwood Drive and SR-A1A, was observed in the AM peak and off-peak periods, respectively. The off-peak delays are higher than the PM peak delays at seven intersections.

Table 4.2 Delay (s) for Each Intersection Through Movement along the NB Direction – "Off" Study

Delay at Intersections (sec)	AM Peak	Off-Peak	PM Peak
Seminole Rd	0.00	0.00	0.00
Penman Rd	3.40	3.41	22.49
Atlantic Village	7.97	8.72	17.74
Mayport Rd	0.00	9.62	0.45
Plaza Rd	0.00	7.97	10.31
Levy Rd	0.00	0.00	9.33
E. Dutton Island Rd	0.63	2.15	1.69
Fairway Villas Dr	2.42	77.63	0.46
Assisi Ln	3.78	12.56	8.83
SR-A1A	**3.75**	**23.45**	**9.35**
Mazama Rd	0.00	8.46	0.31
Middle School Rd	2.42	0.00	0.00
Wonderwood Dr.	**7.62**	**1.79**	**4.09**

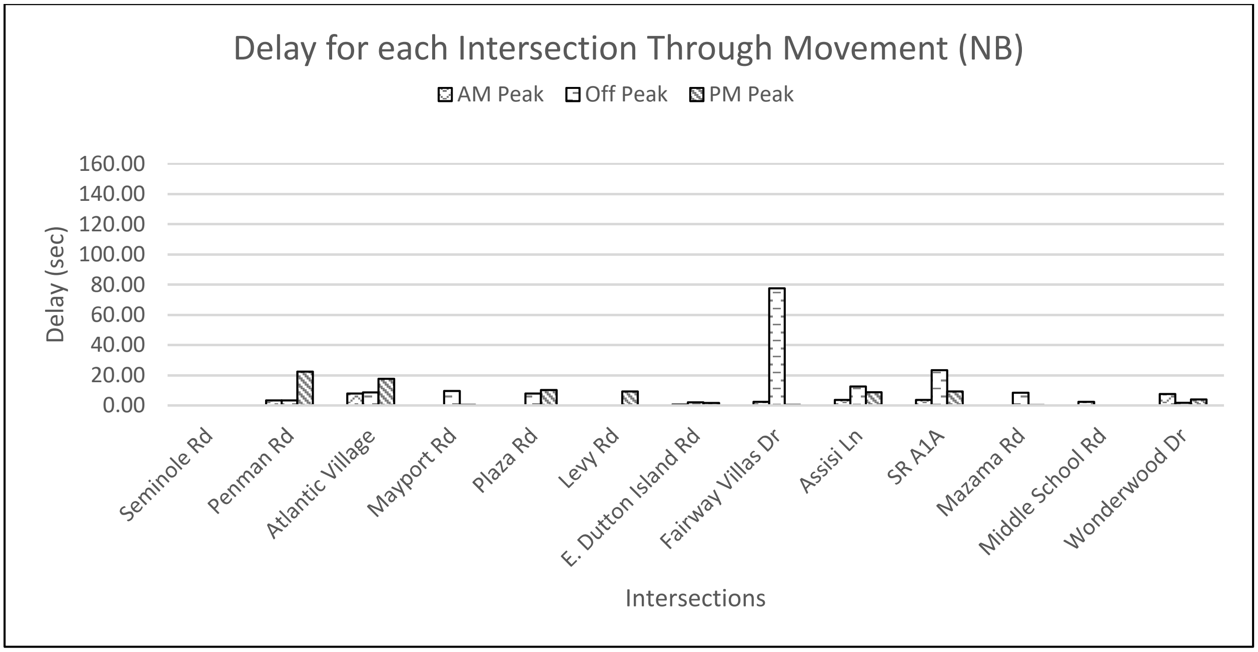


Figure 4.2 Delay (sec) for Each Intersection Through Movement along the NB Direction – "Off" Study

4.2. "On" Study (March 19-20, 2019)

Table 4.3 and Figure 4.3 summarize the delay data for the "On" study in the SB direction. The data shows that the highest intersection delay for the AM peak and off-peak periods is reached at the Mayport Road intersection, while the largest intersection delay for the PM peak period was observed in the SR-A1A intersection. At other intersections, the delay was significantly lower. A few intersections had none to very low delay for all runs.

Table 4.3 Delay (s) for Each Intersection Through Movement along the SB Direction –"On" Study

Delay at Intersections (sec)	AM Peak	Off-Peak	PM Peak
Wonderwood	**20.09**	**11.11**	**10.22**
Middle School Rd.	0.00	0.33	6.11
Mazama Rd.	1.82	0.00	0.00
SR-A1A	**9.80**	**29.44**	**61.56**
Assisi Ln	5.45	4.88	15.10
Fairway Villas Dr.	0.00	0.00	0.60
E Dutton Island Dr.	1.36	8.63	12.20
Levy Rd.	3.27	6.13	2.90
Plaza Rd.	0.00	4.50	0.00
Mayport Rd.	27.27	52.00	45.70
Atlantic Village	18.91	1.38	0.00
Penman Rd.	7.64	0.00	4.80
Seminole Rd.	8.64	0.00	0.00

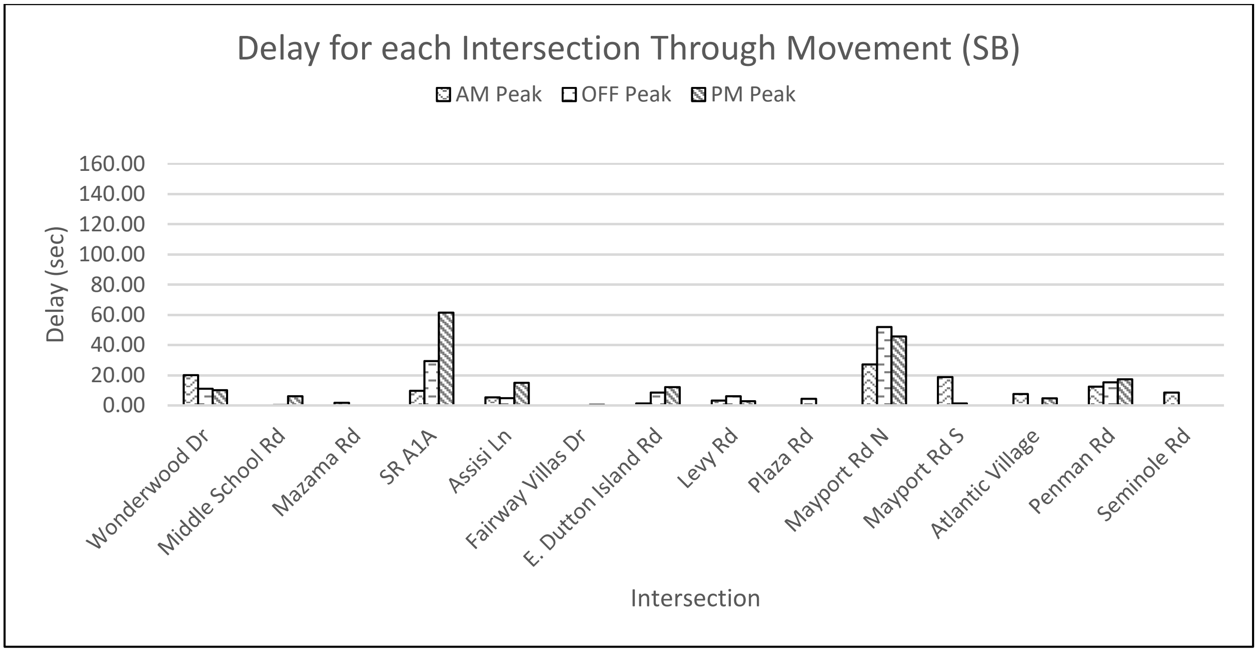


Figure 4.3 Delay (sec) for Each Intersection Through Movement along the SB Direction – "On" Study

Table 4.4 and Figure 4.4 provide the delay data for the NB direction. As shown, the highest delay was observed at the intersections of Penman and Mayport Road during the PM peak period. The highest delays for the AM and off-peak periods were observed in the Plaza and Penman Road intersections, respectively. Significantly lower delays were reported for the SR-A1A and Mayport Road intersections.

Table 4.4 Delay (s) for Each Intersection Through Movement along the NB Direction– "On" Study

Delay at Intersections (sec)	AM Peak	Off-Peak	PM Peak
Seminole Rd	5.82	0.00	0.00
Penman Rd	6.18	20.14	21.20
Atlantic Village	4.45	16.39	18.35
Mayport Rd	0.00	0.56	0.00
Plaza Rd	15.82	8.39	18.18
Levy Rd	1.55	3.14	3.49
E. Dutton Island Rd	1.18	4.67	3.71
Fairway Villas Dr	2.36	5.72	0.00
Assisi Ln	9.18	10.97	12.02
SR-A1A	**1.36**	**7.92**	**3.60**
Mazama Rd	0.00	0.00	0.00
Middle School Rd	0.00	0.00	0.00
Wonderwood Dr.	**3.42**	**11.09**	**0.00**

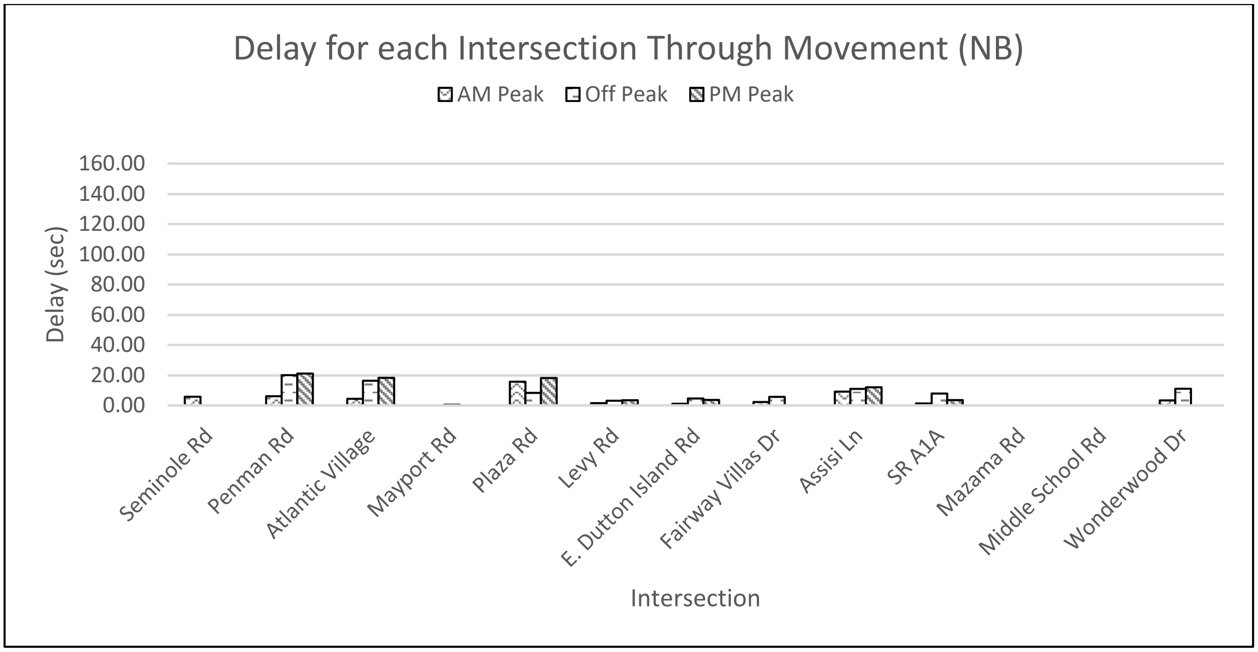


Figure 4.4 Delay (sec) for Each Intersection Through Movement along the NB Direction – “On” Study

4.3. Comparisons of “Off” and “On” Intersection Delay Times

The differences in delay between the “Off” and “On” data collection periods are shown in Table 4.5 and Table 4.6. The tables are color-coded as follows: green shows significant improvement, yellow shows modest change (either improvement or deterioration), and red shows significant deterioration in delay. Several gradations of each color are used to represent variations within each classification. The darker red represents the most deterioration while the darker green represents the most improvement. Dark yellow represents no change.

Table 4.5 Difference in Delay (sec) for Each Intersection Through Movement along the SB Direction

Delay at Intersections (sec)	AM Peak	Off-Peak	PM Peak
Wonderwood Dr	1.09	11.11	10.22
Middle School Rd	-5.58	0.00	6.11
Mazama Rd	-7.77	-9.92	-98.92
SR-A1A	7.30	-6.89	35.72
Assisi Ln	0.45	3.96	15.10
Fairway Villas Dr	-1.17	-136.25	-30.82
E. Dutton Island Rd	-2.30	8.63	8.70
Levy Rd	-1.48	6.13	2.90
Plaza Rd	-55.92	-94.83	-137.67
Mayport Rd N	-31.06	52.00	45.70
Mayport Rd S	12.49	1.38	0.00
Atlantic Village	1.72	-18.08	-10.95
Penman Rd	0.46	5.79	3.40
Seminole Rd	-3.28	0.00	0.00
Average	-6.07	-12.64	-10.75

Table 4.6 Difference in Delay (sec) for Each Intersection Through Movement along the NB Direction

Delay at Intersections (sec)	AM Peak	Off-Peak	PM Peak
Seminole Rd	5.82	0.00	0.00
Penman Rd	2.78	16.73	-1.29
Atlantic Village	-3.52	7.67	0.60
Mayport Rd	0.00	-9.06	-0.45
Plaza Rd	15.82	0.41	7.87
Levy Rd	1.55	3.14	-5.84
E. Dutton Island Rd	0.56	2.51	2.02
Fairway Villas Dr	-0.05	-71.91	-0.46
Assisi Ln	5.40	-1.59	3.18
SR-A1A	-2.39	-15.53	-5.75
Mazama Rd	0.00	-8.46	-0.31
Middle School Rd	-2.42	0.00	0.00
Wonderwood Dr.	-4.20	9.30	-4.09
Average	1.49	-5.14	-0.35

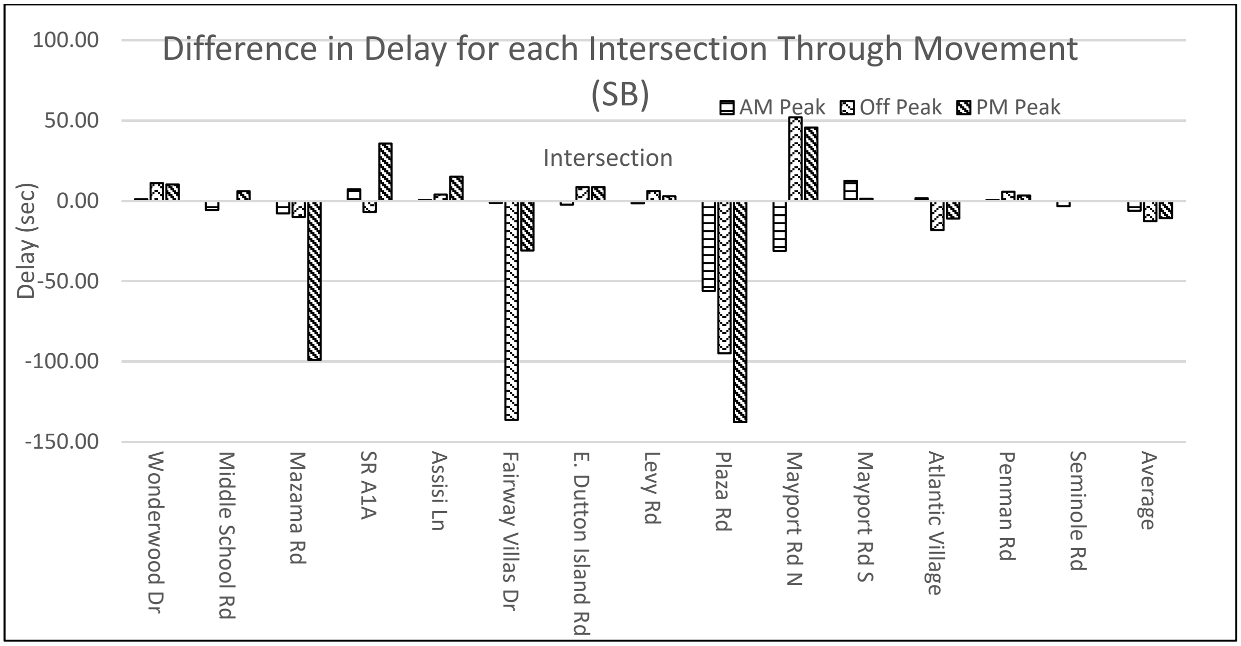


Figure 4.5 Difference in Delay (sec) for Each Intersection Through Movement along the SB Direction

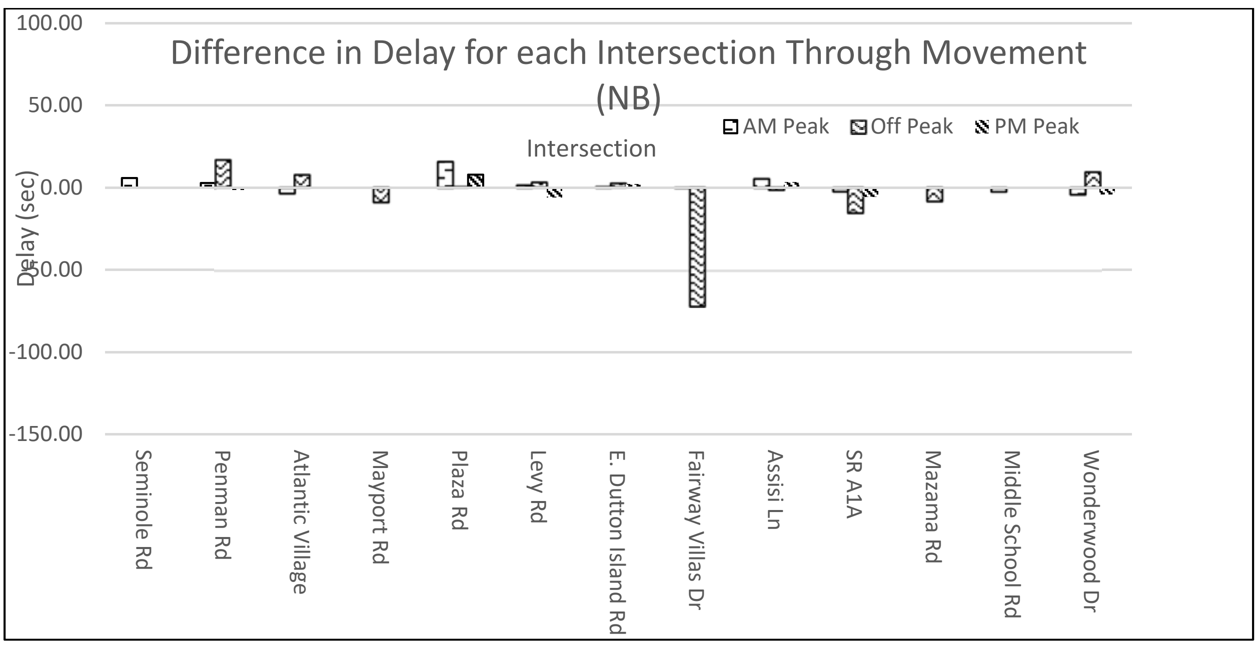


Figure 4.6 Difference in Delay (sec) for Each Intersection Through Movement along the NB Direction

4.4. Discussion

The following can be concluded from the comparison of delays:

- The data shows that following the installation of the InSync system, there was an overall decrease in delay in the SB movement.
- Reduction in delay was observed for the Mazama Road, Fairway Villas Drive, and Plaza Road intersections in the SB direction. Additionally, decrease in delay was observed in the Fairway Villas Drive intersection in the NB direction.
- Marginal increase in delay was observed for intersections SR-A1A, Assisi Lane, and Mayport Road, in the SB direction.
- The travel time improvement in the NB is minimal, because there was relatively low delay along this direction during the “Off” data collection.

5. QUEUE LENGTH

Queue length (number of vehicles/lane) data are presented by movement and by time period. This measure is used to evaluate oversaturated conditions at the critical intersections along the study corridor. The queue length reported here is the observed maximum number of vehicles queued during each cycle, and does not represent the total number of vehicles that may have stopped during the cycle. During some time periods, because of cycle failure, vehicles need to stop multiple times passing through the intersection.

Figure 5.1 presents the schematic of the lane configurations at the two critical intersections. The queue length is reported for each of these lanes.

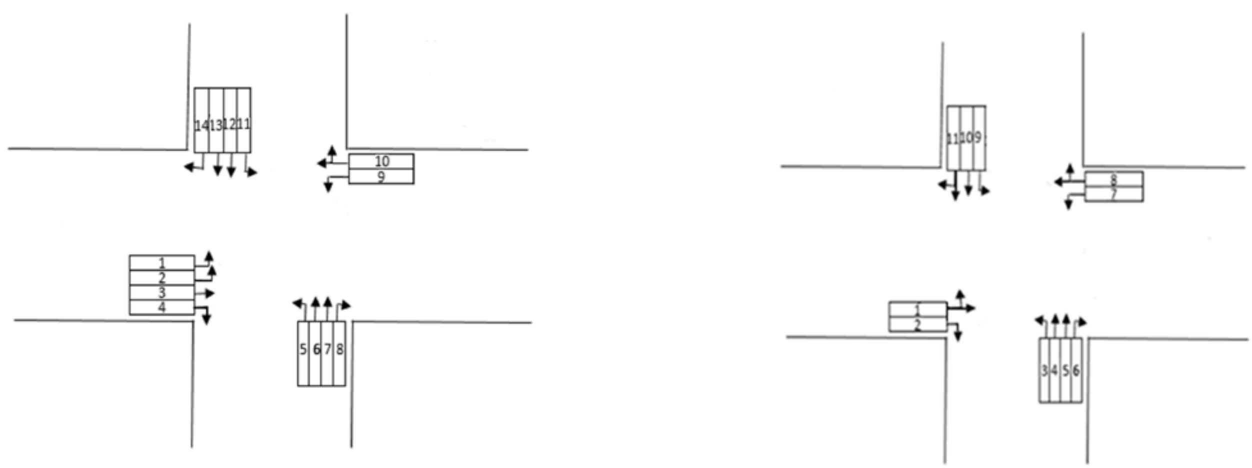


Figure 5.1 Lane Configuration Schematic of Critical Intersections

5.1. "Off" Study (April 9-10, 2019)

Table 5.1 Average Queue Length by Lane (veh/lane) at Mayport Rd. & Wonderwood Dr. – "Off" Study.

Time Period	Time Segment (15 min)	Eastbound				Northbound				Westbound		Southbound			
		Left		Through	Right	Left	Through		Right	Left	T/R	Left	Through		Right
Lane Number		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
AM Peak	1	8	6	7	0	1	3	2	0	0	1	0	1	1	0
	2	10	10	4	0	2	2	1	0	1	1	0	2	3	1
	3	6	6	8	0	4	2	2	0	2	2	1	1	2	0
	4	3	4	1	0	1	1	1	0	2	1	0	0	1	0
	Average	7	6	5	0	2	2	2	0	1	1	0	1	2	0
Off-Peak	1	2	3	1	0	1	1	1	0	1	1	0	5	4	0
	2	2	3	2	0	2	4	3	0	1	2	0	3	3	0
	3	2	2	1	0	0	2	2	0	2	1	0	3	2	0
	4	3	3	2	0	1	2	2	0	1	1	0	1	2	0
	Average	2	3	1	0	1	2	2	0	1	1	0	3	3	0
PM Peak	1	2	2	2	0	4	1	1	0	3	9	0	9	4	7
	2	3	4	1	0	4	0	0	0	3	6	0	7	4	7
	3	3	5	1	0	13	1	1	0	3	5	0	6	4	7
	4	2	4	3	0	5	1	1	0	2	2	0	5	4	7
	Average	3	4	2	0	7	1	1	0	3	5	0	7	4	7

Table 5.2 Average Queue Length (veh/lane) at Mayport Rd. & Wonderwood Dr. – "Off" Study.

Time Period	EB			NB			WB			SB		
	Left	**Through**	**Right**	**Left**	**Through**	**Right**	**Left**	**Through**	**Right**	**Left**	**Through**	**Right**
AM Peak	7	5	0	2	2	0	1	1	1	0	1	0
Off-Peak	2	1	0	1	2	0	1	1	0	0	3	0
PM Peak	3	2	0	7	1	0	3	5	0	0	5	7

Table 5.3 Average Queue Length by Lane (veh/lane) at Mayport Rd. & SR-A1A Blvd. – "Off" Study.

Time Period	Time Segment (15 min)	Eastbound		Northbound				Westbound		Southbound		
		L/T	Right	Left	Through		Right	Left	T/R	Left	Through	T/R
Lane Number		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
AM Peak	1	0	0	13	3	3	0	1	1	3	3	4
	2	1	0	15	3	4	0	1	1	0	4	5
	3	1	0	12	5	6	1	1	2	0	9	10
	4	2	0	4	2	1	0	1	2	0	4	4
	Average	**1**	**0**	**11**	**4**	**4**	**0**	**1**	**1**	**1**	**5**	**6**
Off-Peak	1	1	1	9	3	4	0	1	1	2	6	8
	2	1	0	13	5	6	0	2	2	3	3	4
	3	1	0	13	3	4	0	1	1	2	5	6
	4	1	0	15	3	4	0	1	0	2	4	4
	Average	**1**	**0**	**12**	**3**	**4**	**0**	**1**	**1**	**2**	**4**	**5**
PM Peak	1	2	5	18	10	5	1	1	3	1	24	24
	2	2	8	18	5	4	0	2	2	2	24	24
	3	2	7	18	5	5	1	1	3	1	25	25
	4	1	8	18	6	6	0	1	4	3	10	11
	Average	**2**	**7**	**18**	**6**	**5**	**1**	**1**	**3**	**2**	**21**	**21**

Table 5.4 Average Queue Length (veh/lane) at Mayport Rd. & SR-A1A Blvd. – "Off" Study

Time Period	EB			NB			WB			SB		
	Left	Through	T/R	Left	Through	T/R	Left	Through	T/R	Left	Through	T/R
AM Peak	1	0	0	11	4	0	1	1	1	1	5	0
Off-Peak	0	0	0	12	4	0	1	1	0	2	5	0
PM Peak	1	1	7	18	6	1	1	3	0	2	20	1

For the Mayport Road and Wonderwood Drive intersection, the longest queue observed was 13 vehicles for the NB left movement. Also, long queues were observed for several other approaches, including the EB left and SB through approaches, with up to 10 vehicles during certain times.

As shown above, the longest queues were observed at the Mayport Road and SR-A1A intersection for the SB through and through/right movements, with queues reaching up to 25 vehicles.

5.2. “On” Study (March 19-20, 2019)

Tables 5.5 to 5.8 show the average queue length by lane and by movement for both critical intersections for the “On” study.

Table 5.5 Average Queue Length by Lane (veh/lane) at Mayport Road & Wonderwood Drive – "On" Study

Time Period	Time Segment (15 min)	Eastbound				Northbound				Westbound		Southbound			
		Left		Through	Right	Left	Through		Right	Left	T/R	Left	Through		Right
Lane Number		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
AM Peak	1	13	12	10	0	1	2	1	0	1	1	0	2	2	1
	2	9	9	6	0	1	1	1	0	2	4	1	2	4	0
	3	7	8	3	0	4	1	1	0	3	1	0	3	2	0
	4	6	6	1	0	2	0	1	0	1	1	0	2	2	0
	Average	**9**	**9**	**5**	**0**	**2**	**1**	**1**	**0**	**2**	**2**	**0**	**2**	**2**	**0**
Off-Peak	1	4	5	2	0	1	1	2	0	2	2	0	6	6	0
	2	4	4	1	0	1	2	3	0	2	1	0	4	5	0
	3	5	6	1	0	1	1	1	0	1	1	0	4	3	0
	4	3	3	2	0	1	1	1	0	0	2	0	4	4	0
	Average	**4**	**4**	**2**	**0**	**1**	**1**	**2**	**0**	**1**	**2**	**0**	**4**	**4**	**0**
PM Peak	1	5	4	4	0	6	1	2	0	4	7	1	12	10	6
	2	4	5	4	0	12	0	1	0	7	10	0	13	13	9
	3	3	4	3	0	17	2	2	0	5	9	0	15	17	3
	4	3	5	3	0	5	0	0	0	2	3	0	9	10	7
	Average	**3**	**4**	**3**	**0**	**10**	**1**	**1**	**0**	**4**	**7**	**0**	**12**	**13**	**6**

Table 5.6 Average Queue Length (veh/lane) at Mayport Road & Wonderwood Drive – "On" Study

Time Period	EB			NB			WB			SB		
	Left	**Through**	**Right**	**Left**	**Through**	**Right**	**Left**	**Through**	**Right**	**Left**	**Through**	**Right**
AM Peak	7	5	0	2	2	0	1	1	0	0	1	0
Off-Peak	2	1	0	1	2	0	1	1	1	0	3	0
PM Peak	3	2	0	7	1	0	3	5	1	0	5	7

Table 5.7 Average Queue Length by Lane (veh/lane) at Mayport Road & SR-A1A – “On” Study

Time Period	Time Segment (15 min)	Eastbound		Northbound				Westbound		Southbound		
		L/T	Right	Left	Through		Right	Left	T/R	Left	Through	T/R
Lane Number		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
AM Peak	1	1	3	7	2	1	0	0	0	0	3	3
	2	1	6	9	1	1	0	0	0	0	4	7
	3	0	6	7	2	2	0	1	0	0	9	8
	4	1	2	6	2	1	0	1	0	0	5	5
	Average	**1**	**4**	**7**	**2**	**2**	**0**	**0**	**0**	**0**	**5**	**6**
Off-Peak	1	4	3	11	3	3	0	3	3	8	14	16
	2	1	2	8	1	2	0	2	2	1	6	8
	3	1	0	14	2	2	0	2	3	2	8	10
	4	1	1	5	1	1	0	2	3	2	6	9
	Average	**2**	**1**	**9**	**2**	**2**	**0**	**2**	**2**	**3**	**8**	**11**
PM Peak	1	1	8	16	2	2	0	2	3	1	17	17
	2	2	9	15	1	1	0	3	2	2	14	14
	3	1	10	8	1	2	0	2	2	3	17	17
	4	1	8	13	1	1	0	2	2	1	10	11
	Average	**1**	**8**	**13**	**1**	**1**	**0**	**2**	**2**	**2**	**15**	**15**

Table 5.8 Average Queue Length (veh/lane) at Mayport Road & SR-A1A – “On” Study

Time Period	EB			NB			WB			SB		
	Left	Through	T/R	Left	Through	T/R	Left	Through	T/R	Left	Through	T/R
AM Peak	0	0	4	7	2	0	0	0	0	0	5	1
Off-Peak	1	1	1	9	2	0	2	1	1	3	9	1
PM Peak	1	0	8	13	1	0	2	2	0	2	14	2

For the Mayport Road and Wonderwood Drive intersection, the longest queue observed was 17 vehicles for the NB left and SB through movements. Also, long queues were observed in other approaches, with up to 15 vehicles observed during the PM peak period for the SB through movement.

For the Mayport Road and SR-A1A intersection, the longest queue was also reported as 17 vehicles, occurring during the PM peak period for the SB through movement. Additionally, long queues were observed in several approaches, reaching up to 16 vehicles for the NB left and SB through or right movements.

5.3. Comparison of "Off" and "On" Queue Lengths for Critical Intersections

The differences in queue length between the "Off" and "On" measurements are shown in Table 5.9 to Table 5.12. The tables are color-coded as follows: green shows significant improvement, yellow shows modest change (either improvement or deterioration), and red shows significant deterioration in delay. Several gradations of each color are used to represent variations within each classification. The darker red represents the most deterioration while the darker green represents the most improvement. Dark yellow represents no change.

Table 5.9 Difference in Avg. Queue Length by Lane (veh/lane) at Mayport Road & Wonderwood Drive

Time Period	Eastbound				Northbound				Westbound		Southbound				Average
	Left		Through	Right	Left	Through		Right	Left	T/R	Left	Through		Right	
Lane Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
AM Peak	1.73	2.23	0.13	0.00	0.05	-0.84	-0.63	-0.14	0.51	0.66	0.15	1.19	0.57	0.12	0.41
Off-Peak	1.57	1.75	0.27	0.00	-0.21	-0.62	-0.38	0.05	-0.03	0.51	0.01	1.40	1.61	0.18	0.44
PM Peak	0.89	0.68	1.78	0.10	3.39	-0.17	0.68	0.00	1.85	1.69	0.08	5.35	8.45	-0.81	1.71

Table 5.10 Difference in Avg. Queue Length (veh/lane) at Mayport Road & Wonderwood Drive

Time Period	Eastbound			Northbound			Westbound			Southbound			Average
	Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
AM Peak	1.98	0.13	0.00	0.05	-0.73	-0.14	0.51	0.50	0.16	0.15	0.88	0.12	0.30
Off-Peak	1.66	0.27	0.00	-0.21	-0.50	0.05	-0.03	0.27	0.24	0.01	1.50	0.18	0.29
PM Peak	0.79	1.78	0.10	3.39	0.25	0.00	1.85	1.52	0.17	0.08	6.90	-0.81	1.33

Table 5.11 Difference in Average Queue Length (veh/lane) at Mayport Road & SR-A1A

Time Period	Eastbound		Northbound				Westbound		Southbound			Average
	L/T	Right	Left	Through		Right	Left	T/R	Left	Through	T/R	
Lane Number	1	2	3	4	5	6	7	8	9	10	11	
AM Peak	-0.20	3.80	-3.81	-1.75	-1.95	-0.34	-0.59	-1.29	-0.51	0.35	-0.40	-0.61
Off-Peak	0.87	1.37	-3.05	-1.53	-2.38	0.00	0.83	1.36	0.96	4.09	5.32	0.71
PM Peak	-0.54	1.47	-4.97	-4.91	-3.54	-0.50	0.91	-0.52	-0.25	-6.10	-6.19	-2.28

Table 5.12 Difference in Avg. Queue Length by Lane (veh/lane) at Mayport Road & SR-A1A

Time Period	Eastbound			Northbound			Westbound			Southbound			Average
	Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
AM Peak	-0.53	0.16	3.80	-3.81	-1.85	-0.34	-0.59	-0.77	-0.52	-0.51	-0.15	0.25	-0.40
Off-Peak	0.84	0.42	1.37	-3.05	-1.95	0.00	0.83	0.64	0.72	0.96	4.35	0.71	0.49
PM Peak	-0.30	-0.21	1.47	-4.97	-4.23	-0.50	0.91	-0.61	0.10	-0.25	-5.82	-0.64	-1.25

5.4. Discussion

The following can be concluded from the comparison of queue lengths:

- At Wonderwood Drive there were no significant changes in queues except for the SB through movement during the PM peak. However, as shown in the delay charts, delays along the rest of the corridor are minimal. Hence this queue increase could be due to the ASCT deliberately forming platoons at the first intersection in order to optimize operations along the remainder of the corridor.
- At SR-A1A, queues decreased significantly for the NB through ($p<0.05$) and NB left ($p<0.05$) during all time periods, and for the SB through ($p<0.05$) during the PM peak. The only significant increase in queue was for the SB through ($p<0.05$) during the off-peak period. As shown in the delay charts, delays at Mazama Road (upstream of SR-A1A for the SB traffic) decline significantly after ASCT implementation. This may increase the throughput for this movement, which in turn results in higher delays for the downstream through movement (SB through at SR-A1A) during the off-peak period.

6. QUEUE-TO-LANE STORAGE RATIO

In addition to queue length, it is important to assess any impact to adjacent lanes or to upstream facilities. The queue-to-link/lane storage ratio is used to establish the likelihood of spillback. The data collected are presented in this section by movement and by time period.

The following assumptions are used:

- The storage capacity is estimated as the maximum number of vehicles that can be accommodated in a lane or link.
- The queue to link/lane storage ratio is estimated as 1 if the observer reported "spillback", and as 0.8 if reported as the maximum number of vehicles visible to the observer.
- Queue-to-lane storage ratios over 80% are highlighted in yellow, as they represent conditions with a high probability for spillback.

6.1. "Off" Study (April 9-10, 2019)

Table 6.1 Average Queue Storage Ratio by Lane and by Period at Mayport Road & Wonderwood Drive – "Off" Study

Time Period	Time Segment	Eastbound				Northbound				Westbound		Southbound			
		Left		Through	Right	Left	Through		Right	Left	T/R	Left	Through		Right
Lane Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14
AM Peak	1	0.56	0.50	0.39	0.00	0.06	0.10	0.08	0.02	0.02	0.08	0.01	0.04	0.06	0.00
	2	0.68	0.64	0.26	0.00	0.08	0.06	0.05	0.02	0.07	0.08	0.03	0.11	0.17	0.04
	3	0.39	0.36	0.64	0.00	0.12	0.09	0.07	0.04	0.09	0.13	0.04	0.08	0.14	0.00
	4	0.20	0.32	0.05	0.00	0.03	0.04	0.04	0.00	0.13	0.07	0.00	0.01	0.07	0.00
	Average	0.46	0.45	0.33	0.00	0.07	0.07	0.06	0.02	0.07	0.09	0.02	0.06	0.11	0.01
OFF Peak	1	0.13	0.15	0.06	0.00	0.05	0.03	0.05	0.00	0.05	0.07	0.02	0.33	0.29	0.00
	2	0.12	0.20	0.10	0.00	0.07	0.13	0.12	0.01	0.07	0.12	0.01	0.18	0.15	0.00
	3	0.18	0.16	0.06	0.00	0.01	0.04	0.05	0.00	0.12	0.07	0.01	0.11	0.08	0.00
	4	0.18	0.23	0.14	0.00	0.02	0.07	0.08	0.00	0.10	0.07	0.00	0.07	0.12	0.00
	Average	0.15	0.19	0.09	0.00	0.04	0.07	0.08	0.00	0.08	0.08	0.01	0.17	0.16	0.00
PM Peak	1	0.12	0.12	0.12	0.00	0.14	0.02	0.02	0.00	0.17	0.62	0.00	0.43	0.27	0.51
	2	0.17	0.24	0.04	0.00	0.16	0.01	0.01	0.00	0.18	0.41	0.01	0.39	0.22	0.42
	3	0.23	0.33	0.05	0.00	0.56	0.05	0.04	0.00	0.20	0.33	0.02	0.37	0.25	0.41
	4	0.16	0.27	0.20	0.00	0.17	0.04	0.02	0.00	0.14	0.13	0.00	0.25	0.21	0.40
	Average	0.17	0.24	0.11	0.00	0.26	0.03	0.02	0.00	0.17	0.38	0.01	0.36	0.24	0.44

Table 6.2 Average Queue Storage Ratio by Lane and by Period at Mayport Road & SR-A1A – "Off" Study

Time Period	Time Segment	Eastbound		Northbound				Westbound		Southbound		
		L/T	Right	Left	Through		Right	Left	T/R	Left	Through	T/R
Lane Number		1	2	3	4	5	6	7	8	9	10	11
AM Peak	1	0.04	0.00	0.77	0.18	0.17	0.01	0.03	0.02	0.10	0.11	0.15
	2	0.02	0.00	0.59	0.15	0.19	0.01	0.04	0.01	0.00	0.13	0.18
	3	0.03	0.00	0.46	0.21	0.22	0.06	0.01	0.01	0.00	0.31	0.33
	4	0.06	0.01	0.14	0.09	0.05	0.00	0.00	0.00	0.00	0.13	0.15
	Average	0.03	0.00	0.49	0.15	0.16	0.02	0.02	0.01	0.03	0.17	0.20
OFF Peak	1	0.07	0.00	0.40	0.13	0.16	0.00	0.03	0.03	0.20	0.19	0.28
	2	0.03	0.00	0.44	0.16	0.19	0.00	0.09	0.11	0.23	0.11	0.14
	3	0.04	0.00	0.63	0.15	0.18	0.00	0.06	0.05	0.10	0.16	0.19
	4	0.03	0.00	0.61	0.12	0.16	0.00	0.02	0.01	0.03	0.11	0.10
	Average	0.04	0.00	0.52	0.14	0.17	0.00	0.05	0.05	0.14	0.14	0.18
PM Peak	1	0.04	0.13	0.40	0.21	0.10	0.02	0.05	0.08	0.01	0.53	0.53
	2	0.05	0.35	0.68	0.18	0.16	0.00	0.09	0.07	0.13	0.82	0.83
	3	0.04	0.21	0.59	0.17	0.18	0.04	0.07	0.13	0.06	0.83	0.83
	4	0.04	0.22	0.55	0.14	0.15	0.00	0.03	0.12	0.04	0.25	0.25
	Average	0.04	0.23	0.56	0.17	0.14	0.02	0.06	0.10	0.06	0.61	0.61

6.2. “On” Study (March 19-20, 2019)

Table 6.3 Average Queue Storage Ratio by Lane and by Period at Mayport Road & Wonderwood Drive – “On” Study

Time Period	Time Segment	Eastbound				Northbound				Westbound		Southbound			
		Left		Through	Right	Left	Through		Right	Left	T/R	Left	Through		Right
Lane Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14
AM Peak	1	0.87	0.63	0.61	0.00	0.04	0.07	0.03	0.00	0.05	0.03	0.02	0.07	0.07	0.01
	2	0.60	0.61	0.39	0.00	0.04	0.03	0.03	0.00	0.13	0.28	0.07	0.09	0.22	0.01
	3	0.38	0.42	0.17	0.00	0.15	0.04	0.04	0.00	0.19	0.08	0.00	0.20	0.13	0.00
	4	0.40	0.39	0.04	0.00	0.07	0.01	0.02	0.00	0.09	0.09	0.00	0.12	0.12	0.01
	Average	0.56	0.51	0.30	0.00	0.08	0.04	0.03	0.00	0.12	0.12	0.02	0.12	0.13	0.01
OFF Peak	1	0.27	0.30	0.13	0.00	0.05	0.05	0.07	0.00	0.12	0.14	0.01	0.32	0.35	0.02
	2	0.24	0.28	0.08	0.00	0.02	0.06	0.10	0.00	0.11	0.09	0.01	0.21	0.26	0.00
	3	0.36	0.40	0.07	0.00	0.04	0.04	0.05	0.02	0.08	0.09	0.01	0.24	0.15	0.00
	4	0.17	0.24	0.16	0.00	0.03	0.06	0.06	0.02	0.00	0.13	0.00	0.19	0.20	0.02
	Average	0.26	0.31	0.11	0.00	0.04	0.05	0.07	0.01	0.08	0.11	0.01	0.24	0.24	0.01
PM Peak	1	0.31	0.26	0.23	0.00	0.23	0.02	0.06	0.00	0.27	0.44	0.04	0.68	0.60	0.36
	2	0.27	0.33	0.25	0.00	0.43	0.00	0.05	0.00	0.44	0.67	0.00	0.75	0.78	0.54
	3	0.17	0.24	0.20	0.03	0.64	0.06	0.07	0.00	0.33	0.61	0.00	0.88	1.00	0.16
	4	0.18	0.30	0.21	0.00	0.17	0.00	0.01	0.00	0.13	0.17	0.01	0.53	0.58	0.41
	Average	0.23	0.28	0.22	0.01	0.37	0.02	0.05	0.00	0.29	0.47	0.01	0.71	0.74	0.37

Table 6.4 Average Queue Storage Ratio by Lane and by Period at Mayport Road & SR-A1A – "On" Study

Time Period	Time Segment	Eastbound		Northbound				Westbound		Southbound		
		L/T	Right	Left	Through		Right	Left	T/R	Left	Through	T/R
Lane Number		1	2	3	4	5	6	7	8	9	10	11
AM Peak	1	0.03	0.19	0.51	0.12	0.08	0.01	0.01	0.02	0.00	0.09	0.12
	2	0.05	0.29	0.52	0.05	0.07	0.00	0.01	0.00	0.00	0.14	0.22
	3	0.02	0.29	0.38	0.13	0.13	0.00	0.03	0.00	0.03	0.29	0.25
	4	0.04	0.08	0.33	0.09	0.07	0.00	0.04	0.00	0.01	0.16	0.16
	Average	0.03	0.21	0.43	0.10	0.09	0.00	0.02	0.00	0.01	0.17	0.19
OFF Peak	1	0.19	0.15	0.59	0.15	0.18	0.00	0.13	0.13	0.65	0.46	0.54
	2	0.09	0.07	0.44	0.07	0.09	0.00	0.12	0.09	0.10	0.21	0.26
	3	0.06	0.02	0.67	0.14	0.09	0.00	0.09	0.13	0.19	0.26	0.33
	4	0.06	0.09	0.28	0.07	0.04	0.00	0.09	0.18	0.07	0.18	0.26
	Average	0.10	0.08	0.49	0.11	0.10	0.00	0.11	0.13	0.25	0.28	0.35
PM Peak	1	0.06	0.39	0.88	0.08	0.09	0.00	0.09	0.16	0.08	0.57	0.57
	2	0.08	0.46	0.81	0.07	0.05	0.00	0.15	0.08	0.17	0.46	0.46
	3	0.04	0.51	0.47	0.08	0.09	0.01	0.12	0.12	0.22	0.57	0.57
	4	0.05	0.40	0.70	0.05	0.07	0.00	0.11	0.09	0.06	0.35	0.37
	Average	0.06	0.44	0.72	0.07	0.08	0.00	0.12	0.11	0.13	0.49	0.49

6.3. Comparisons of "Off" and "On" Queue Storage Ratios

The differences in Queue Storage Ratio between "Off" and "On" measurements are shown in Tables 6.5 and 6.6. The tables are color-coded as follows: green shows significant improvement, yellow shows modest change (either improvement or deterioration), and red shows significant deterioration in delay. Several gradations of each color are used to represent variations within each classification. The darker red represents the most deterioration while the darker green represents the most improvement. Dark yellow represents no change.

Table 6.5 Difference in Avg. Queue Storage Ratios at Mayport Road & Wonderwood Drive

Time Period	Eastbound				Northbound				Westbound		Southbound				Average
	Left		Through	Right	Left	Through		Right	Left	T/R	Left	Through		Right	
Lane #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
AM Peak	0.10	0.06	-0.03	0.00	0.00	-0.03	-0.03	-0.02	0.04	0.03	0.00	0.06	0.03	0.00	0.02
Off-Peak	0.11	0.12	0.02	0.00	0.00	-0.02	-0.01	0.01	-0.01	0.03	0.00	0.07	0.08	0.01	0.03
PM Peak	0.06	0.04	0.12	0.01	0.11	-0.01	0.03	0.00	0.12	0.10	0.00	0.35	0.50	-0.07	0.10

Table 6.6 Difference in Avg. Queue Storage Ratios at Mayport Road & SR-A1A

Time Period	Eastbound		Northbound				Westbound		Southbound			Average
	L/T	Right	Left	Through		Right	Left	T/R	Left	Through	T/R	
Lane #	1	2	3	4	5	6	7	8	9	10	11	
AM Peak	0.00	0.21	-0.05	-0.06	-0.07	-0.01	0.01	0.00	-0.02	0.00	-0.02	0.00
Off-Peak	0.06	0.08	-0.03	-0.04	-0.07	0.00	0.06	0.08	0.11	0.13	0.17	0.05
PM Peak	0.02	0.21	0.16	-0.10	-0.07	-0.01	0.05	0.02	0.07	-0.12	-0.12	0.01

6.4. Discussion

The following are concluded from the comparison of queue storage ratios:

- At Wonderwood Drive there was a general decrease in average queue length storage ratio for the NB approach. However, there was in increase in the queue length for the SBT in the PM peak, as discussed in previous sections.
- At A1A, the queue-storage ratio improved somewhat for the NB, while the greatest decrease in average queue-storage ratio was observed for the SB through approach, during the PM peak.
- In general, there were very few instances of queues reaching storage (Q/S>0.8) during both “Off” and “On” studies. Overall, no significant changes in queue-storage ratio were observed at the two critical intersections.

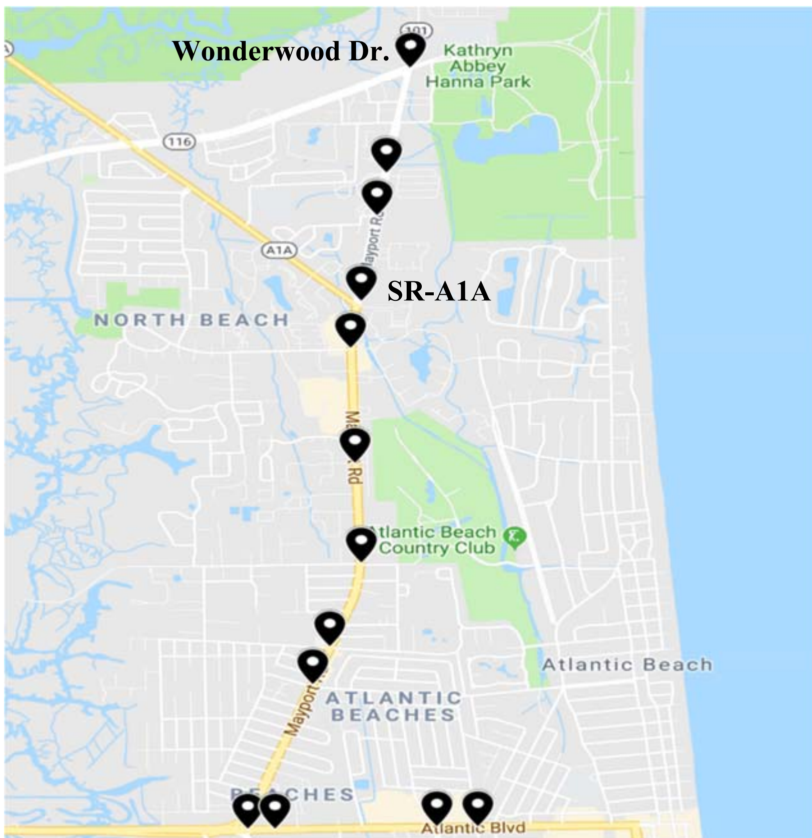


Figure 6.1 Corridor with Critical Intersections

7. EQUIVALENT PCE FLOWS

Traffic flows were counted manually and converted to equivalent PCE flows (pce/hour) by considering the percentage of heavy vehicles. It was assumed that the PCE for trucks is 2.

7.1. Truck Percentage Observations for "Off" Study (Nov. 9 & Nov. 10, 2016)

Table 7.1 Truck Percentages at Mayport Road & Wonderwood Drive – "Off" Study

Period	Interval	Eastbound			Northbound			Westbound			Southbound			Average
		Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
AM Peak	1	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.94%	0.25%
	2	0.00%	0.00%	5.56%	0.00%	1.40%	0.00%	0.00%	0.00%	0.00%	0.00%	4.76%	7.32%	1.59%
	3	2.38%	1.59%	0.00%	2.08%	3.77%	5.00%	0.00%	0.00%	7.69%	0.00%	0.00%	0.00%	1.88%
	4	1.22%	0.00%	2.44%	2.38%	0.00%	10.00%	0.00%	0.00%	0.00%	0.00%	0.00%	8.82%	2.07%
	Average	**0.90%**	**0.40%**	**2.00%**	**1.12%**	**1.29%**	**3.75%**	**0.00%**	**0.00%**	**1.92%**	**0.00%**	**1.19%**	**4.77%**	**1.44%**
Off-Peak	1	10.53%	0.00%	0.00%	11.11%	0.00%	50.00%	7.14%	10.00%	0.00%	33.33%	1.23%	3.36%	10.56%
	2	7.32%	0.00%	0.00%	0.00%	0.00%	0.00%	7.69%	0.00%	25.00%	0.00%	1.84%	1.27%	3.59%
	3	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	4.96%	0.87%	0.49%
	4	0.00%	100.00%	0.00%	0.00%	0.91%	8.33%	14.29%	33.33%	50.00%	0.00%	1.47%	2.86%	17.60%
	Average	**4.46%**	**25.00%**	**0.00%**	**2.78%**	**0.23%**	**14.58%**	**7.28%**	**10.83%**	**18.75%**	**8.33%**	**2.38%**	**2.09%**	**8.06%**
PM Peak	1	2.56%	5.88%	6.06%	2.44%	1.72%	5.26%	0.00%	3.45%	0.00%	0.00%	2.35%	0.00%	2.48%
	2	1.89%	6.67%	5.00%	2.67%	2.27%	0.00%	2.27%	0.00%	0.00%	0.00%	1.73%	0.00%	1.87%
	3	6.90%	33.33%	0.00%	4.48%	1.75%	7.14%	3.23%	0.00%	0.00%	0.00%	0.00%	0.00%	4.74%
	4	1.92%	15.38%	0.00%	3.13%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.70%	1.36%	1.87%
	Average	**3.32%**	**15.32%**	**2.77%**	**3.18%**	**1.44%**	**3.10%**	**1.37%**	**0.86%**	**0.00%**	**0.00%**	**1.20%**	**0.34%**	**2.74%**

Table 7.2 Truck Percentages at Mayport Road & SR-A1A – “Off” Study

Period	Interval	Eastbound			Northbound			Westbound			Southbound			Average
		Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
AM Peak	1	0.00%	0.00%	0.00%	2.74%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.94%	0.00%	0.47%
	2	0.00%	0.00%	1.35%	3.75%	0.55%	11.11%	0.00%	0.00%	0.00%	0.00%	3.90%	0.00%	1.72%
	3	0.00%	0.00%	1.79%	5.56%	2.21%	0.00%	0.00%	0.00%	0.00%	0.00%	1.45%	0.00%	0.92%
	4	0.00%	0.00%	1.57%	3.80%	1.46%	0.00%	0.00%	0.00%	0.00%	0.00%	1.46%	0.00%	0.69%
	Average	**0.00%**	**0.00%**	**1.18%**	**3.96%**	**1.06%**	**2.78%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**2.44%**	**0.00%**	**0.95%**
Off-Peak	1	0.00%	20.00%	1.28%	6.33%	0.00%	18.18%	0.00%	0.00%	0.00%	0.00%	1.03%	9.09%	4.66%
	2	0.00%	0.00%	4.65%	1.41%	2.14%	0.00%	25.00%	30.00%	0.00%	0.00%	0.59%	0.00%	5.32%
	3	0.00%	0.00%	5.94%	4.55%	0.00%	10.00%	0.00%	0.00%	0.00%	0.00%	2.05%	0.00%	1.88%
	4	0.00%	33.33%	10.20%	5.26%	3.90%	16.67%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	5.78%
	Average	**0.00%**	**13.33%**	**5.52%**	**4.39%**	**1.51%**	**11.21%**	**6.25%**	**7.50%**	**0.00%**	**0.00%**	**0.92%**	**2.27%**	**4.41%**
PM Peak	1	0.00%	11.11%	1.68%	3.37%	4.51%	20.00%	0.00%	7.69%	0.00%	0.00%	1.78%	0.00%	4.18%
	2	0.00%	0.00%	1.65%	6.19%	4.69%	0.00%	0.00%	0.00%	0.00%	0.00%	0.68%	12.50%	2.14%
	3	0.00%	0.00%	6.06%	0.91%	3.95%	10.00%	8.33%	0.00%	0.00%	0.00%	1.74%	50.00%	6.75%
	4	25.00%	0.00%	3.29%	5.88%	4.44%	0.00%	0.00%	0.00%	0.00%	0.00%	1.05%	6.67%	3.86%
	Average	**6.25%**	**2.78%**	**3.17%**	**4.09%**	**4.40%**	**7.50%**	**2.08%**	**1.92%**	**0.00%**	**0.00%**	**1.31%**	**17.29%**	**4.23%**

7.2. PCE Flow Rates for “Off” Study (Nov. 9 & Nov. 10, 2016)

Table 7.3 PCE Flow Rates (pce/15 min and pce/hour) a Mayport Road & Wonderwood Drive – “Off” Study

Time Period		Eastbound			Northbound			Westbound			Southbound		
		Left	**Through**	**Right**	**Left**	**Through**	**Right**	**Left**	**Through**	**Right**	**Left**	**Through**	**Right**
AM Peak	1	142	46	12	16	131	39	0	1	2	1	31	35
	2	184	42	19	9	145	26	3	2	3	1	44	44
	3	129	64	41	49	110	42	19	22	14	13	37	37
	4	83	8	42	43	85	22	11	7	2	2	54	37
	Flow Rate	**538**	**160**	**114**	**117**	**471**	**129**	**33**	**32**	**21**	**17**	**166**	**153**
Off-Peak	1	42	10	10	10	51	3	15	11	3	8	246	123
	2	44	12	7	23	111	9	14	1	5	8	166	80
	3	61	11	7	18	137	12	11	6	7	1	148	116
	4	46	2	8	30	111	13	8	4	3	1	69	72
	Flow Rate	**193**	**35**	**32**	**81**	**410**	**37**	**48**	**22**	**18**	**18**	**629**	**391**
PM Peak	1	40	18	35	42	59	20	17	30	1	0	174	260
	2	54	16	21	77	45	36	45	50	4	8	176	245
	3	31	8	39	70	58	15	32	37	0	5	188	266
	4	53	15	17	66	57	9	20	24	2	6	144	224
	Flow Rate	**178**	**57**	**112**	**255**	**219**	**80**	**114**	**141**	**7**	**19**	**682**	**995**

Table 7.4 PCE Flow Rates (pce/15 min and pce/hour) a Mayport Road & SR-A1A – "Off" Study

Time Period		Eastbound			Northbound			Westbound			Southbound		
		Left	**Through**	**Right**	**Left**	**Through**	**Right**	**Left**	**Through**	**Right**	**Left**	**Through**	**Right**
AM Peak	1	2	3	115	75	154	11	12	20	1	2	70	4
	2	6	5	150	83	182	10	1	3	0	1	80	3
	3	6	1	171	95	185	4	1	0	0	2	140	4
	4	5	0	129	82	139	5	0	1	0	1	139	2
	Flow Rate	**19**	**9**	**565**	**335**	**660**	**30**	**14**	**24**	**1**	**6**	**429**	**13**
Off-Peak	1	3	6	79	84	94	13	5	2	9	32	196	12
	2	10	4	90	72	143	11	5	13	10	25	170	5
	3	10	11	107	92	171	22	12	13	14	8	149	5
	4	5	4	108	100	160	7	3	8	4	8	170	5
	Flow Rate	**28**	**25**	**384**	**348**	**568**	**53**	**25**	**36**	**37**	**73**	**685**	**27**
PM Peak	1	6	10	121	92	139	6	9	14	1	14	229	12
	2	7	1	123	103	134	20	7	8	2	2	296	9
	3	9	6	140	111	184	22	13	12	3	10	351	3
	4	10	6	157	108	141	12	13	24	5	3	289	16
	Flow Rate	**32**	**23**	**541**	**414**	**598**	**60**	**42**	**58**	**11**	**29**	**1165**	**40**

- The highest average flow rate was observed for the SR-A1A SB through movement, during the PM peak (Table 7.3).
- The movement was the highest observed at the Wonderwood Drive intersection (Table 7.2), as this route serves commuters leaving the Mayport Naval Station to reach Atlantic Boulevard.
- The high level of traffic flow observed in the left EB approach for the Wonderwood Drive during the AM Peak further underlines the significant impact of the Mayport Naval Station commuters along the corridor. Truck Percentage Observations for "On" Study (May 16 & May 17, 2017)

Table 7.5 Truck Percentages at Mayport Road & Wonderwood Drive– "On" Study

Period	Interval	Eastbound			Northbound			Westbound			Southbound			Average
		Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
AM Peak	1	0.71%	0.00%	0.00%	5.88%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.69%	4.35%	1.55%
	2	0.00%	0.00%	13.64%	7.69%	0.87%	0.00%	0.00%	9.09%	0.00%	0.00%	0.00%	0.00%	2.61%
	3	1.27%	3.03%	0.00%	0.00%	1.09%	3.45%	6.25%	15.38%	0.00%	0.00%	4.44%	0.00%	2.91%
	4	0.00%	10.00%	0.00%	2.63%	6.10%	8.33%	0.00%	0.00%	0.00%	12.50%	2.00%	3.45%	3.75%
	Average	**0.49%**	**3.26%**	**3.41%**	**4.05%**	**2.01%**	**2.95%**	**1.56%**	**6.12%**	**0.00%**	**3.13%**	**3.53%**	**1.95%**	**2.71%**
Off-Peak	1	5.41%	0.00%	0.00%	4.76%	0.00%	14.29%	16.67%	0.00%	0.00%	0.00%	0.43%	1.11%	3.56%
	2	2.44%	0.00%	11.76%	5.26%	1.33%	0.00%	0.00%	0.00%	7.14%	25.00%	0.83%	2.78%	4.71%
	3	4.62%	0.00%	0.00%	0.00%	0.00%	8.33%	0.00%	11.11%	0.00%	0.00%	0.00%	1.18%	2.10%
	4	0.00%	11.11%	11.11%	0.00%	0.00%	11.11%	0.00%	0.00%	25.00%	0.00%	1.06%	0.00%	4.95%
	Average	**3.11%**	**2.78%**	**5.72%**	**2.51%**	**0.33%**	**8.43%**	**4.17%**	**2.78%**	**8.04%**	**6.25%**	**0.58%**	**1.27%**	**3.83%**
PM Peak	1	13.56%	3.23%	8.70%	0.00%	1.64%	0.00%	0.00%	0.00%	0.00%	0.00%	0.61%	0.61%	2.36%
	2	0.00%	0.00%	6.25%	1.19%	1.52%	0.00%	0.00%	0.00%	50.00%	0.00%	0.70%	0.46%	5.01%
	3	0.00%	0.00%	0.00%	1.61%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.20%	1.17%	0.33%
	4	0.00%	0.00%	0.00%	2.27%	2.94%	0.00%	6.67%	3.45%	0.00%	0.00%	1.75%	0.94%	1.50%
	Average	**3.39%**	**0.81%**	**3.74%**	**1.27%**	**1.52%**	**0.00%**	**1.67%**	**0.86%**	**12.50%**	**0.00%**	**1.07%**	**0.79%**	**2.30%**

Table 7.6 Truck Percentages at Mayport Road & SR-A1A – "On" Study

Period	Interval	Eastbound			Northbound			Westbound			Southbound			Average
		Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
AM Peak	1	10.00%	16.67%	0.00%	11.63%	0.00%	0.00%	50.00%	0.00%	0.00%	0.00%	1.43%	0.00%	7.48%
	2	0.00%	0.00%	0.00%	13.33%	2.03%	0.00%	0.00%	0.00%	0.00%	0.00%	4.35%	14.29%	2.83%
	3	0.00%	0.00%	2.10%	10.81%	1.18%	0.00%	16.67%	0.00%	0.00%	0.00%	0.00%	0.00%	2.56%
	4	0.00%	0.00%	1.74%	5.88%	5.69%	0.00%	0.00%	0.00%	0.00%	0.00%	3.45%	0.00%	1.40%
	Average	**2.50%**	**4.17%**	**0.96%**	**10.41%**	**2.22%**	**0.00%**	**16.67%**	**0.00%**	**0.00%**	**0.00%**	**2.31%**	**3.57%**	**3.57%**
Off-Peak	1	20.00%	0.00%	1.98%	5.13%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	2.01%	0.00%	2.43%
	2	0.00%	0.00%	0.99%	2.60%	1.56%	15.00%	14.29%	0.00%	0.00%	0.00%	0.77%	0.00%	2.93%
	3	0.00%	0.00%	0.00%	2.06%	0.00%	12.50%	0.00%	0.00%	0.00%	5.00%	3.03%	0.00%	1.88%
	4	11.11%	14.29%	0.00%	2.38%	3.28%	5.88%	11.76%	11.11%	0.00%	0.00%	2.22%	0.00%	5.17%
	Average	**7.78%**	**3.57%**	**0.74%**	**3.04%**	**1.21%**	**8.35%**	**6.51%**	**2.78%**	**0.00%**	**1.25%**	**2.01%**	**0.00%**	**3.10%**
PM Peak	1	0.00%	0.00%	0.84%	0.00%	3.73%	40.74%	11.76%	0.00%	0.00%	10.53%	3.03%	0.00%	5.89%
	2	16.67%	0.00%	4.10%	3.42%	9.21%	0.00%	0.00%	0.00%	0.00%	0.00%	17.62%	0.00%	4.25%
	3	0.00%	0.00%	0.80%	5.66%	2.76%	0.00%	0.00%	0.00%	0.00%	0.00%	1.17%	0.00%	0.87%
	4	0.00%	0.00%	0.73%	0.82%	0.66%	0.00%	0.00%	0.00%	0.00%	0.00%	1.35%	0.00%	0.30%
	Average	**4.17%**	**0.00%**	**1.62%**	**2.47%**	**4.09%**	**10.19%**	**2.94%**	**0.00%**	**0.00%**	**2.63%**	**5.79%**	**0.00%**	**2.83%**

7.3. PCE Flow Rates for "On" Study (May 16 & May 17, 2017)

Table 7.7 PCE Flow Rates (pce/15 min and pce/hour) at Mayport Road & Wonderwood Drive – "On" Study

Time Period (15 min)		Eastbound			Northbound			Westbound			Southbound		
		Left	**Through**	**Right**	**Left**	**Through**	**Right**	**Left**	**Through**	**Right**	**Left**	**Through**	**Right**
AM Peak	1	142	79	17	18	188	28	2	0	1	0	28	24
	2	119	52	25	14	116	23	6	12	3	3	43	32
	3	80	68	33	54	93	30	17	15	6	10	47	34
	4	91	11	17	39	87	13	4	10	2	9	51	30
	Flow Rate	**432**	**210**	**92**	**125**	**484**	**94**	**29**	**37**	**12**	**22**	**169**	**120**
Off-Peak	1	39	3	10	22	92	16	7	3	0	15	233	91
	2	42	2	19	20	152	17	9	7	15	5	121	74
	3	68	24	13	25	123	13	6	10	2	1	113	86
	4	50	10	10	25	94	10	11	5	5	1	95	85
	Flow Rate	**199**	**39**	**52**	**92**	**461**	**56**	**33**	**25**	**22**	**22**	**562**	**336**
PM Peak	1	67	32	25	35	62	34	32	23	5	5	164	166
	2	41	23	17	85	67	38	25	25	3	1	144	220
	3	40	25	32	63	57	36	20	39	3	5	168	173
	4	48	8	23	90	70	23	16	30	2	3	174	215
	Flow Rate	**196**	**88**	**97**	**273**	**256**	**131**	**93**	**117**	**13**	**14**	**650**	**774**

Table 7.8 PCE Flow Rates (pce/15 min and pce/hour) at Mayport Road & SR-A1A – "On" Study

Time Period (15 min)		Eastbound			Northbound			Westbound			Southbound		
		Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right
AM Peak	1	11	7	92	96	129	6	6	3	0	3	71	4
	2	2	1	110	68	151	8	1	0	1	3	72	8
	3	5	1	146	82	172	1	7	1	1	1	127	7
	4	8	0	117	72	130	8	2	3	0	0	150	6
	Flow Rate	**26**	**9**	**465**	**318**	**582**	**23**	**16**	**7**	**2**	**7**	**420**	**25**
Off-Peak	1	6	9	103	82	95	12	6	6	9	30	203	7
	2	8	4	102	79	130	23	8	6	12	36	131	8
	3	4	12	115	99	162	27	19	6	15	21	34	6
	4	10	8	104	86	189	18	19	10	6	17	138	8
	Flow Rate	**28**	**33**	**424**	**346**	**576**	**80**	**52**	**28**	**42**	**104**	**506**	**29**
PM Peak	1	5	7	120	84	139	38	19	5	1	21	238	31
	2	7	1	127	121	166	9	7	10	2	9	307	9
	3	4	7	126	112	149	5	11	7	5	11	259	9
	4	10	2	138	123	152	20	22	16	1	6	226	10
	Flow Rate	**26**	**17**	**511**	**440**	**606**	**72**	**59**	**38**	**9**	**47**	**1030**	**59**

7.4. Comparisons of "Off" and "On" Flow Rates

The differences in traffic flow rates between the "Off" and "On" measurements are shown in Table 7.9 and Table 7.10. The tables are color-coded as follows: green shows significant decrease, yellow shows modest change (either improvement or deterioration), and red shows significant deterioration in delay. Several gradations of each color are used to represent variations within each classification. (The deepest red represents the biggest deterioration and deepest green represents the best improvement and no change is represented by deepest yellow. Depth of all in-between shades correspond to the magnitude of change).

Table 7.9 Differences in Traffic Flow Rates (pce/hr) at Mayport Road & Wonderwood Drive

Period	Eastbound			Northbound			Westbound			Southbound		
	Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right
AM Peak	-106	50	-22	8	13	-35	-4	5	-9	5	3	-33
Off-Peak	6	4	20	11	51	19	-15	3	4	4	-67	-55
PM Peak	18	31	-15	18	37	51	-21	-24	6	-5	-32	-221

Table 7.10 Differences in Traffic Flow Rates (pce/hr) at Mayport Road & SR-A1A

Period	Eastbound			Northbound			Westbound			Southbound		
	Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right
AM Peak	7	0	-100	-17	-78	-7	2	-17	1	1	-9	12
Off-Peak	0	8	40	-2	8	27	27	-8	5	31	-179	2
PM Peak	-6	-6	-30	26	8	12	17	-20	-2	18	-135	19

7.5. Discussion

The following were concluded from the comparison of traffic flow rates:

- At Wonderwood Drive, throughput increased slightly but uniformly for the EB and NB approaches, with the largest increase of 51 veh/h for NBT in the off-peak. Conversely, a decrease in flow was observed for the SB.
- At SR-A1A, the traffic traveling southbound (EB right and SB through approaches) show marginal decrease in throughput.
- In general (except for the SB through movement at the SR-A1A intersection), the traffic throughput either marginally improved or remained the same.

8. CONSIDERATION OF TRAFFIC FLOW RATES JOINTLY WITH QUEUE LENGTH

The differences in "Traffic Flow Rate" and "Queue Length" between "Off" and "On" measurements are shown in Table 8.1 and Table 8.3. The tables are color-coded as follows: green indicates that "Queue" decreases and "Traffic Flow Rate" increases, red indicates "Queue" increases and "Traffic Flow Rate" decreases, no color indicates "Traffic Flow Rate" and "Queue" increase or decrease at the same time. Generally, green indicates improvement despite an increase in flow rate.

Table 8.1 Differences in Traffic Flow Rate (TF) and Queue Length (Q) at Mayport Road & Wonderwood Drive

Time Period	EB						NB						WB						SB					
	Left		Through		Right		Left		Through		Right		Left		Through		Right		Left		Through		Right	
	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q
AM Peak	-106	2.0	50.0	0.1	-22	0.0	8	0.1	13.0	-0.7	-35	-0.1	-4.0	0.5	5.0	0.5	-9.0	0.2	5.0	0.2	3.0	0.9	-33	0.1
Off-Peak	6.0	1.7	4.0	0.3	20.0	0.0	11	-0.2	51.0	-0.5	19.0	0.1	-15	0.0	3.0	0.3	4.0	0.2	4.0	0.0	-67	1.5	-55	0.2
PM Peak	18.0	0.8	31.0	1.8	-15	0.1	18	3.4	37.0	0.3	51.0	0.0	-21	1.9	-24.0	1.5	6.0	0.2	-5.0	0.1	-32	6.9	-221	-0.8

Table 8.2 Difference (%) in Traffic Flow Rate (TF) and Queue Length (Q) at Mayport Road & Wonderwood Drive

Time Period	EB						NB						WB						SB					
	Left		Through		Right		Left		Through		Right		Left		Through		Right		Left		Through		Right	
	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q
AM Peak	-20%	29%	31%	3%	-19%	-	7%	3%	3%	-42%	-27%	-100%	-12%	43%	16%	51%	-43%	51%	29%	60%	2%	62%	-22%	68%
Off-Peak	3%	67%	11%	22%	63%	-	14%	-19%	12%	-25%	51%	167%	-31%	-2%	14%	42%	22%	43%	22%	7%	-11%	54%	-14%	-
PM Peak	10%	25%	54%	113%	-13%	-	7%	52%	17%	38%	64%	-	-18%	73%	-17%	31%	86%	31%	-26%	60%	-5%	127%	-22%	-11%

Table 8.3 Differences in Traffic Flow Rate (TF) and Queue Length (Q) at Mayport Road & SR-A1A

Time Period	EB						NB						WB						SB					
	Left		Through		Right		Left		Through		Right		Left		Through		Right		Left		Through		Right	
	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q
AM Peak	7.0	-0.5	0.0	0.2	-100.0	0.0	-17.0	-3.8	-78.0	-1.9	-7.0	-0.3	2.0	-0.6	-17.0	-0.8	1.0	-0.5	1.0	-0.5	-9.0	-0.1	12.0	0.2
Off-Peak	0.0	0.8	8.0	0.4	40.0	1.4	-2.0	-3.0	8.0	-2.0	27.0	0.0	27.0	0.8	-8.0	0.6	5.0	0.7	31.0	1.0	-179.0	4.3	2.0	0.7
PM Peak	-6.0	-0.3	-6.0	-0.2	-30.0	1.5	26.0	-5.0	8.0	-4.2	12.0	-0.5	17.0	0.9	-20.0	-0.6	-2.0	0.1	18.0	-0.2	-135.0	-5.8	19.0	-0.6

Table 8.4 Difference (%) in Traffic Flow Rate (TF) and Queue Length (Q) at Mayport Road & SR-A1A

Time Period	EB						NB						WB						SB					
	Left		Through		Right		Left		Through		Right		Left		Through		Right		Left		Through		Right	
	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q	TF	Q
AM Peak	37%	-53%	-	-	-18%	-	-5%	-34%	-12%	-52%	-24%	-87%	14%	-56%	-71%	-92%	100%	-96%	17%	-81%	-2%	-3%	92%	74%
Off-Peak	-	-	35%	-	11%	-	-1%	-25%	1%	-52%	56%	-	113%	63%	-24%	96%	14%	163%	42%	43%	-26%	92%	8%	178%
PM Peak	-20%	-30%	-27%	-32%	-6%	21%	7%	-28%	1%	-76%	21%	-95%	41%	65%	-35%	-23%	-18%	73%	62%	-14%	-12%	-30%	51%	-30%

8.1. Discussion

The following can be concluded from the comparison of traffic flow rates jointly with queue length:

- At Wonderwood Road, when traffic flows and queues are considered together there is no clear change for the EB and NB directions. The WB deteriorates as the main line is favored. The SB has an increase in queues. However, as discussed previously, when examining the delay charts, there are minimal delays for the remainder of the SB through movements once vehicles get the green at Wonderwood Road.
- At SR-A1A, conditions improved for the NB approach, and the side streets (WB and EB) had a net improvement in performance.

9. CONCLUSIONS

The implementation of the ASCT system resulted in an overall decrease in travel time in both directions (21.2% for the SB, and 4.4% for the NB) for the Mayport Road-Atlantic Blvd Corridor. Significant improvements were observed for the SB direction. The performance of the corridor in the NB direction did not improve, mostly because it was already operating efficiently.

Significant decreases in delay for the SB direction were observed for the Mazama, Plaza, and Fairway Villas Drive intersections. The only intersection with relatively high delay in the NB direction was the Fairway Villas Drive intersection, and it showed improvement with the ASCT system. Regarding queue length, the SR-A1A intersection had significant improvement along the SB direction. Relatively longer queues were observed at Wonderwood Road (northernmost intersection) in the SB, most likely because the ASCT system generated optimal platoons, which resulted in minimal delays for the remainder of the southbound route.

Traffic flow rates are affected by Mayport Naval Station commuter traffic. This is the case particularly for the Wonderwood Drive EB left and NB through movements, which experience high demands during the AM peak period, as commuters arrive in the morning. During the PM peak period, the SB right and SB through movements have higher volumes as commuters depart. Traffic throughput throughout the corridor either marginally improved or remained the same, except for the SB through at SR-A1A, which intersects heavy EBR volumes. Thus, the ASCT system generally improved operations along the corridor by reducing travel times and queue lengths at several locations.

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