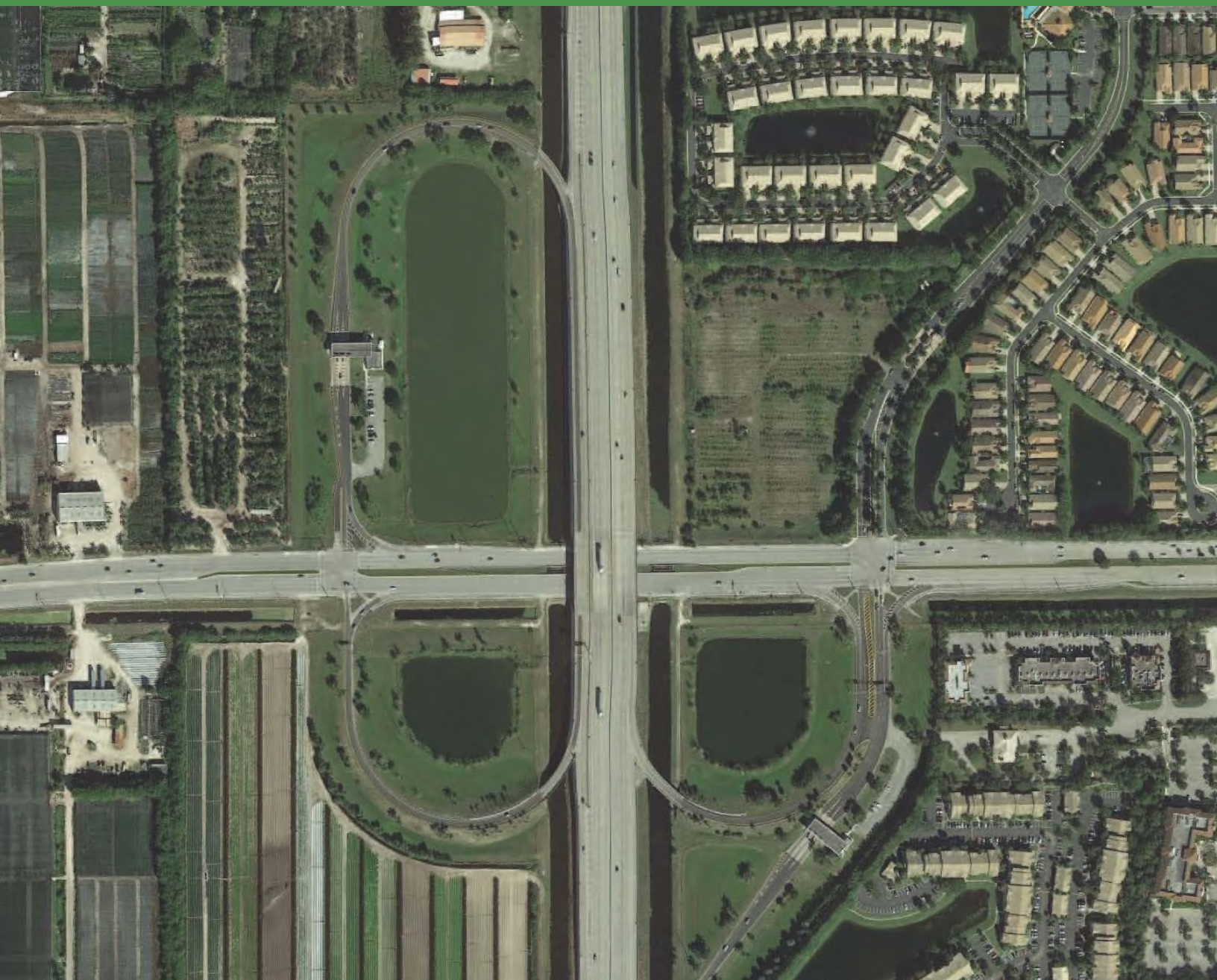
June 2021

Florida's Turnpike (SR 91) and Boynton Beach Boulevard (SR 804)

Palm Beach County, Florida

Financial Project ID: 437169-1

INTERCHANGE MODIFICATION REPORT



Florida's Turnpike (SR 91) and Boynton Beach Boulevard (SR 804) Interchange Modification Report

Financial Project No: 437169-1

Florida Department of Transportation

Determination of Engineering and Operational Acceptability

Acceptance of this document indicates successful completion of the review and determination of engineering and operational acceptability of the Interchange Access Request. Approval of the access request is contingent upon compliance with applicable Federal requirements, specifically the National Environmental Policy Act (NEPA) or Department's Project Development and Environment (PD&E) Procedures. Completion of the NEPA/PD&E process is considered approval of the project location design concept described in the environmental document.

Requestor	DocuSigned by: Carol Scott 3B887FB255B94F2... Carol Scott, CPM Florida's Turnpike Enterprise Planning Manager	6/21/2021 | 9:49 AM ED Date
Interchange Review Coordinator	DocuSigned by: Carol Scott 3B887FB255B94F2... Carol Scott, CPM Florida's Turnpike Enterprise	6/21/2021 | 9:49 AM ED Date
District Interchange Review Coordinator	DocuSigned by: Cesar Martinez DC7B7B72D0BD4A2... Cesar Martinez, PE FDOT District 4 Project Development Manager	6/21/2021 | 9:22 PM ED Date
Systems Management Administrator	DocuSigned by: jenna bowman 4AD03E6A337F4C1... Jenna Bowman, PE Systems Implementation Office-Central Office	6/24/2021 | 7:04 AM ED Date

SYSTEMS IMPLEMENTATION OFFICE

QUALITY CONTROL CERTIFICATION FOR INTERCHANGE ACCESS REQUEST SUBMITTAL

Submittal Date: 6/18/2021 | 2:20 PM EDT

FM Number: 437169-1

Project Title: Florida's Turnpike (SR 91) and Boynton Beach Boulevard (SR 804) - Interchange Modification Report

District: Turnpike

Requestor: Carol Scott, CPM. Phone: 407-264-3023

District IRC: Carol Scott, CPM Phone: 407-264-3023

Document Type: ☐ MLOU ☐ IJR ☑ IMR ☐ IOAR ☐ OTHER

Status of Document (Only complete documents will be submitted for review; however, depending on the complexity of the project, interim reviews may be submitted as agreed upon in the MLOU)

Quality Control (QC) Statement

This document has been prepared following FDOT Procedure Topic No. 525-030-160 (New or Modified Interchanges) and complies with the FHWA two policy requirements. Appropriate District level quality control reviews have been conducted and all comments and issues have been resolved to their satisfaction. A record of all comments and responses provided during QC review is available in the project file or Electronic Review Comments (ERC) system.

Requestor: DocuSigned by: Carol Scott 3B887FB255B94F2... Date: 6/18/2021 | 2:20 PM EDT

Carol Scott, CPM

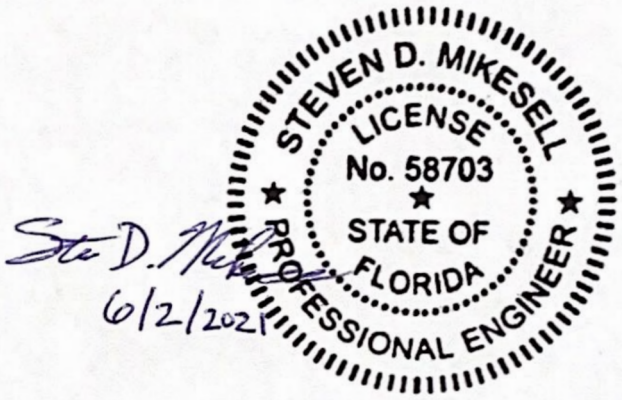
IRC: DocuSigned by: Carol Scott 3B887FB255B94F2... Date: 6/18/2021 | 2:20 PM EDT

Carol Scott, CPM

Engineer's Certification

I, Steven Mikesell, PE number 58703, certify that I currently hold an active Professional Engineer's License in the State of Florida, and I am competent through education or experience to provide engineering services in the civil and traffic engineering disciplines contained in this report. I further certify that this report was prepared by me or under my responsible charge as defined in Chapter 61G15-18.001 F.A.C. and that the statements, conclusions, and recommendations made herein are true and correct to the best of my knowledge and ability.

Project Description: Florida's Turnpike (SR 91) and Boynton Beach Boulevard (SR 804) - Interchange Modification Report



Steven Mikesell, PE
Florida Registration PE No. 58703
AECOM Technical Services, Inc.
Orlando, Florida 32801

Table of Contents

Table of Contents

Tables **Page**

Figures

Appendices

The primary purpose of the Boynton Beach Boulevard Interchange Modification Report (IMR) project is to identify the long-term needs through 2045 and to evaluate the concepts to address existing traffic congestion and related capacity deficiencies caused by the short weaving section which is currently operating at Level of Service (LOS) F during AM peak hour. As traffic demand increases in the future, traffic operations are expected to deteriorate within the interchange weaving section and thus impacting the freeway mainline. This IMR evaluates the traffic operations of the No-Build and Build alternatives.

The information and analysis indicate that several of the merge, diverge, and weaving areas along Florida's Turnpike and ramp intersections along Boynton Beach Boulevard are projected to experience operational failures in 2045. Proposed modifications to the mainline, ramps, and the interchange are recommended to address projected deficiencies in the future. Listed below are specific modifications and projected benefits:

- The proposed Build Alternative includes relocating the southbound off-ramp upstream of Boynton Beach Boulevard. The southbound on-ramp serving the westbound to southbound traffic merges with the mainline upstream of Boynton Beach Boulevard as a lane-add. A new southbound on-ramp serving the eastbound to southbound traffic is added and merges with the mainline. The two-lane exit for the northbound off-ramp will have a lane-drop under the Build condition. The Build alternative lane configuration is depicted on **Figure 5.1**.
- Under the 2045 No-Build condition, majority of the freeway mainline segments are projected to operate at LOS E or worse in both the northbound and southbound directions either during one or both design hours. The proposed Build alternative with a 10-lane section south of Boynton Beach Boulevard and an 8-lane section north of Boynton Beach Boulevard will provide LOS D or better operations for all freeway mainline segments.
- Under 2045 No-Build condition, the failure of the existing barrier separated southbound weaving section between the southbound off-ramp and the southbound on-ramp is expected to cause operational and safety problems on the Turnpike mainline. The freeway mainline will be over-capacity south of the southbound on-ramp merge from Boynton Beach Blvd. The proposed elimination of this weaving section under the Build condition will significantly improve the safety and flow of traffic along the Turnpike mainline.
- The proposed two-lane exit for the northbound off-ramp with a lane-drop under the 2045 Build condition will significantly improve the ramp junction Level of Service from LOS F under the 2045 No-Build condition to LOS D under the Build condition. Further modification was made at the northbound off ramp terminal by assigning northbound shared left, thru and right turn lane which will stop at the traffic signal and an exclusive northbound right turn lane which will operate under yield condition as part of the Transportation System Management and Operations (TSM&O). This configuration will reduce the weaving issue for the northbound off-ramp traffic turning eastbound left at Hagen Ranch Road.

- The southbound ramp improvements and modifications proposed under the 2045 Build condition will improve the Level of Service of the southbound ramp terminal intersection from LOS F under the 2045 No-Build condition to LOS B under the Build condition during AM design hour.
- All mainline and ramp freeway segments projected to operate at LOS E or worse under the 2045 No-Build condition are expected to operate at LOS D or better under the 2045 Build condition.

These improvements address the traffic operation deficiencies by eliminating or improving the failing conditions within the interchange influence area and improving safety by reducing congestion and improving operating conditions along Boynton Beach Boulevard. Considering the overall operations along Florida's Turnpike, ramp terminals, and along Boynton Beach Boulevard, the Build alternative is projected to provide better operating conditions than the No-Build. The Highway Safety Manual (HSM) safety analysis shows that the Build condition is expected to have approximately 499 fewer crashes than the No-Build with a saving of approximately $46 million over a 20-year period in 2020 present value.

The Federal Highway Administration's (FHWA's) newly adopted policy on *Access to the Interstate System* became effective on May 22, 2017 and replaces the policy of August 27, 2009 on *Access to the Interstate System*, published at 74 Federal Register 43743. The changes in this policy are made to ensure this policy focuses on safety, operational, and engineering issues. The consideration of social, economic, and environmental impacts discussed in the 2009 policy are removed from this policy. However, the removal from this policy does not eliminate the need to consider those matters. Those issues will be addressed under the National Environmental Policy Act and other statutes and regulations applicable to the approval process.

Considerations and Requirements

1. *An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes mainline lanes, existing, new, or modified ramps, and ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections. The analysis should, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access (Title 23, Code of Federal Regulations (CFR), paragraphs 625.2(a), 655.603(d) and 771.111(f)). The crossroads and the local street network, to at least the first major intersection on either side of the proposed change in access, should be included in this analysis to the extent necessary to fully evaluate the safety and operational impacts that the proposed change in access and other transportation improvements may have on the local street network (23 CFR 625.2(a) and 655.603(d)). Requests for a proposed change in access should include a description and assessment of the impacts and ability of the proposed changes to safely and efficiently collect, distribute, and accommodate traffic on the Interstate facility, ramps, intersection of ramps with crossroad, and local street network (23 CFR 625.2(a) and 655.603(d)). Each request should also include a conceptual plan of the type and location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d).*

The operational analysis conducted for the IMR confirmed that the proposed interchange modifications are not expected to have any adverse impacts on safety and operations on the interstate facility (Florida's Turnpike). The proposed elimination of the barrier separated southbound weaving segment between the southbound off-ramp and the southbound on-ramp will significantly improve the safety and flow of traffic along the Turnpike mainline and the southbound ramps. The proposed two-lane exit for the northbound off-ramp with a lane-drop under the Build condition will significantly improve the ramp junction Level of Service from LOS F under the No-Build to LOS D under the Build condition. The southbound ramp improvements and modifications proposed under the Build condition will improve the Level of Service of the southbound ramp terminal intersection from LOS F under the No-Build condition to LOS B under the Build condition during the AM design hour. In addition, all mainline and ramp freeway segments projected to operate at LOS E or worse under the No-Build condition are expected to operate at LOS D or better under the Build condition.

The projected failing conditions under the No-Build Alternative are expected to increase future crash risk within the project corridor. This potential for increased crash risk is alleviated by the capacity improvements proposed in the Build Alternative. The predictive crash analysis comparison between No-Build and Build Alternatives shows that the overall predicted number of crashes are lower for Build compared to the No-Build. The Build Alternative is predicted to have a 20-year crash cost savings of approximately $46 Million compared to the No-Build Alternative, in 2020 present value.

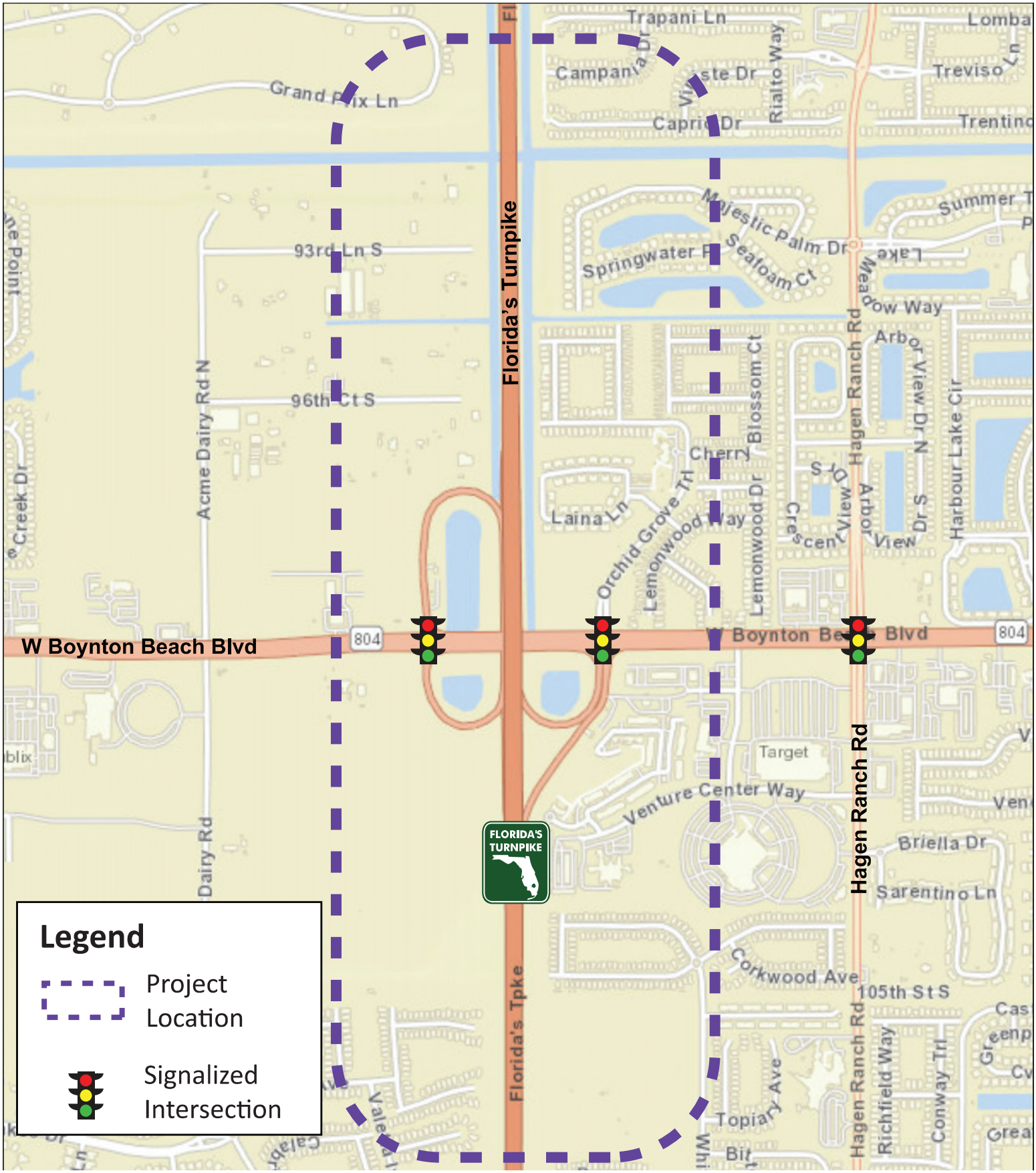
2. *The proposed access connects to a public road only and will provide for all traffic movements. Less than "full interchanges" may be considered on a case-by-case basis for applications requiring special access, such as managed lanes (e.g., transit or high occupancy vehicle and high occupancy toll lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards (23 CFR 625.2(a), 625.4(a)(2), and 655.603(d)). In rare instances where all basic movements are not provided by the proposed design, the report should include a full-interchange option with a comparison of the operational and safety analyses to the partial-interchange option. The report should also include the mitigation proposed to compensate for the missing movements, including wayfinding signage, impacts on local intersections, mitigation of driver expectation leading to wrong-way movements on ramps, etc. The report should describe whether future provision of a full interchange is precluded by the proposed design.*

   This IMR does not propose any new interchanges along Florida's Turnpike. The existing interchange provides access to public roads only. The improvements proposed at the interchange will maintain full access to the existing cross streets and accommodate all movements.

1.1 INTRODUCTION

Boynton Beach is one of the fastest growing cities in Palm Beach County. According to US Census Bureau, from 2016 to 2018 its population has grown at a rate of 14.4 percent compared to 7.9 percent countywide growth. This growth is projected to continue leading to high traffic growth in the study corridor and the surrounding arterials. The Boynton Beach Boulevard interchange is the only direct access to and from Florida's Turnpike in Boynton Beach, leading to more traffic demand than the existing capacity. Due to the increased travel demand expected in the future, the corridor is being evaluated for the widening to 10 lanes south of Boynton Beach and 8 lanes north of the interchange. The existing mainline within the study area has three continuous mainline travel lanes per direction. The Boynton Beach Boulevard interchange at Mile Post 86 (MP 86) is a partial cloverleaf configuration with three loop ramps. The existing interchange configuration creates a short weave zone between southbound off-ramp and on-ramp traffic within a short distance (about 1,300 feet). **Figure 1.1** depicts the project location map and the existing interchange configuration is shown in **Figure 1.2**.

At the request of the Department and as part of Financial Project ID 437169-1, this study will evaluate the ultimate improvements under the Florida's Turnpike Mainline Widening Project from north of the Atlantic Avenue interchange (MP 81) through the Boynton Beach Boulevard interchange (MP 86) in Palm Beach County. The traffic analysis will include the evaluation of the proposed additional mainline capacity, the safety, and the operational and engineering (SO&E) acceptability for the modifications of Boynton Beach Boulevard interchange.



FLORIDA'S TURNPIKE	**Boynton Beach Boulevard Interchange Modification Report**	**Project Location Map**	**Figure 1.1**

FLORIDA'S TURNPIKE	Boynton Beach Boulevard Interchange Modification Report	Boynton Beach Boulevard Interchange	Figure 1.2

1.2 PURPOSE AND NEED

According to US Census Bureau, from 2016 to 2018 the population of Boynton Beach has grown at a rate of 14.4 percent compared to 7.9 percent county-wide growth. The Boynton Beach Boulevard interchange is the only direct access to and from Florida's Turnpike in Boynton Beach, leading to future demand increase than the existing weaving segment capacity. The Boynton Beach Boulevard interchange is a partial cloverleaf configuration with three loop ramps and a slip ramp. The existing interchange configuration creates a short weave zone between southbound off-ramp and on-ramp traffic within a short distance (about 1,300 feet). The weaving segment between the southbound ramps is a one-sided weaving type, with a single on-ramp lane closely followed by a single off-ramp lane. The weaving maneuver occurs within a two-lane segment where the southbound on-ramp and off-ramp traffic converge before joining or exiting the mainline.

Modification of the Boynton Beach Boulevard interchange is being proposed to address existing traffic congestion and related capacity deficiencies caused by the short weaving section which is currently operating at LOS F during AM peak hour. As traffic demand increases in the future, traffic operations are expected to deteriorate within the interchange weaving section and thus impacting the freeway mainline.

1.3 PLANNED AND PROGRAMMED TRANSPORTATION PROJECTS

Applicable Master Plans, Florida Department of Transportation's (FDOT's) Five (5) Year Work Program, interchange planning and safety studies performed by FDOT District Four and future projects identified in the Palm Beach Metropolitan Planning Organization (MPO) Transportation Improvement Program (TIP), FDOT Florida Intrastate Highway System (FIHS)/Strategic Intermodal System (SIS) Plan, Palm Beach MPO 2040 Long Range Transportation Plan (LRTP), local government comprehensive plans, and active Development of Regional Impact (DRI) applications were reviewed to identify any planned and programmed improvements within the study limits of the Interchange Modification Report (IMR). The IMR improvements will be developed to be consistent with these plans or steps will be taken to achieve consistency. The key planned improvements include:

- Florida's Turnpike Mainline Design and Widening (FPID: FPN 417169-1) is being evaluated for the widening to 10 lanes south of Boynton Beach and 8 lanes north of the interchange. This project extends from Atlantic Avenue in Delray Beach at MP 81 to Boynton Beach Boulevard interchange at MP 86. The interchange will be modified to eliminate the weave.
- Transportation System Management and Operations (TSM&O) strategies for safety and congestion management such as addition of turn lanes and storage length at northbound off ramp have been programmed under the Work Program for construction in FY 2023. This project is within FTE'S system and will be funded by FTE.

The methodology applied for the Boynton Beach Boulevard (SR 804) IMR is documented in the Methodology Letter of Understanding (MLOU) dated March 4, 2020. The MLOU was approved by FDOT District 4 and the Systems Implementation Office (SIO) of FDOT Central Office. The MLOU outlines the criteria, assumptions, processes, analyses and documentation requirements for the project. The approved MLOU is included in **Appendix A** for ease of reference. The following summarizes some of the more prominent topics covered under the MLOU.

2.1 AREA OF INFLUENCE

Based on FDOT's 2018 Interchange Access Request User's Guide (IARUG), the Interchange Access Modification Request should include an area of influence based on safety and operations concerns. The Atlantic Avenue interchange (MP 81) is 5 miles south of Boynton Beach Boulevard, while the Lake Worth Road interchange (MP 93) is 7 miles north of Boynton Beach Boulevard.

Based on these distances, and since the proposed modification at the Boynton Beach interchange is not expected to change adjacent interchange demand or operation, the anticipated Area of Influence (AOI) along the Turnpike Mainline will not include the freeway merge/diverge ramps at interchanges to the south and north of Boynton Beach Boulevard. The anticipated AOI for the IMR is depicted on **Figure 2.1**, which includes the approaching mainline basic segments; merging, diverging, and weaving segments; and the ramp terminals. Since the proposed modification is not anticipated to influence operations of the intersections located more than half a mile from the interchange ramps, the AOI along Boynton Beach Boulevard will only include the east and west ramp terminal intersections, the Hagen Ranch Road intersection and the approaching arterial segments.

2.2 ANALYSIS YEARS

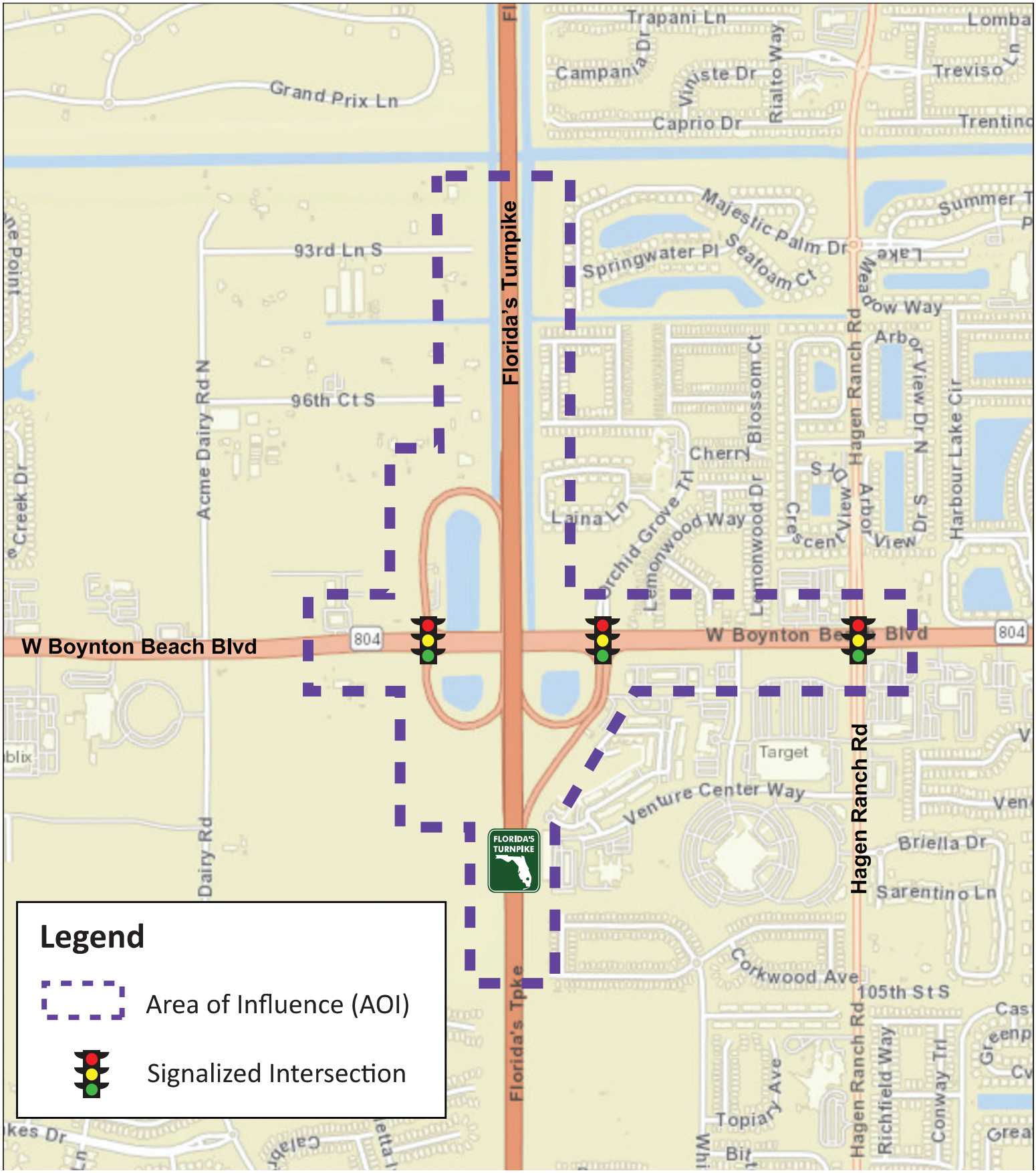
The analysis years for the project were determined as follows:

For Traffic Forecasting:

- Base year 2010 revalidated to 2017
- Opening year 2025
- Horizon year 2045

For Traffic Operational Analysis:

- Existing year 2018
- Opening year 2025
- Design year 2045



FLORIDA'S TURNPIKE	**Boynton Beach Boulevard Interchange Modification Report**	**Area of Influence**	**Figure 2.1**

2.3 TRAVEL DEMAND FORECASTING

2.3.1 Selected Travel Model

The Southeast Regional Planning Model version 7 (SERPM 7) was used to develop the traffic forecasts for this project. The SERPM covers a three-county region in Southeast Florida: Palm Beach, Broward, and Miami-Dade. The SERPM produces traffic volumes at a daily level, as well as for five periods: AM Peak (6:00 – 9:00 AM), PM Peak (3:00 – 7:00 PM), Mid-Day (MD, 9:00 AM– 3:00 PM), Evening (EV, 7:00 – 10:00 PM), and Nighttime (NT, remainder of the day). The SERPM version 7 (SERPM 7) was used as a base model for this project since this Activity Based version has an enhanced modeling process for truck traffic. Numerous updates were made to the SERPM 7, including socioeconomic data and networks, to produce a modified version of SERPM 7 FTE model. The model was updated specifically for evaluating toll road and Managed/Express lanes projects in southeast Florida.

2.3.2 Project Traffic Forecast Development Methodology

The development of the project traffic forecast was a multi-step effort involving a combination of internal modeling procedures and post-model evaluation. The historical growth rates provided by Palm Beach County were used to develop cross street Annual Average Daily Traffic (AADT). For the Turnpike Mainline and ramps, the growth rates from SERPM 7 FTE model was applied.

The traffic forecasting methodology for each approach for each intersection was performed based on the most recently available AADT (from the field), and the 2017 re-validated base year and 2045 SERPM model volumes. The recommended 2045 AADTs was calculated by applying the model growth rate to the most recently available field AADT. For the roadway links, comparison was made between the 2017 and 2045 model AADTs and a minimum annual compound growth rate of 0.5 percent was adopted. Additionally, the National Cooperative Highway Research Program (NCHRP) 765 forecasting procedure was employed to further refine the future No-Build estimates.

The final forecasted AADTs from the subarea model, along with K-factors and D-factors, was used to develop corridor-level directional design hour volumes (DDHVs), consistent with the guidelines set forth in the FDOT Project Traffic Forecasting Handbook. For managed lane facilities, the SERPM 7 FTE regional model period trip tables were utilized in the Express Lane Time of Day version 4 (ELToDv4) model to determine hourly traffic for the general purpose and managed lanes. Additionally, local development approval sources such as the Traffic Performance Standards (TPS) database for Palm Beach County were reviewed to assure that the design traffic accounted for the approved development impacts such as the Boynton Commons/The Grove Multiple Use Planned Development (MPUD) District within the operational footprint of the project.

2.3.3 Model Validation Methodology

The model development for this project involved enhancing the SERPM regional model by correcting roadway configurations and adding local streets important to local circulation around the study corridor. The SERPM model was re-validated to reflect 2017 traffic conditions in an iterative fashion,

following standard model validation procedures and principles by adjusting link attributes at the regional level. Land use and socioeconomic data were reviewed to verify that existing and proposed land uses within the study area are properly accounted for within the model. Once the SERPM 7 FTE model was validated, the trip list produced by the model was extracted and refined for managed lanes modeling in ELToDv4 Model. The ELToDv4 is a Dynamic Traffic Assignment (DTA) model with an advanced mixed multinomial logit (MMNL) toll choice model embedded to allow vehicles to perform a choice between managed lanes (ML) and general toll lanes (GTL) at each ingress and egress point. The model estimates future traffic and toll rates in 15-minute intervals for a 24-hour day.

2.3.4 Adjustment Procedures

Procedures outlined in the Project Traffic Forecasting Handbook and Procedure (525-030-120) were used for post-model adjustments. Additionally, traffic forecasts provided in the Turnpike's Annual Traffic Trends Report were also be referenced and compared with the No-Build volumes on the Turnpike Mainline. As previously stated, post-model adjustments were also considered for 2017 model volumes with the 2045 No-Build and Build forecasts. No-Build and Build AADTs were checked and adjusted to reflect adequate growth between 2017 and 2045.

2.4 TRAFFIC FACTORS

The proposed Traffic factors for this IMR are summarized on **Table 2.1**

Table 2.1
Existing Traffic Factor Values

Roadway	K_{STD}%	D%	24T%	DHTf%	PHF	MOCF
Florida's Turnpike	9.5	56.6	8.5	5.0	0.95	0.97
Boynton Beach Boulevard	9.0	60.3	3.6	2.0	0.95	0.95

Source: Turnpike's Standard K factor is based on FTE's annual factor development. Arterials Standard K is from Florida Transportation Information (FTI) and FDOT Project Traffic Forecasting Handbook. D and T factors were estimated during existing conditions traffic development following the FDOT Project Traffic Forecasting Handbook methodology.

2.5 TRAFFIC OPERATIONAL ANALYSIS

Traffic operational analyses were performed for the Existing Conditions and future No-Build and Build Alternatives. Analyses were performed using the Highway Capacity Software (HCS) Version 7.9 and Synchro Version 11.

The HCS and Synchro operations analyses were performed for the following conditions:

- Existing year 2018 conditions, AM and PM peak hours
- Year 2025 conditions for No-Build and Build Alternatives, AM and PM design hours
- Year 2045 conditions for No-Build and Build Alternatives, AM and PM design hours
- Existing year Synchro analysis was conducted using the existing signal timing data
- All future year Synchro analysis for both the No-Build and Build conditions included signal optimization.

2.5.1 Measures of Effectiveness (MOEs)

Analyses of the interchange ramp terminals and adjacent intersections were conducted using Synchro 11 software. The LOS target for state roads during peak travel hours is "D" in urbanized areas, per the State Highway System Policy No. 000-525-006c, effective April 19, 2017.

It should be noted that the traffic operational objectives were to maintain or improve the No-Build operations; therefore, the Build Alternatives may not meet the Department's LOS D target in urbanized areas because of the design constraints.

In addition to the signalized intersection LOS criteria stated above, operational analysis criteria also included the following:

- Density (passenger cars/mile/lane) for HCS analysis
- Delay (seconds per vehicle)
- Volume-to-capacity (v/c) ratio: Where possible, each intersection movement was designed to have a v/c ratio of 1.0 or less.
- Interchange off-ramp queue lengths: The 95th percentile queue was utilized to determine the required storage length for all interchange off-ramp queue lengths. The 95th percentile queue was calculated utilizing Synchro queue results which are reported in feet by lane. In order to obtain the total queue length, Synchro reported queue length was multiplied by the number of turn lanes and the lane utilization factor.

3.1 EXISTING ROAD CHARACTERISTICS

The general characteristics of the roadway facilities located within the project limits are described in the sections below. The data below is based on information gathered from the FDOT's Roadway Characteristics Inventory, Straight Line Diagrams (SLDs), Palm Beach County MPO, Palm Beach County Traffic and Engineering Division and field reviews. The existing roadway and intersection lane configurations are depicted in **Figure 3.1**.

3.1.1 Florida's Turnpike (SR 91) from north of Atlantic Avenue interchange (MP 81) to south of Lake Worth Road interchange (MP 93)

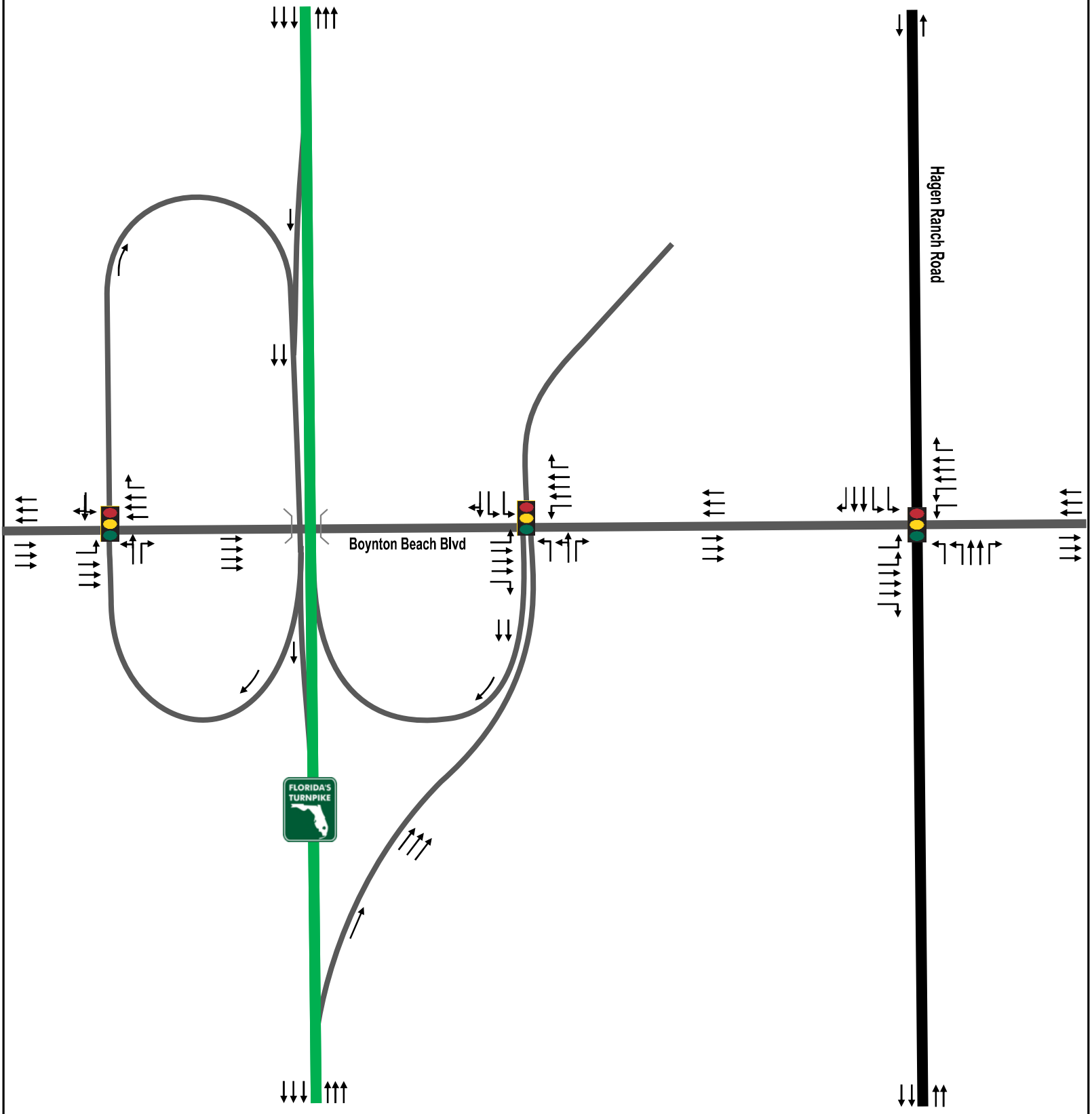
Facility Type: Freeway, Limited Access Toll, SIS Facility
Functional Classification: Urban Principal Arterial
Access Management Classification (FDOT): Class 1
Typical Section:

North of Atlantic Avenue to Lantana Toll Plaza:
Northbound and Southbound: 3 GP
Posted Speed Limit: 65 mph

North of Lantana Toll Plaza to South of Lake Worth Road:
Northbound and Southbound: 2 GP
Posted Speed Limit: 70 mph

3.1.2 Boynton Beach Boulevard

Facility Type: Arterial
Functional Classification: Urban Principal Arterial - Other
Access Management Classification (FDOT): Class 5
Typical Section: EB & WB: 3 Lanes/Raised Median
Posted Speed Limit: 45 mph



FLORIDA'S TURNPIKE	**Boynton Beach Boulevard** **Interchange Modification Report**	**2018 Existing Roadway & Intersection Lane Configuration** FF Free Flow Signalized Intersection Lane Configuration	**Figure 3.1**

3.2 EXISTING TRAFFIC DATA

Existing traffic data was obtained from various sources, including FTE, FDOT, and Palm Beach County, in addition to aerial photography and field collected data. Field visits were conducted to collect information on existing lane geometry, storage lengths, and traffic signal phasing. The signal timing plans for signalized intersections were obtained from Palm Beach County.

Existing traffic data were obtained from the FDOT and FTE and through traffic data collection efforts undertaken as part of this project. The traffic data include:

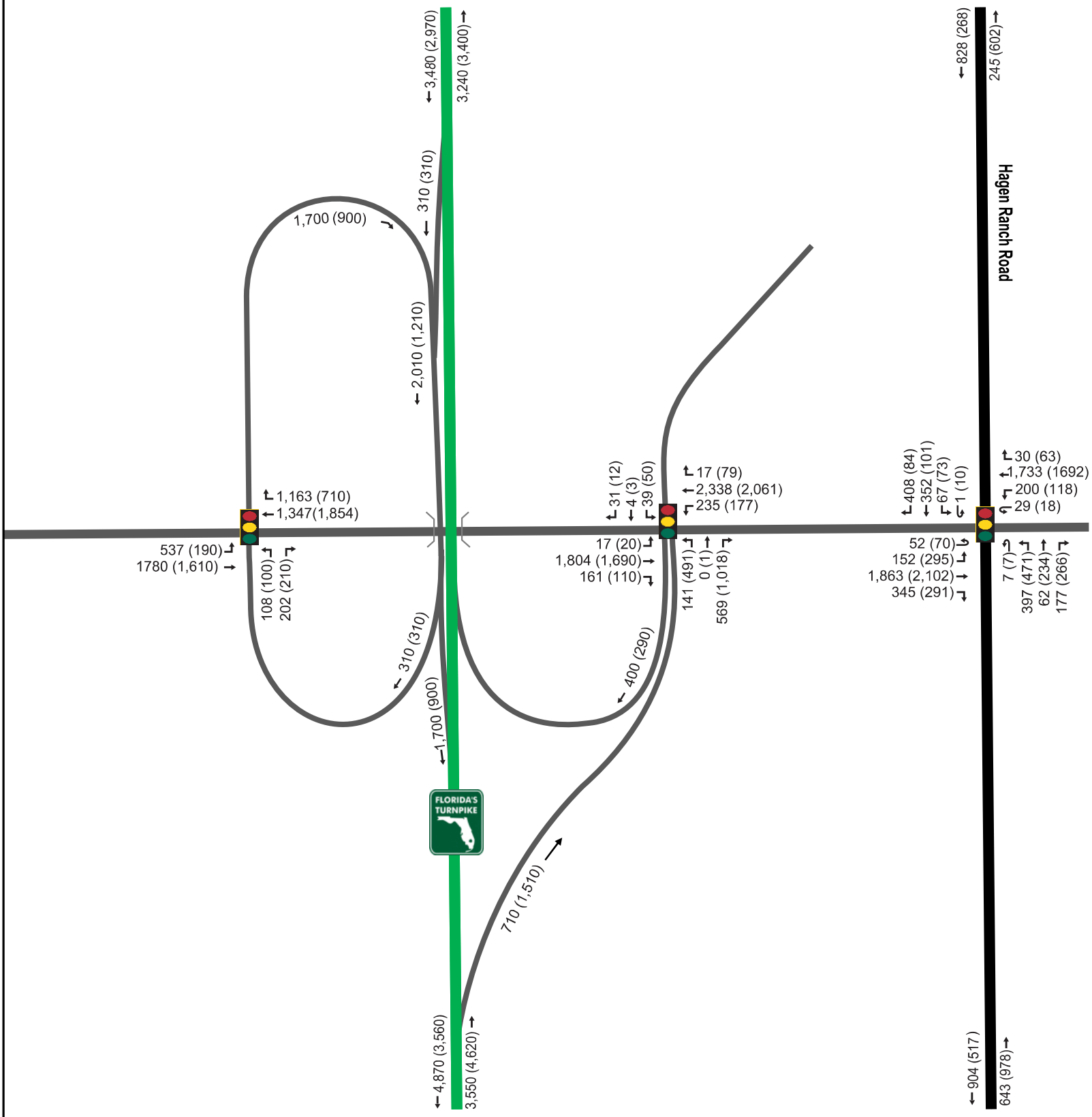
- Directional link traffic volume counts
- Weekday peak period (AM and PM) turning movement counts (TMCs) at AOI signalized intersections and on-ramp and off-ramp terminal intersections
- Ramp Traffic Counts from Toll Data
- Traffic Signal data
- Field Observations

3.2.1 Existing Traffic Volumes

The 2018 annual average daily traffic (AADT) volumes from the *Florida's Turnpike System Traffic Engineer's Annual Report (TEAR)* are shown in **Table 3.1**. The bold text represents the Turnpike Mainline volumes and the non-bold text represents the ramp volumes. **Figure 3.2** presents a summary of the balanced 2018 existing peak season peak hour traffic volumes. The raw traffic counts and the existing signal timing is provided in **Appendix B**.

Table 3.1
2018 Annual Average Daily Traffic Daily Traffic (AADT) Volumes

Milepost - Description	2018
86 – Boynton Beach Blvd (SR 804)	**74,900** 6,000 18,000 **86,900**



FLORIDA'S TURNPIKE	Boynton Beach Boulevard Interchange Modification Report	2018 Existing Peak Season Peak Hour Volumes Signalized Intersection xxx (xxx) AM (PM) Volumes	Figure 3.2

3.3 EXISTING TRAFFIC OPERATIONAL ANALYSIS

A traffic operational analysis was conducted to evaluate the existing conditions in the study area. Major analysis parameters include volume, design hour truck percentage, peak hour factor (PHF) and roadway geometry. The existing intersection PHFs were used for the intersection analysis. Design Hour Truck (DHT) values were calculated based on historical data from the FDOT count sites within the study area, mechanical classification counts and turning movement counts conducted as part of this study. Peak hour values from mechanical counts were calculated as half the daily value in accordance with the FDOT Project Traffic Forecasting Handbook. The calculated DHT used for the Florida's Turnpike mainline and ramps was 5.0%. The calculated DHT used was 2.0% for the interchange cross-streets.

3.3.1 Existing Traffic - Freeway Operational Analysis

The measure of effectiveness used to estimate the LOS was density and volume to capacity ratio. The LOS for each freeway segment was determined using the corresponding HCS Freeways, Weaving or Ramps modules when applicable.

The mainline/basic, weaving, and ramp merge/diverge analysis results are summarized on **Figures 3.3** and **3.4** for the Northbound and Southbound directions, respectively. Documentation of the existing traffic freeway operational analysis is provided in **Appendix C**. The results indicate that all freeway segments and ramp junctions are operating at LOS D or better during both the AM and PM peak hours in both the northbound and southbound directions. However, it is important to note that due to the limitations in the HCS analysis software, a barrier separated two-lane weaving section could not be analyzed. Therefore, a CORSIM traffic simulation model was developed to analyze the weaving section. The simulation output is included in Appendix C. The analysis shows LOS C and B for the weaving segment during the AM and PM peak hours, respectively. However, the southbound loop on-ramp connecting to the weaving section operates at LOS F during the AM peak hour and the southbound on-ramp connecting to the Turnpike mainline operates at LOS E during the AM peak hour. Field observation has also shown that this barrier separated weaving section between the southbound off-ramp and the southbound on-ramp experiences congestion resulting in operational and safety concerns, particularly during the AM peak hour. The weaving section is less than 1,300 feet in length and the weaving volumes exceed 2,000 vehicles during the AM peak and 1,200 vehicles during the PM peak hour.

Figure 3.3: 2018 Existing Year Freeway Analysis Results - Northbound

Segment	Freeway GPL Vol AM (PM) vph	AM LOS/Density (PC/MI/LN)	PM LOS/Density (PC/MI/LN)
Basic Freeway	3,240 (3,400)	B (17.8)	C (18.7)
Merge - Entry from Boynton Beach Blvd EB & WB	3,240 (3,400)	B (14.4)	B (14.9)
Basic Freeway	2,840 (3,110)	B (15.6)	B (17.1)
Diverge to Boynton Beach Blvd EB & WB	3,550 (4,620)	C (20.7)	C (27.8)
Basic Freeway	3,550 (4,620)	C (19.6)	D (26.7)

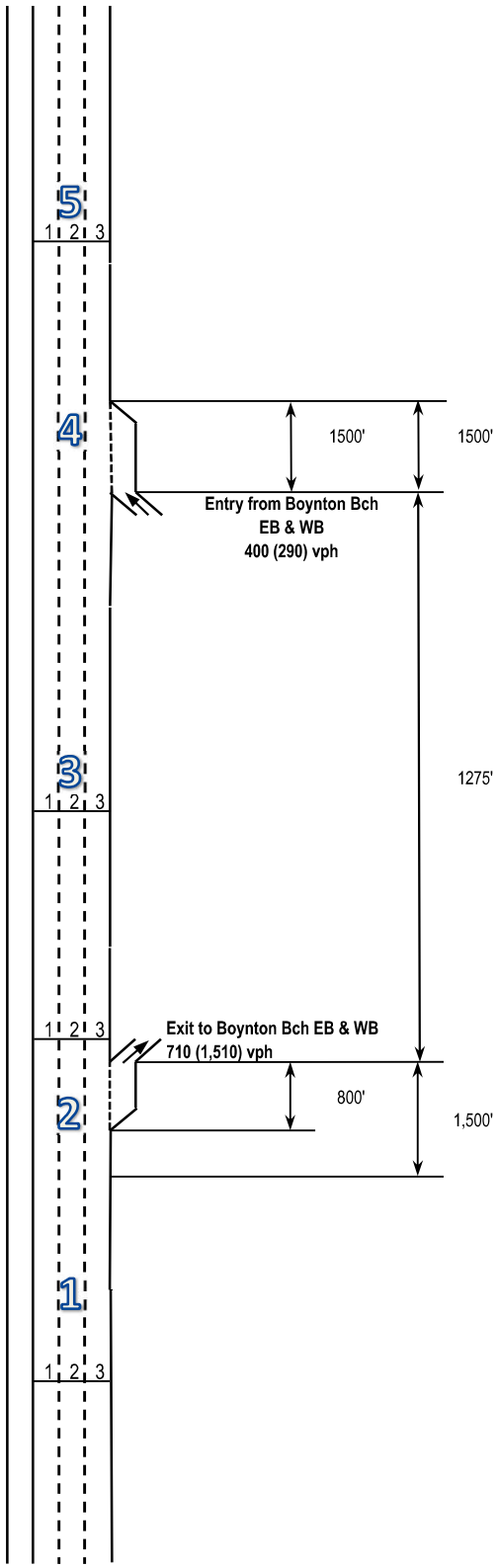
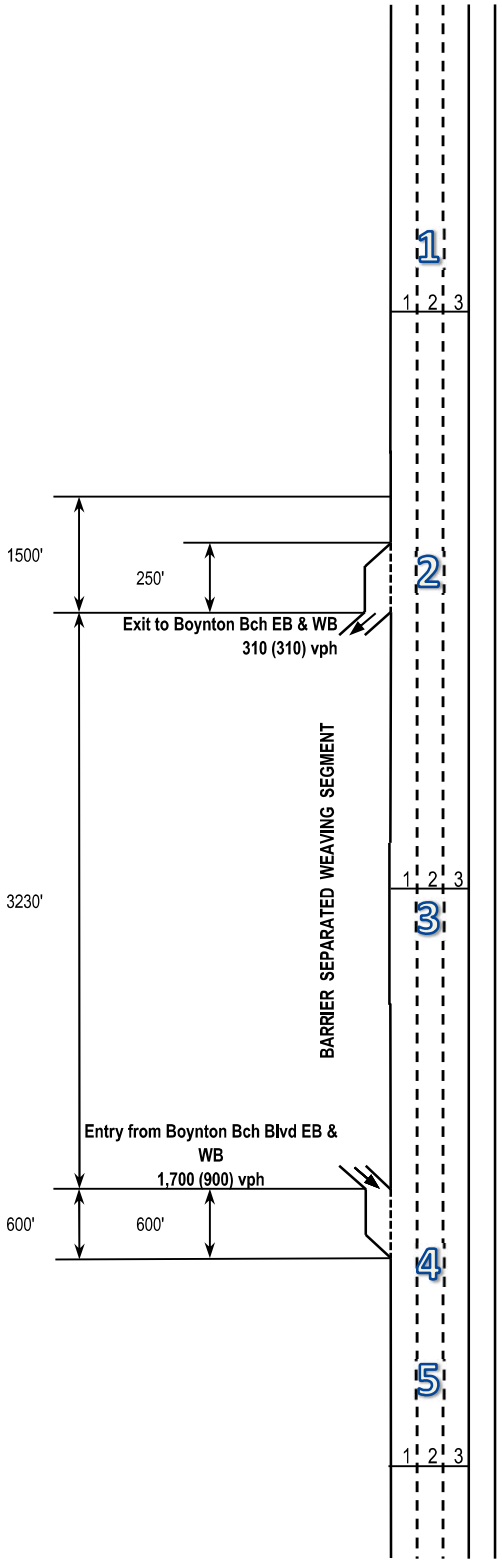


Figure 3.4: 2018 Existing Year Freeway Analysis Results - Southbound



Segment	Freeway GPL Vol AM (PM) vph	AM LOS/Density (PC/MI/LN)	PM LOS/Density (PC/MI/LN)
Basic Freeway	3,480 (2,970)	C (19.1)	B (16.3)
Diverge to Boynton Beach Blvd EB and WB	3,480 (2,970)	C (24.5)	C (21.7)
Basic Freeway	3,170 (2,660)	B (16.3)	B (14.6)
Barrier Saparated Weave*	2,010 (1,210)	C (24.3)	B (14.3)
U/S Loop On-Ramp*	1,700 (900)	F (51.0)	D (26.5)
D/S On-Ramp*	1,700 (900)	E (41.0)	C (21.1)
Merge from Boynton Beach Blvd EB and WB	4,870 (3,560)	D (31.8)	C (22.7)
Basic Freeway	4,870 (3,560)	D (28.7)	C (19.6)

* U/S=Upstream, D/S= Downstream, MOEs obtained from CORSIM simulation

3.3.2 Existing Traffic - Intersection Operational Analysis

Intersection analysis for ramp-terminals and adjacent intersections was performed using existing turning movement volumes, existing lane geometry, and signal timing observations, phase sequence for the Hagen Ranch intersection, Origin-Destination (O-D) survey for traffic existing from northbound off-ramp traffic turning eastbound left at Hagen Ranch Road, and information obtained from Palm Beach County (included in **Appendix B**). Analyses of the interchange ramp terminals and adjacent intersections were conducted using Synchro 11 software. The intersection analyses are presented in **Appendix D**.

Tables 3.2 provides a detailed summary of the results of the signalized intersection analyses for the AM and PM peak hours for Boynton Beach Boulevard. The results include delays (in seconds per vehicle) and Level of Service (LOS) by movement, approach, and the overall intersection. The 95th percentile queue lengths have also been summarized by movement. The intersection analysis results indicate the following:

- The northbound, southbound ramp terminals and Hagen Ranch Boulevard intersections are operating at LOS D or better during both the AM and PM peak hours.
- Northbound left turn at Turnpike northbound ramps is operating at LOS F during both AM and PM peak hours.

Table 3.2: 2018 Existing – Boynton Beach Boulevard Intersection Analysis Results

AM Peak

Arterial	Signal Controlled Intersections	Measure of Effectiveness (MOE)	Location	AM Movement/Approach LOS (Delay)												Intersection AM LOS (Delay)
				Eastbound			Westbound			Northbound			Southbound			
				Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
Boynton Beach Boulevard	Turnpike Southbound Ramps	LOS (Delay)	Movement	**E (58.2)**	A (5.9)			D (39.3)	**F (151.5)**		**E (77.2)**	A (0.2)				D (53.2)
			Approach	B (17.5)			**F (89.8)**			C (27.0)						
		Queue Length 95th (ft)	Movement	579	293			#663	#1585		172	0				
	Turnpike Northbound Ramps	LOS (Delay)	Movement	**F (83.8)**	D (42.4)	A (7.2)	D (43.9)	A (7.7)	A (0.0)	**F (96.3)**	**F (96.3)**	A (1.3)	**E (73.5)**	C (33.6)		C (23.5)
			Approach	D (40.1)			B (10.7)			C (20.1)			D (54.8)			
		Queue Length 95th (ft)	Movement	48	731	731	m299	301	m0	#176	#176	33	42	44		
	Hagen Ranch Road	LOS (Delay)	Movement	**E (74.4)**	C (21.0)	A (5.1)	**F (103.5)**	D (38.6)	A (0.0)	**F (88.0)**	**E (66.1)**	B (11.9)	D (48.9)	**E (70.8)**	D (48.4)	D (40.2)
			Approach	C (23.2)			D (45.5)			**E (65.0)**			**E (57.9)**			
		Queue Length 95th (ft)	Movement	m#143	270	m81	#207	624	0	#323	57	70	53	240	415	

PM Peak

Arterial	Signal Controlled Intersections	Measure of Effectiveness (MOE)	Location	PM Movement/Approach LOS (Delay)												Intersection PM LOS (Delay)
				Eastbound			Westbound			Northbound			Southbound			
				Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
Boynton Beach Boulevard	Turnpike Southbound Ramps	LOS (Delay)	Movement	D (47.6)	A (5.2)			B (19.5)	A (4.3)		**E (71.2)**	A (0.2)				B (13.6)
			Approach	A (9.5)			B (15.4)			C (23.1)						
		Queue Length 95th (ft)	Movement	199	232			598	116		150	0				
	Turnpike Northbound Ramps	LOS (Delay)	Movement	**F (86.6)**	D (48.5)	A (3.2)	D (44.3)	A (9.3)	A (0.8)	**F (107.3)**	**F (107.9)**	A (7.4)	**E (75.4)**	D (38.3)		C (30.7)
			Approach	D (46.3)			B (11.6)			D (40.1)			**E (67.2)**			
		Queue Length 95th (ft)	Movement	54	694	28	m237	385	m7	#498	#504	420	52	29		
	Hagen Ranch Road	LOS (Delay)	Movement	**E (56.8)**	B (11.0)	A (1.4)	**F (103.6)**	C (34.5)	A (0.1)	**F (84.0)**	**E (68.4)**	C (30.5)	**E (68.1)**	**F (93.4)**	A (0.8)	C (33.3)
			Approach	B (16.1)			D (38.3)			**E (65.7)**			**E (56.6)**			
		Queue Length 95th (ft)	Movement	m#243	217	m33	#135	571	0	#351	160	183	#89	#99	0	

Synchro Version 11 Build 168. *HCM6 output used for unsignalized intersections due to limitations in Synchro.

LOS notes:

Delay is in sec/veh units

:Level Of Service (LOS) E reflecting at capacity operations

:Level Of Service (LOS) F reflecting over capacity operations

Queue notes:

~: Volume exceeds capacity, queue is theoretically infinite

#: 95th percentile volume exceeds capacity

m: Upstream metering is in effect

Intersection	Distance
SB on/off-ramp 1.915 MM	-
NB on/off-ramp 2.204 MM	1,525 ft
Hagen Ranch Road 2.571 MM	1,940 ft

Table 3.3 summarizes the results of the off-ramp signals back of queue analyses for the AM and PM peak hours. The Synchro reported queue was multiplied by the number of turn lanes and the lane utilization factor to calculate the total queue length. The results present the queue length in feet for each lane group movement. The available storage length was calculated from the stop bar at the ramp terminal intersection to the gore with Turnpike mainline minus the 615 feet required for stopping distance for a design speed of 70 mph per FDOT's 2016 Green book (Table 3-22), and accounting for the changes in number of lanes. For the southbound off-ramp, the storage lengths were estimated similarly with a stopping distance of 385 feet for a design speed of 45 mph on the C - D road weaving area. The analysis shows that the queues on the northbound and southbound off-ramps at Boynton Beach Boulevard interchange do not exceed the available storage lengths during one or both peak hours.

Table 3.3
2018 Existing – Off-Ramp Signals Queuing Analysis Results

Intersection	Approach	Movement	Available Storage (ft)	Queue (ft)	
				AM	PM
Boynton Beach Boulevard at SB Off-Ramp	Northbound	L (WB)	780	172	150
		R (EB)	830	0	0
Boynton Beach Boulevard at NB Off-Ramp	Northbound	L (WB)	2,535	334	946
		R (EB)	1,245	33	420

Queue Notes:
Synchro queue was multiplied by the number of turn lanes and the lane utilization factor to calculate the total queue length.

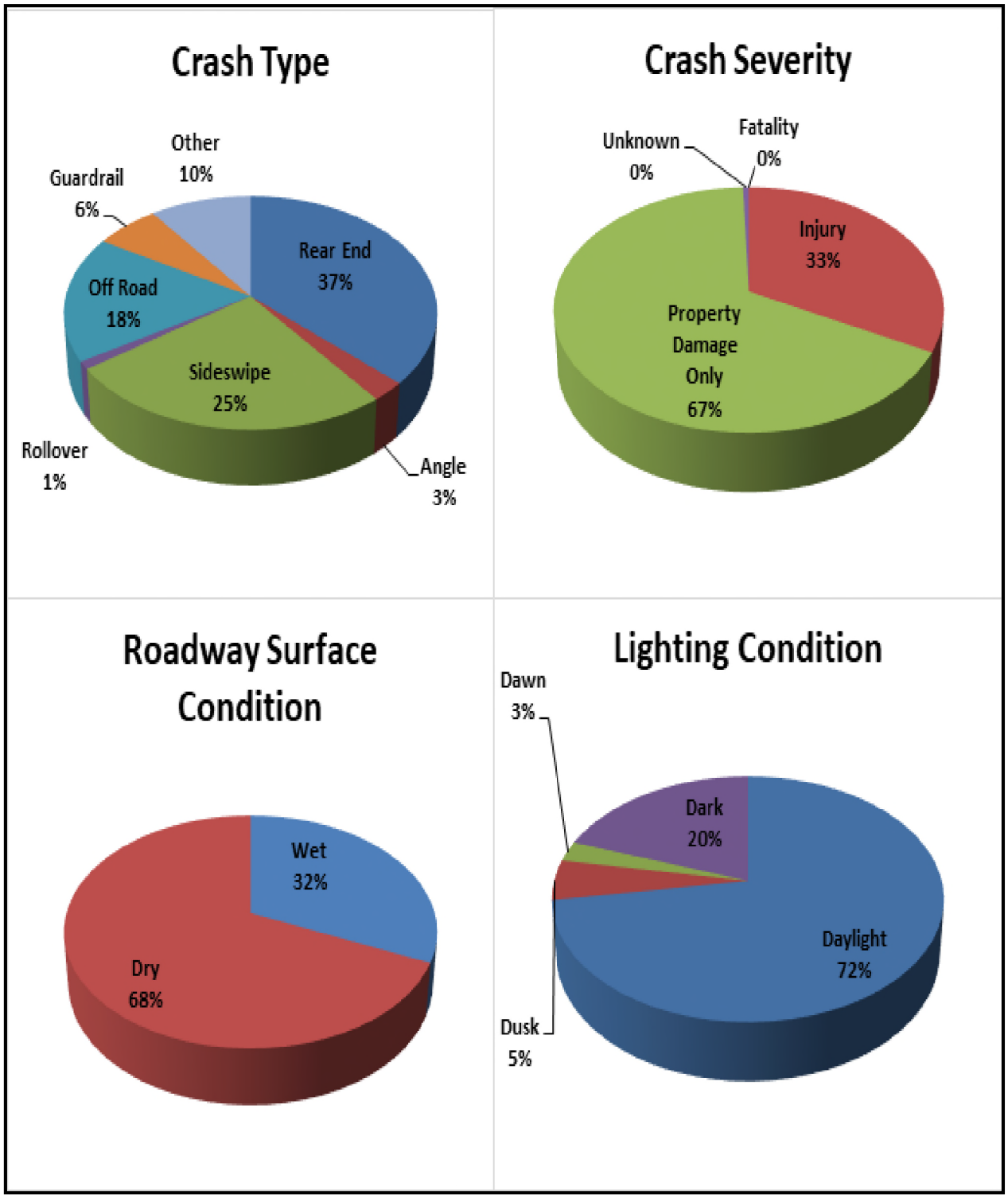
3.4 EXISTING CRASH DATA

Crash data for existing facilities within the Area of Influence (AOI) were processed using the most recent five-year data from the state's Crash Analysis Reporting (CAR) Online, from 2013 through 2017. The data reports were analyzed for each mainline roadway, interchange ramp, and intersection within the study area. Detailed crash reports (long forms) were reviewed to verify the accuracy of the information obtained from the database. Detailed crash reports and analysis tables are provided in **Appendix E**.

3.4.1 Florida's Turnpike Mainline MP 12.472 to MP 14.472

A total of 189 crashes were reported along Florida's Turnpike mainline during the five-year analysis period from 2013 through 2017 with an average of 38 crashes per year. Based on the crash data, majority of crashes occurred south of northbound off-ramp to Boynton Beach Boulevard. No fatalities were reported during this period. Rear-end (37 percent) and sideswipe (25 percent) crashes constituted a majority of the crashes. At least 33 percent of the total crashes resulted in injuries. As shown on **Figure 3.5**, 32 percent of the crashes occurred on wet roadway conditions and 20 percent of the crashes occurred under dark lighting conditions.

Figure 3.5
Crash Data Summary (2013-2017) – Florida's Turnpike Mainline



3.4.2 Boynton Beach Boulevard Interchange Ramp Roadways

The Florida's Turnpike at Boynton Beach Boulevard interchange ramps experienced a total of 34 crashes during the five-year analysis period. There was no fatal crash reported during the study period. At least 18 percent of the total crashes resulted in injuries. As shown on **Figure 3.6**, off-road crashes (approximately 53 percent) and sideswipe crashes (approximately 14 percent) were the prominent crash types along the interchange ramps. Reports indicated that 21 percent of the crashes occurred during wet roadway conditions and 18 percent crashes occurred during night-time hours.

3.4.3 Boynton Beach Boulevard Interchange Southbound Weaving Section

The existing Boynton Beach Boulevard interchange configuration creates a barrier separated weaving section between the southbound off-ramp and the southbound on-ramp traffic within a short distance (less than 1,000 feet) leading to unsafe operations. This weaving section experienced a total of 18 crashes during the five-year analysis period. No fatalities were reported during the study period. At least 17 percent of the total crashes resulted in injuries. As shown on **Figure 3.7**, off-road crashes (28 percent) and sideswipe crashes (28 percent) were the prominent crash types along the C-D road. Reports indicated that 17 percent of the crashes occurred during wet roadway conditions and 22 percent crashes occurred during nighttime.

Figure 3.6
Crash Data Summary (2013-2017) – Boynton Beach Boulevard Interchange Ramp Roadways

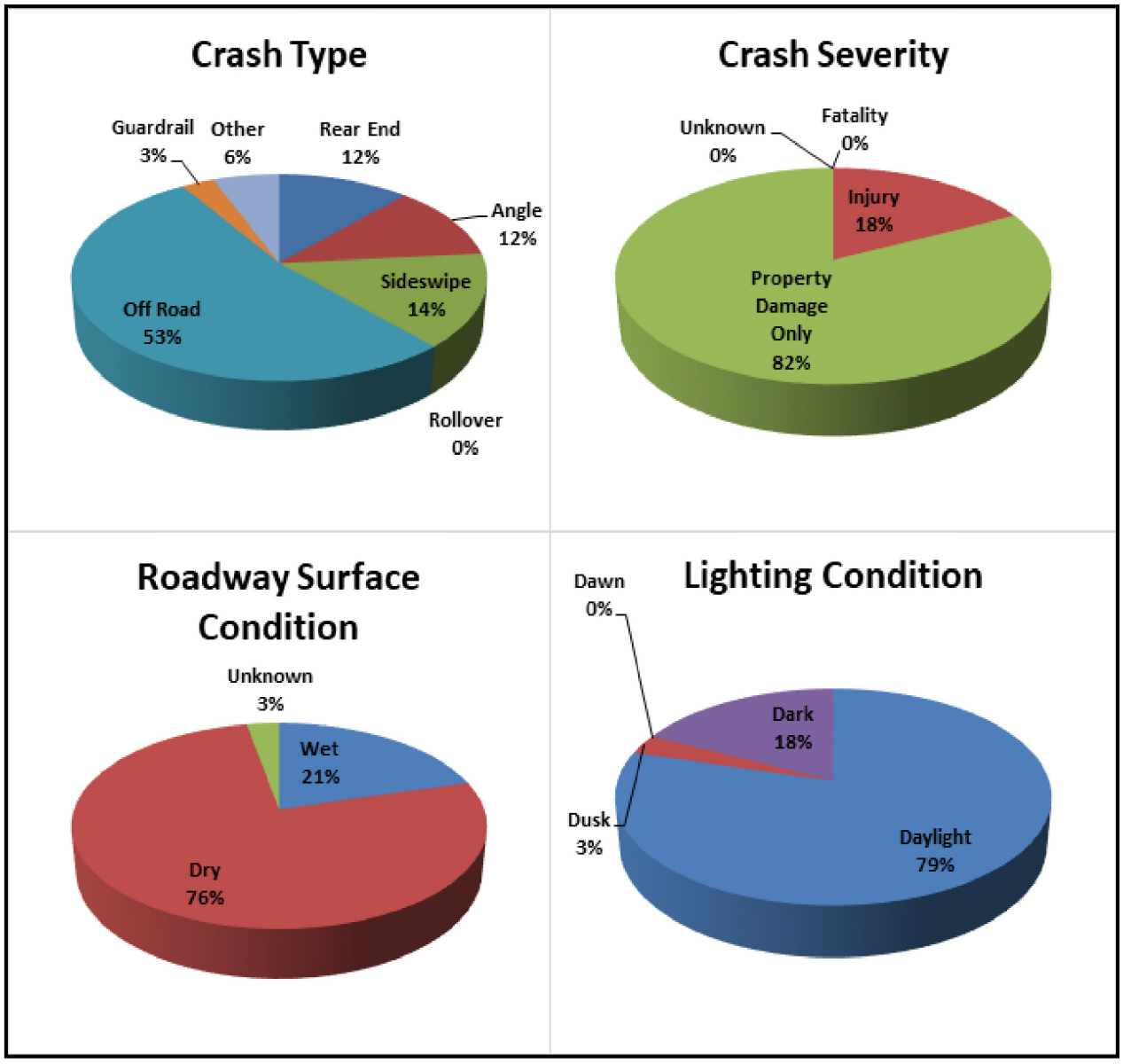
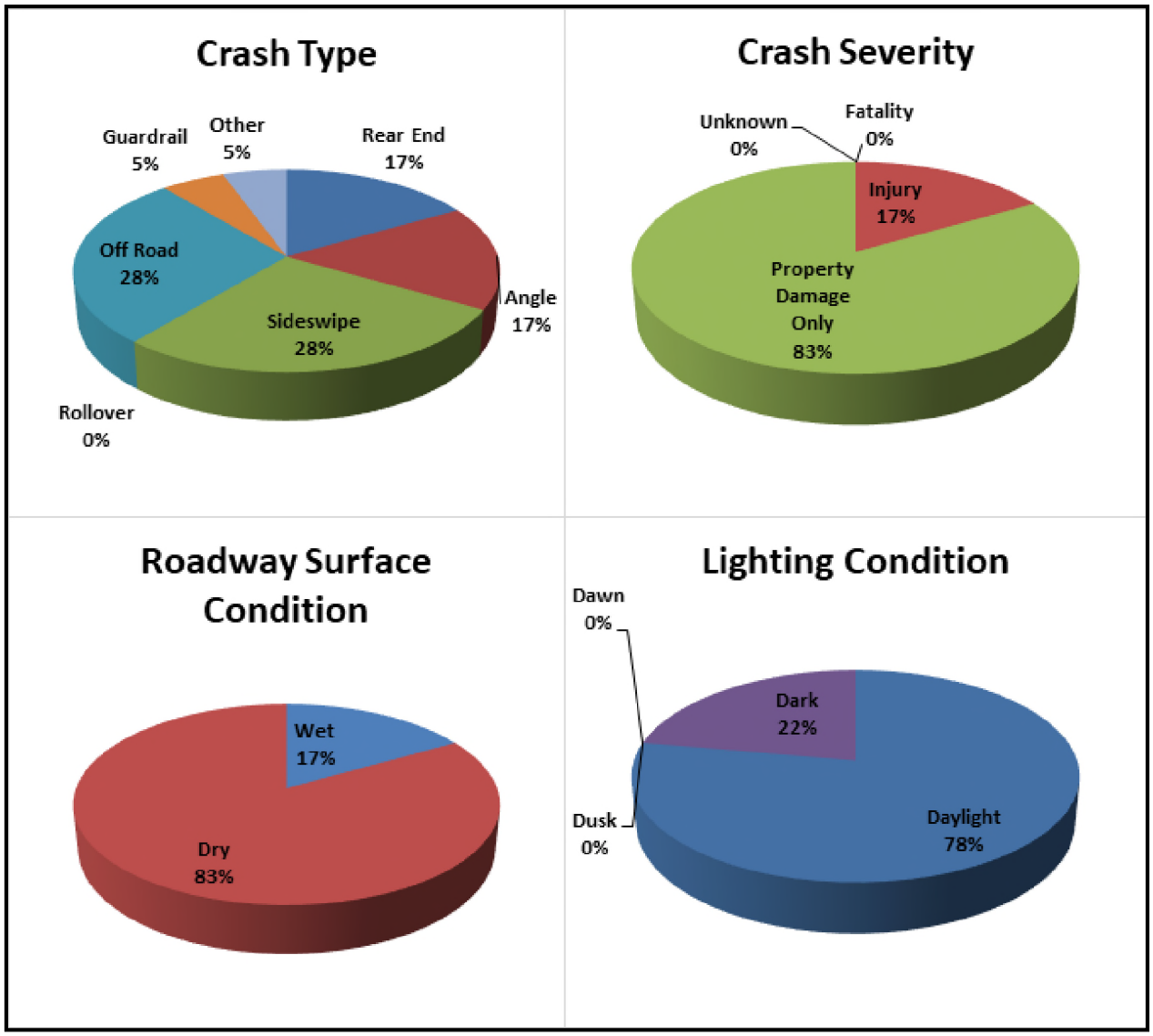


Figure 3.7
Crash Data Summary (2013-2017) – Southbound Weaving Section



Actual crash rates for the freeway mainline and ramp segments were computed and compared with average crash rates for similar facilities within Palm Beach County to assess the safety conditions within the study area. Critical crash rates and safety ratios were also estimated. Crash rates for the roadway were estimated as crashes per Million Vehicles Miles Travelled (MVMT). The critical crash rate is based on the average crash rate for a similar facility adjusted by vehicle exposure and a probability constant. The safety ratio represents the actual crash rate divided by the critical crash rate. If a segment has an actual crash rate higher than the critical crash rate (i.e., safety ratio > 1.0), it may have a safety deficiency. Florida's Turnpike and ramp segments within the study area have actual crash rates lower than the critical crash rate (i.e., safety ratio < 1.0), as shown in **Table 3.4**.

Table 3.4
Mainline and Ramps Crash Rates and Safety Ratios (2013-2017)

Description	Total Crashes	Actual Crash Rate	Average Crash Rate*	Critical Crash Rate	Safety Ratio
Florida's Turnpike Mainline					
North of the Atlantic Avenue interchange to north of the Boynton Beach Boulevard interchange	189	0.61	0.577	0.81	0.76
Florida's Turnpike Interchange					
Boynton Beach Ramps and Weaving Section	52	0.79	0.577	1.10	0.72

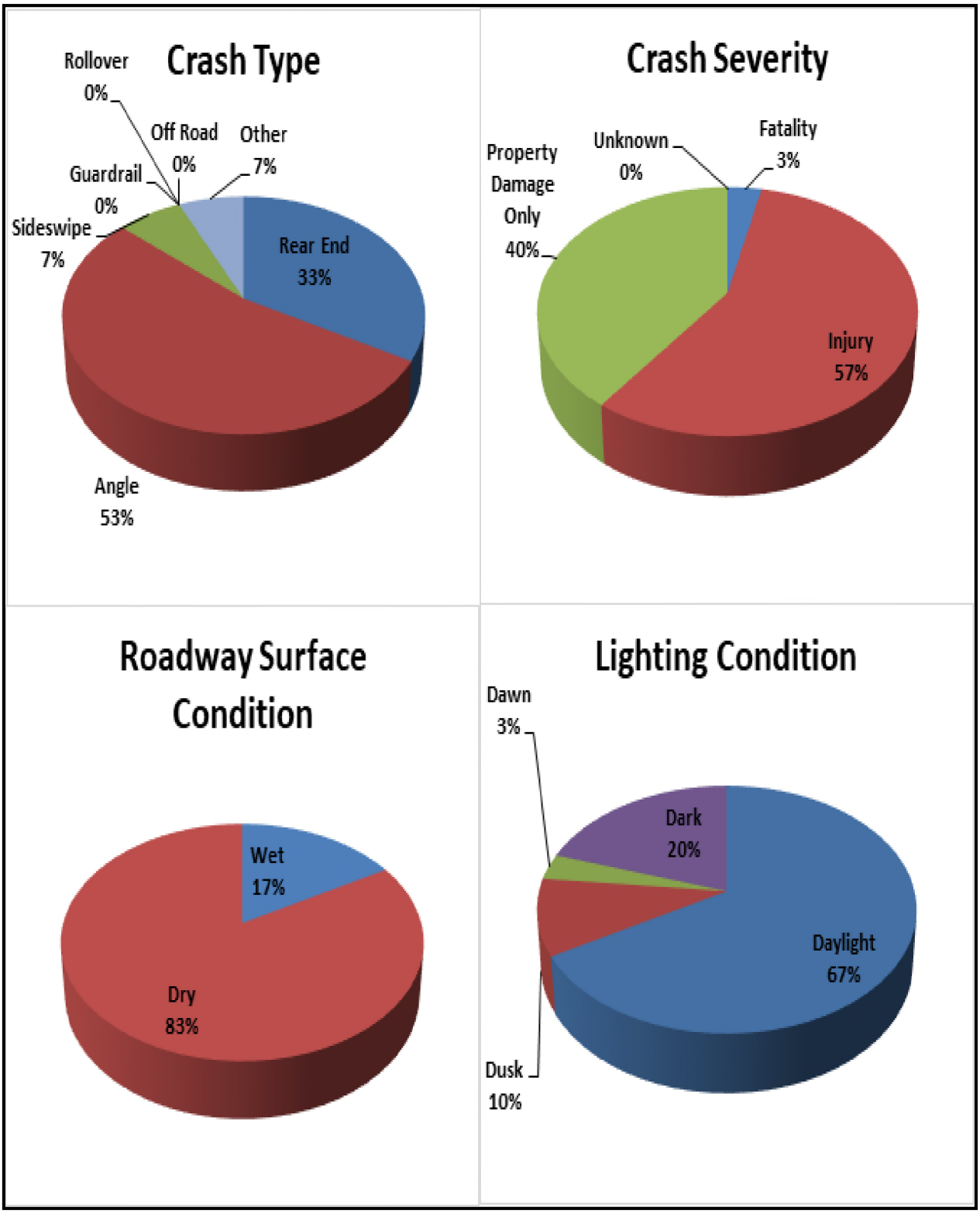
*Palm Beach County Five-year Average Crash Rate for District four (2016)
Freeway and Interchanges Crash Rate used for "Toll Road Urban"
All Interchange Ramps: Ramps Urban
Freeways: Crashes per Million Vehicle Miles Travelled (MVMT)
Highlighted Safety Ratio >1.0

3.4.4 Intersections Along Boynton Beach Boulevard

Signal four, a FDOT-funded database developed in coordination with the state's CAR Online, was used to obtain crash data for side streets that are not included in the FDOT crash database. Intersection crashes were extracted by providing a 250-foot influence area. A brief discussion of the crash analysis for the intersections are provided below.

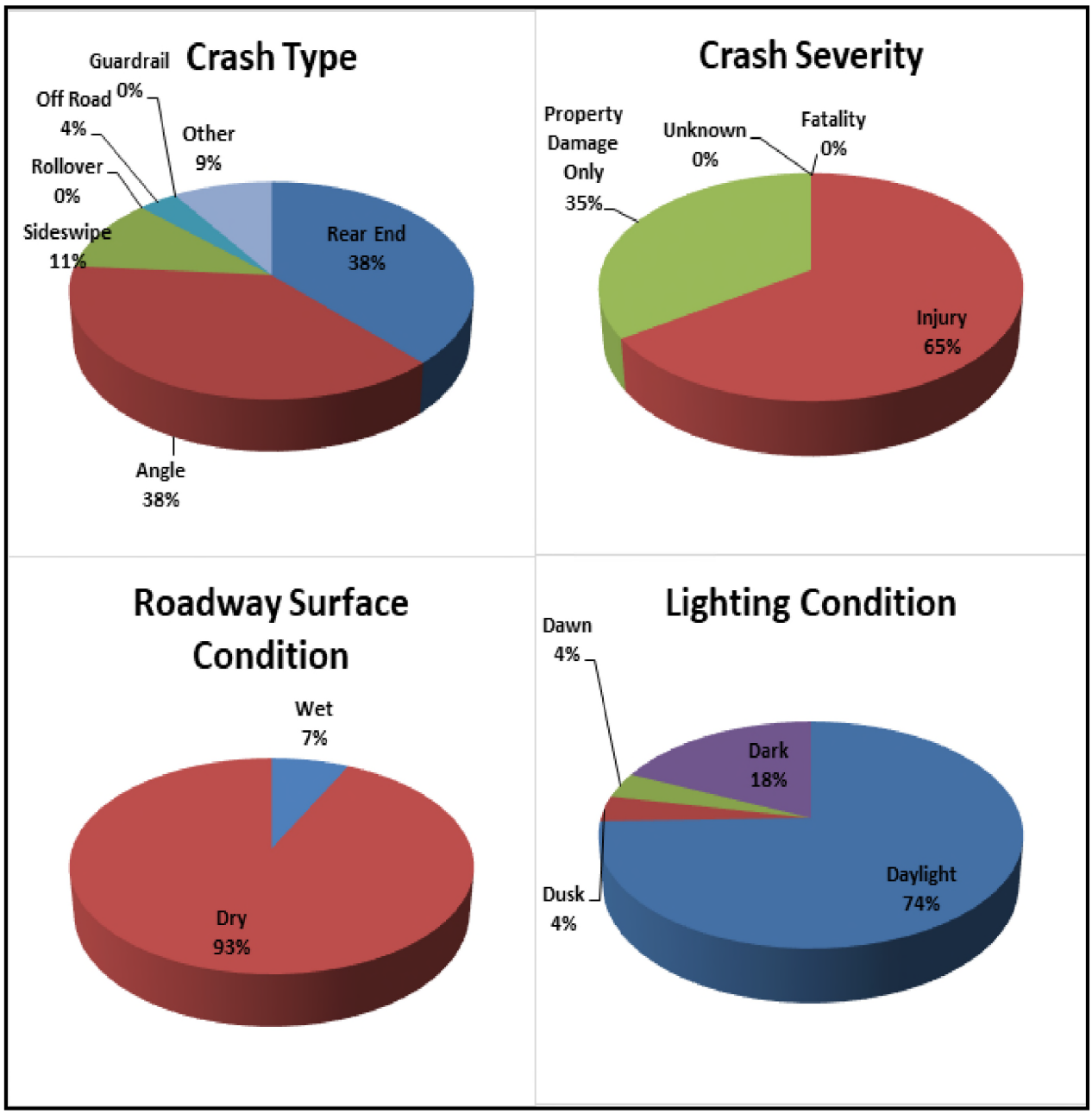
A total of 30 crashes were reported at the intersection of the Florida's Turnpike southbound ramps and Boynton Beach Boulevard intersection from 2013 through 2017. One fatality was reported during the five-year analysis period. Rear-end and angle crashes constituted the majority (approximately 33 percent and 53 percent, respectively) of the crashes. As shown on **Figure 3.8**, the majority (83 percent) of the crashes occurred under dry roadway conditions and 20 percent of the crashes occurred under dark lighting conditions.

Figure 3.8
Crash Data Summary (2013-2017) – Southbound Ramps Intersection



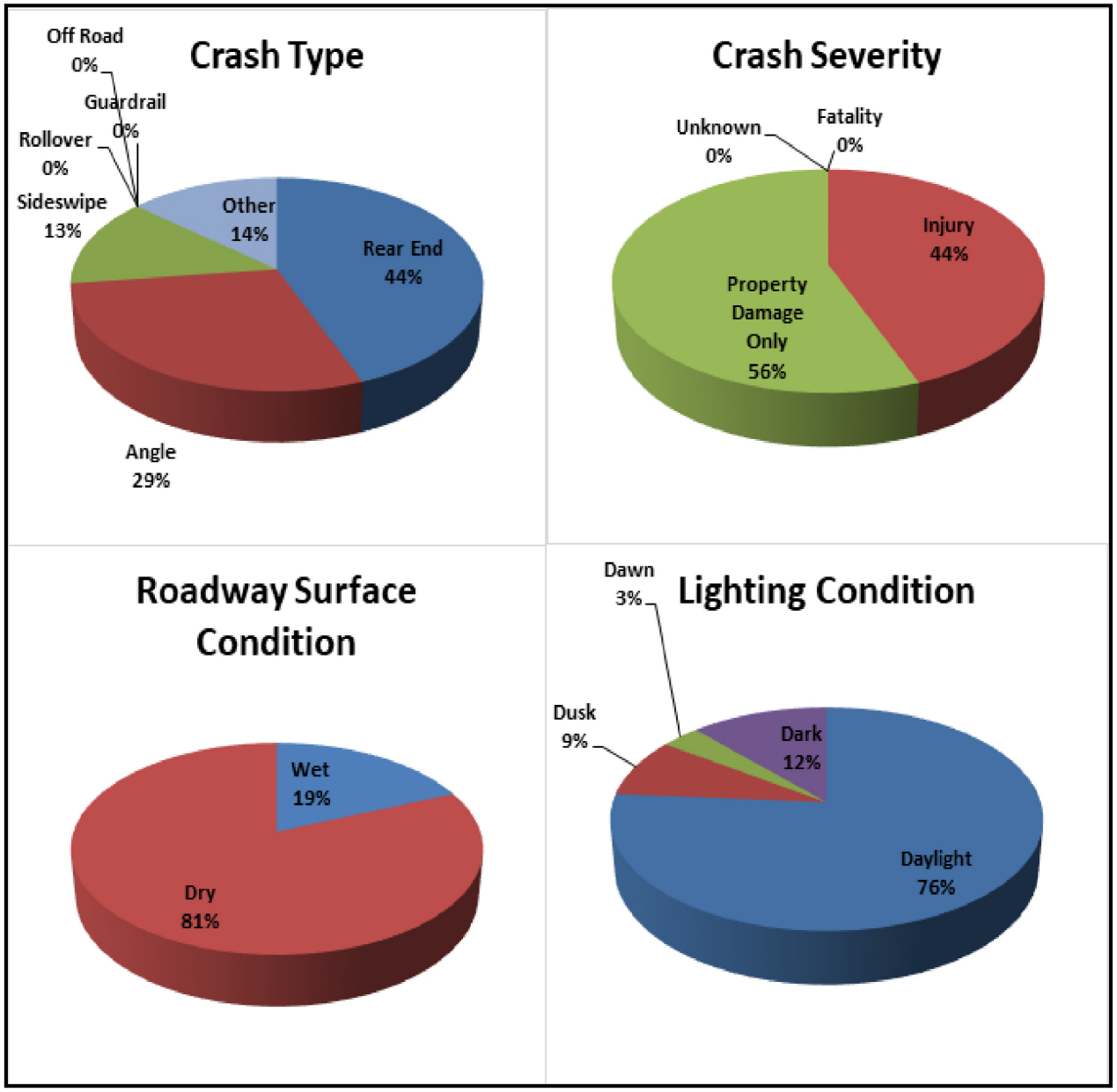
The Florida's Turnpike northbound ramps and Boynton Beach Boulevard intersection experienced a total of 55 crashes during the five-year analysis period. No fatal crashes were reported during this period. At least 65 percent of the total crashes resulted in injuries. As shown on **Figure 3.9**, rear-end crashes (approximately 38 percent) and angle crashes (approximately 38 percent) were the prominent crash types. Reports indicated that 93 percent of the crashes occurred during dry roadway conditions and 18 percent crashes occurred during night-time hours.

Figure 3.9
Crash Data Summary (2013-2017) – Northbound Ramps Intersection



A total of 59 crashes were reported at the intersection of Hagen Ranch Road and Boynton Beach Boulevard intersection from 2013 through 2017. No fatalities were reported during the five-year analysis period. Rear-end and angle crashes constituted a majority (44 percent and 29 percent, respectively) of the crashes. As shown on **Figure 3.10**, the majority (81 percent) of the crashes occurred under dry roadway conditions and 12 percent of the crashes occurred under dark lighting conditions. A total of 34 crashes were reported on midblock section of Boynton Beach Boulevard from northbound ramps terminal and Hagen Ranch Road. Single fatality crash was reported at this location. Rear-end (59 percent) and angle (23 percent) crashes constituted a majority of the crashes at this midblock section.

Figure 3.10
Crash Data Summary (2013-2017) – Hagen Ranch Boulevard Intersection



Actual crash rates at the intersections were computed and compared with average crash rates for similar facilities within Palm Beach County to assess the safety conditions within the study area. Critical crash rates and safety ratios were also estimated. Crash rates for the intersections were estimated as crashes per Million Entering Vehicles (MEV). The critical crash rate is based on the average crash rate for a similar facility adjusted by vehicle exposure and a probability constant. The safety ratio represents the actual crash rate divided by the critical crash rate. If an intersection has an actual crash rate higher than the critical crash rate (i.e., safety ratio > 1.0), it may have a safety deficiency. The crash rates are presented in **Table 3.5**.

Table 3.5
Intersection Crash Rates and Safety Ratios (2013-2017)

Description	Total Crashes	Actual Crash Rate	Average Crash Rate*	Critical Crash Rate	Safety Ratio
Intersections					
Boynton Beach Boulevard/Southbound Ramps	30	0.38	0.476	0.91	0.42
Boynton Beach Boulevard/Northbound Ramps - Orchid Grove Trail	55	0.56	0.476	0.86	0.65
Boynton Beach Boulevard and Hagen Ranch Road	59	0.53	0.476	0.84	0.63

*Palm Beach County Five-year Average Crash Rate for District four (2016)
Intersections: Crashes per Million Entering Vehicles (MEV)
Intersection Average Crash Rate used "Urban 6+Ln 2Wy Divided Road"
Highlighted Safety Ratio >1.0

With the need to estimate pedestrian and bicycle safety within the project limits in the recent past, crash data obtained from Signal Four and CAR Online database were reviewed for crashes involving pedestrians and bicycles. A total of two pedestrian and bicycle crashes were reported along Boynton Beach Boulevard.

Figures 3.11 and **3.12**, on the following pages, graphically depicts the location of crashes by severity and type of crashes within the study area.

Section 5.5 of this report documents the safety analysis of the No-Build and Build alternatives using the predictive methods in Chapters 12 and 19 of the Highway Safety Manual (HSM), where available, and the Enhanced Interchange Safety Analysis Tool (ISATe), which apply a combination of Safety Performance Functions (SPFs), Crash Modification Factors (CMFs), and calibration factors to estimate frequency and cost of crashes for each segment and intersection.

Figure 3.11
Study Area Severity of Crashes (2013-2017)

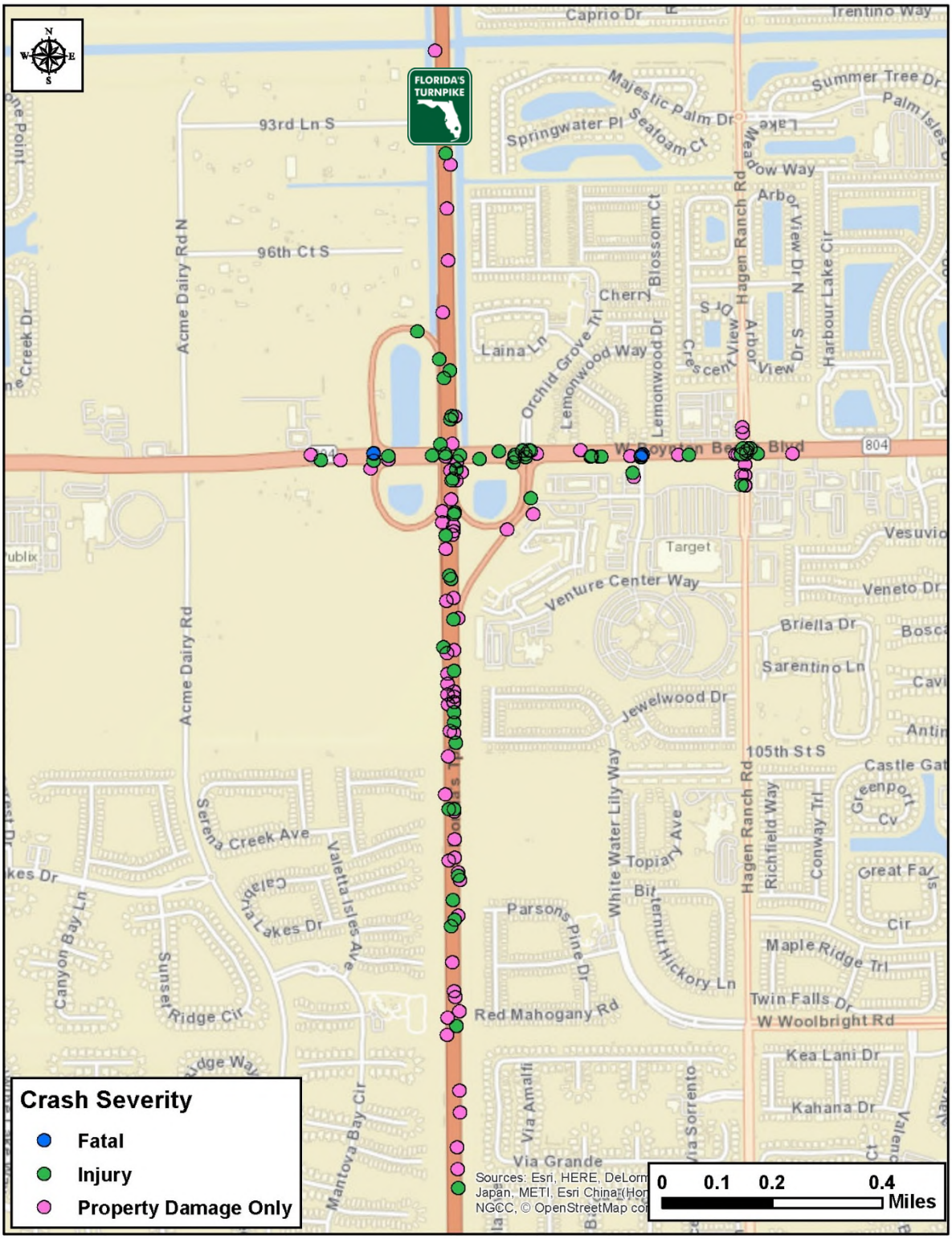
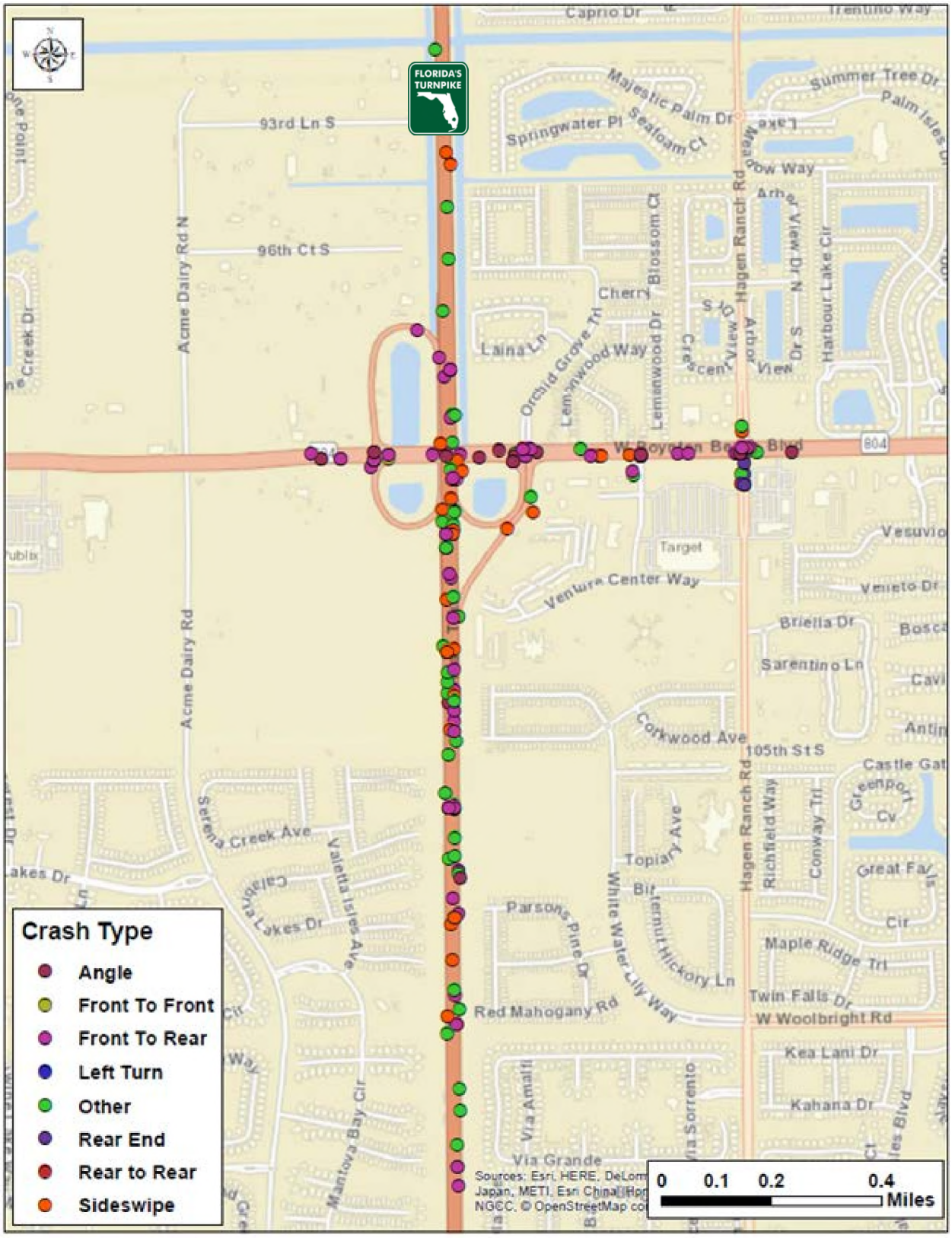


Figure 3.12
Study Area Crash Types (2013-2017)



4.1 NO-BUILD ALTERNATIVE – TRANSPORTATION NETWORK

The future year No-Build Alternative network includes the existing (2018) roadway conditions plus all funded and committed projects within the study corridor. This includes the TSM&O improvements recently approved for the northbound off-ramp terminal intersection. **Figure 4.1** presents the No-Build Lane Configuration for the AOI.

4.2 FUTURE TRAFFIC FORECAST

In December 2019, a Project Design Analysis Report was prepared for the study area. The complete document is included in **Appendix F**.

The demand-based traffic forecasts are used in the analysis of both the No-Build scenario (no widening of the Turnpike Mainline) and Build scenario (widening of the Turnpike Mainline). The forecast is from an unconstrained demand based model and therefore the No-Build and Build forecasts are the same. The future demand is independent of the mainline capacity. Daily forecasts for 2025 and 2045 for the Turnpike Mainline and ramps are shown in **Table 4.1**.

Table 4.1
Forecasted Mainline and Ramp AADTs

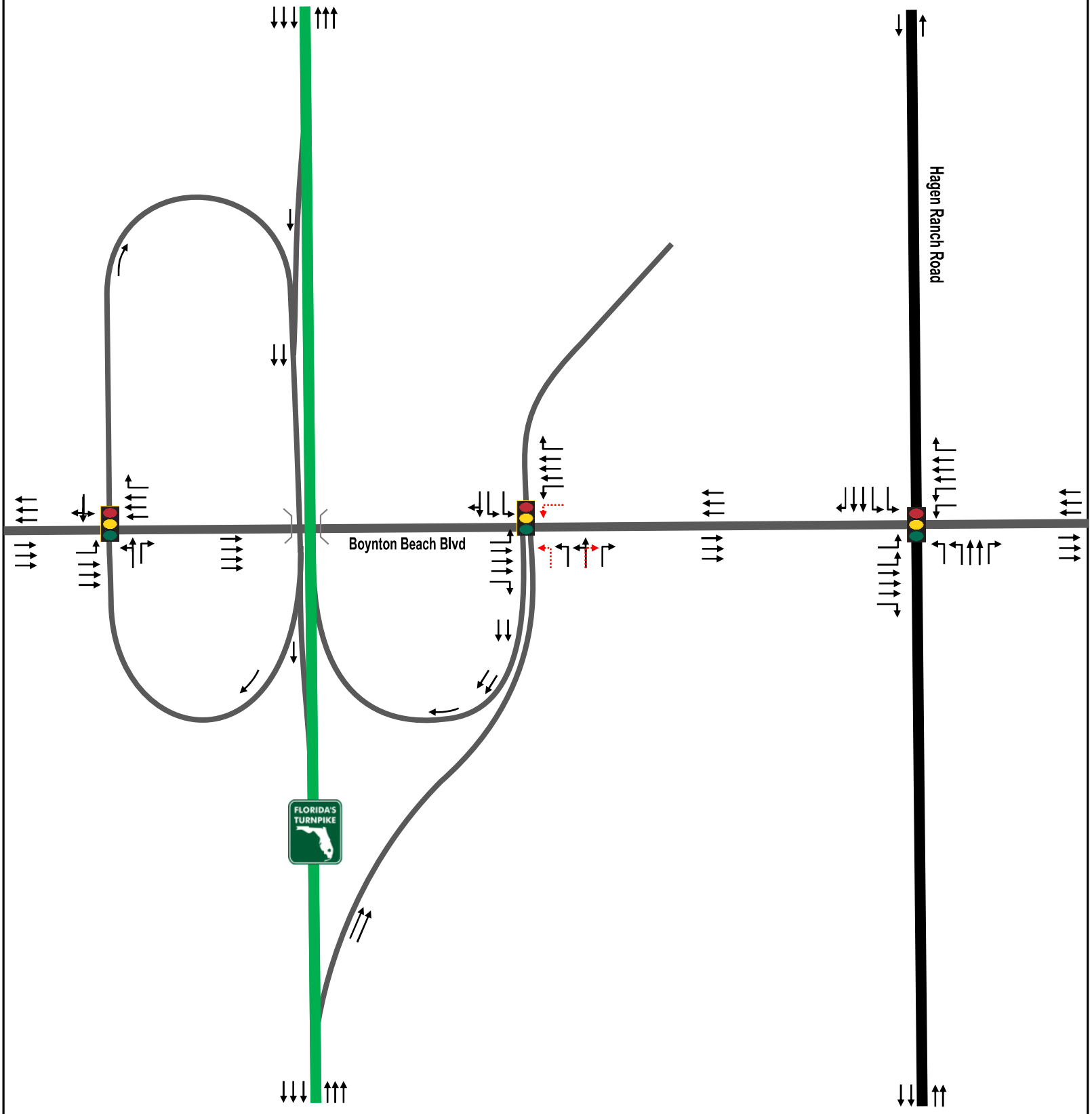
Milepost - Description		2025	2045
86 – Boynton Beach Boulevard (SR 804)		**95,600**	**139,800**
		10,400	14,600
		21,000	27,200
		106,200	**152,400**

The historic growth rates provided by Palm Beach County were used to develop the cross-street volumes, as shown in **Table 4.2**.

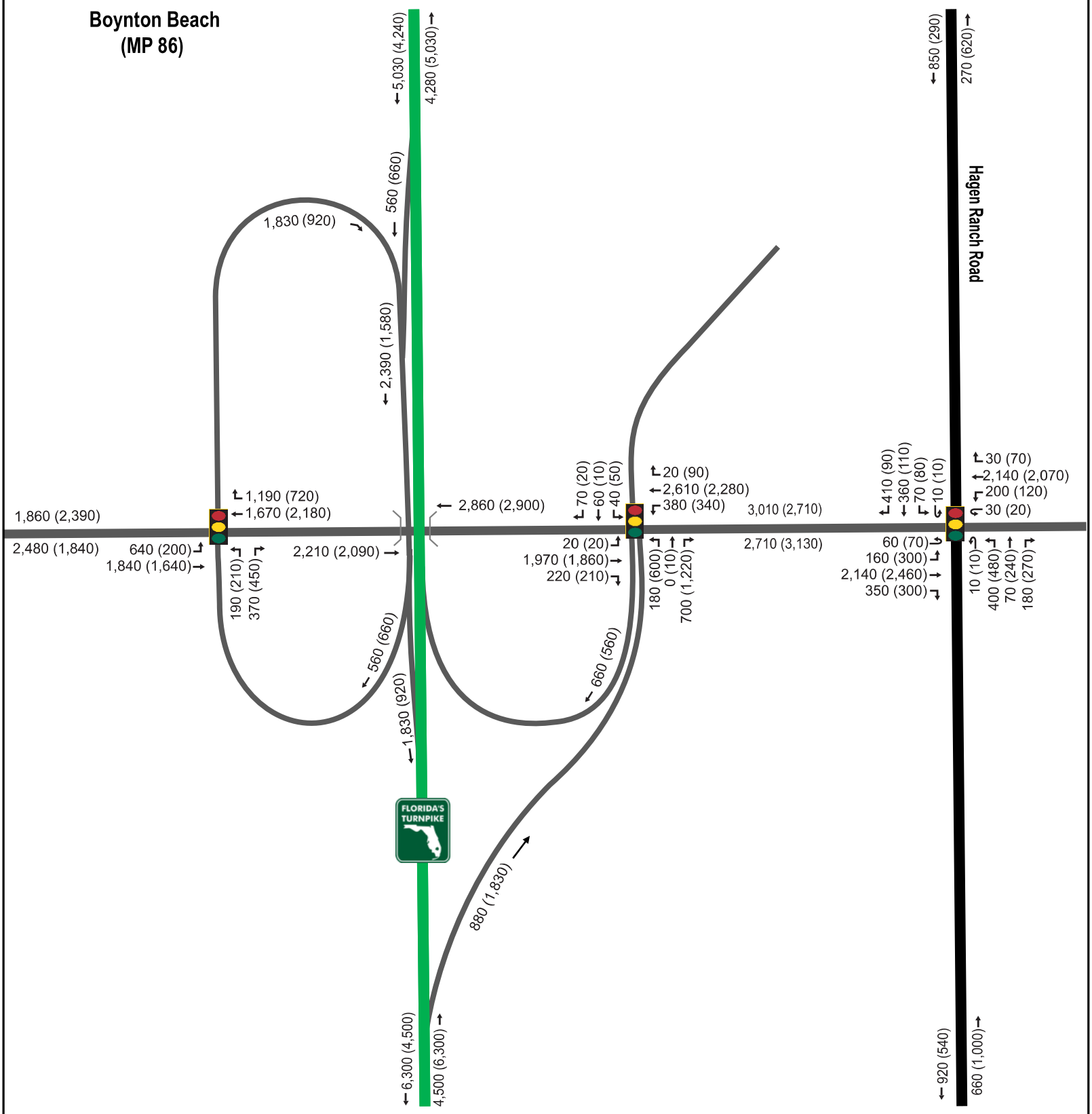
Table 4.2
Forecasted Cross-Street AADTs

Cross Street	Intersection	Direction	2025	2045
Boynton Beach Boulevard	SB Ramps Terminal	East	38,400	50,800
	NB Ramps Terminal	East	47,800	57,800

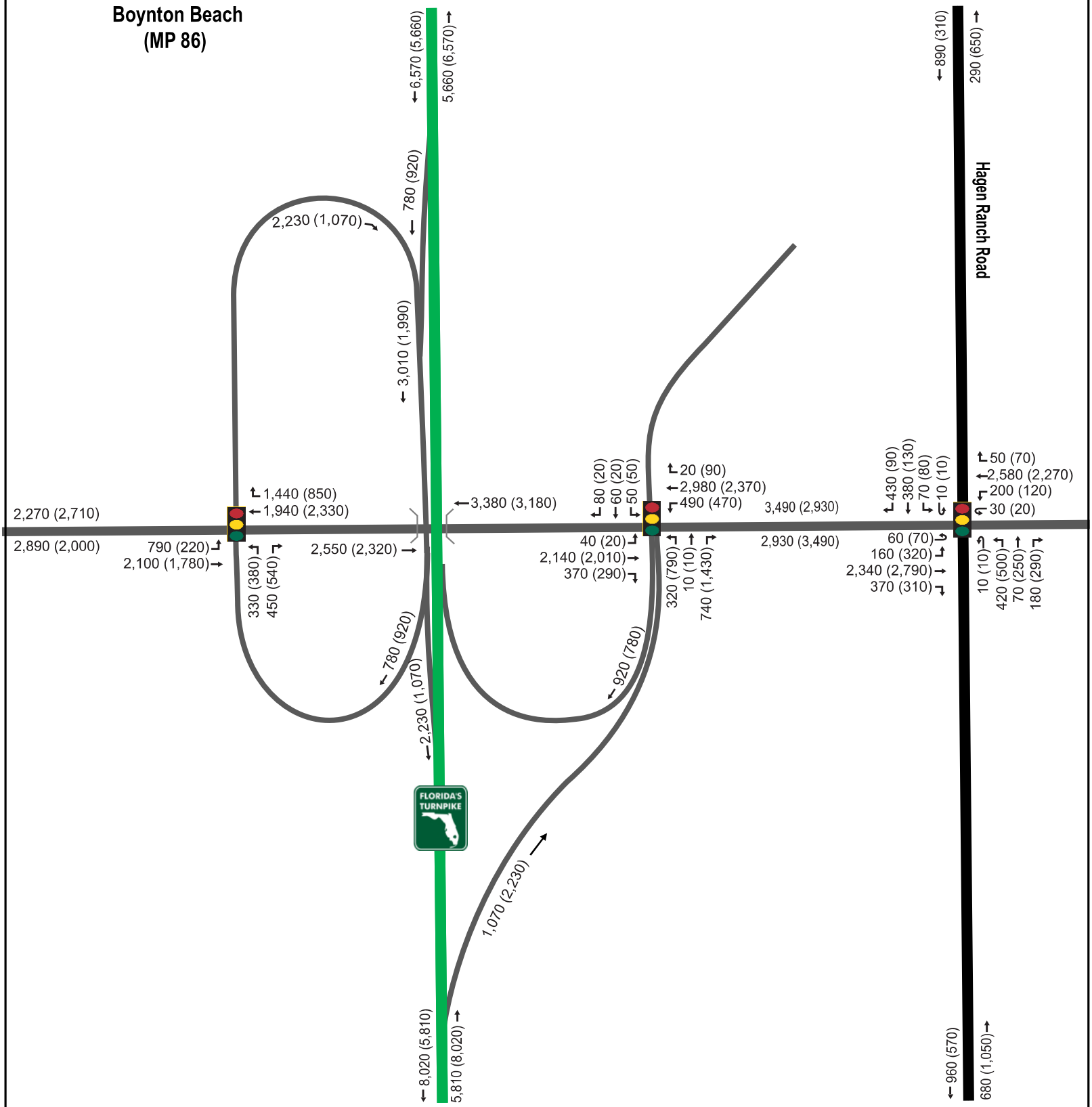
Figures 4.2 and **4.3** present the No-Build Design Hour Volumes for Opening Year 2025 and Design Year 2045, respectively. Note that some volumes remain the same between 2025 and 2045 either because access is provided to an area built out with no expected additional traffic or the volume is so low that the rounding to the nearest 10th does not result in any increase.



FLORIDA'S TURNPIKE	Boynton Beach Boulevard Interchange Modification Report	No-Build/TSM&O Roadway & Intersection Lane Configuration Signalized Intersection Existing Lane Geometry Additional Programmed Lanes	Figure 4.1



FLORIDA'S TURNPIKE	Boynton Beach Boulevard Interchange Modification Report	2025 No-Build Design Hour Volumes Signalized Intersection xxx (xxx) AM (PM) Volumes	Figure 4.2



FLORIDA'S TURNPIKE	Boynton Beach Boulevard Interchange Modification Report	2045 No-Build Design Hour Volumes Signalized Intersection xxx (xxx) AM (PM) Volumes	Figure 4.3

4.2.1 2025 and 2045 No-Build – Freeway Analysis

The mainline/basic, weaving, and ramp merge/diverge analysis results, as applicable, for Opening Year 2025 are summarized and depicted on **Figures 4.4** and **4.5** for the NB and SB directions, respectively. The Design Year 2045 analysis results are summarized and depicted on **Figures** in **4.6** and **4.7** for the NB and SB directions, respectively. Documentation of the 2025 and 2045 No-Build Alternative traffic freeway operational analysis is provided in **Appendix G**. The Design Year 2045 No-Build Alternative analysis indicates that all 5 freeway segments in the NB direction are projected to operate at LOS E or F during one or both design hours. Similarly, all 5 freeway segments in the SB direction are projected to operate at LOS E or F during one or both design hours. It is important to note that due to the limitations in the HCS analysis software, a barrier separated two-lane weaving section could not be analyzed. Therefore, CORSIM traffic simulation model was developed to analyze the weaving section. The simulation output is included in Appendix G. The 2045 analysis shows LOS E for the weaving segment during the AM design hour. However, the southbound loop on-ramp connecting to the weaving section and the southbound on-ramp connecting to the Turnpike mainline operate at LOS F during the AM peak hour. The heavy southbound on-ramp traffic in 2045 is expected to experience much worse operating conditions, particularly during the AM design hour due to the one-lane on-ramp merge with the Turnpike mainline.

4.2.2 2025 and 2045 No-Build – Intersection Analysis

Intersection analysis for ramp-terminals and adjacent intersections was performed in a similar manner as for the existing conditions. The No-Build Alternative includes the existing intersection control, existing lane geometry, and the TSM&O improvements recently approved for the northbound off-ramp terminal intersection. **Figure 4.1**, previously presented, presents the No-Build Alternative Lane Configuration and **Figures 4.2** and **4.3**, previously presented, show the AM and PM intersection volumes for 2025 and 2045 conditions, respectively. Signal timing was optimized to reflect routine maintenance operations. **Appendix H** presents the intersection analysis worksheets.

Tables 4.3 and **4.4** summarize the results of the No-Build signalized intersection analyses for the AM and PM design hours for 2025 and 2045, respectively. The results include delays (in seconds per vehicle) and Level of Service (LOS) by movement, approach, and the overall intersection. The 95th percentile queue lengths have also been summarized by movement. The intersection analysis results indicate the following for the 2045 Design Year:

- The southbound ramp intersection is projected to operate at LOS F during the AM design hour and LOS D during the PM design hour.
- The Hagen Ranch Road intersection is projected to operate at LOS E and LOS D during AM and PM design hours, respectively.

Figure 4.4: 2025 No-Build Freeway Analysis Results - Northbound

Segment	Freeway GPL Vol AM (PM) vph	AM LOS/Density (PC/MI/LN)	PM LOS/Density (PC/MI/LN)
Basic Freeway	4,280 (5,030)	C (24.2)	D (30.1)
Merge - Entry from Boynton Beach Blvd EB & WB	4,280 (5,030)	C (20.1)	C (23.3)
Basic Freeway	3,620 (4,470)	C (19.9)	C (25.5)
Diverge to Boynton Beach Blvd EB & WB	4,500 (6,300)	B (15.2)	F (N/A)
Basic Freeway	4,500 (6,300)	C (25.8)	F (N/A)

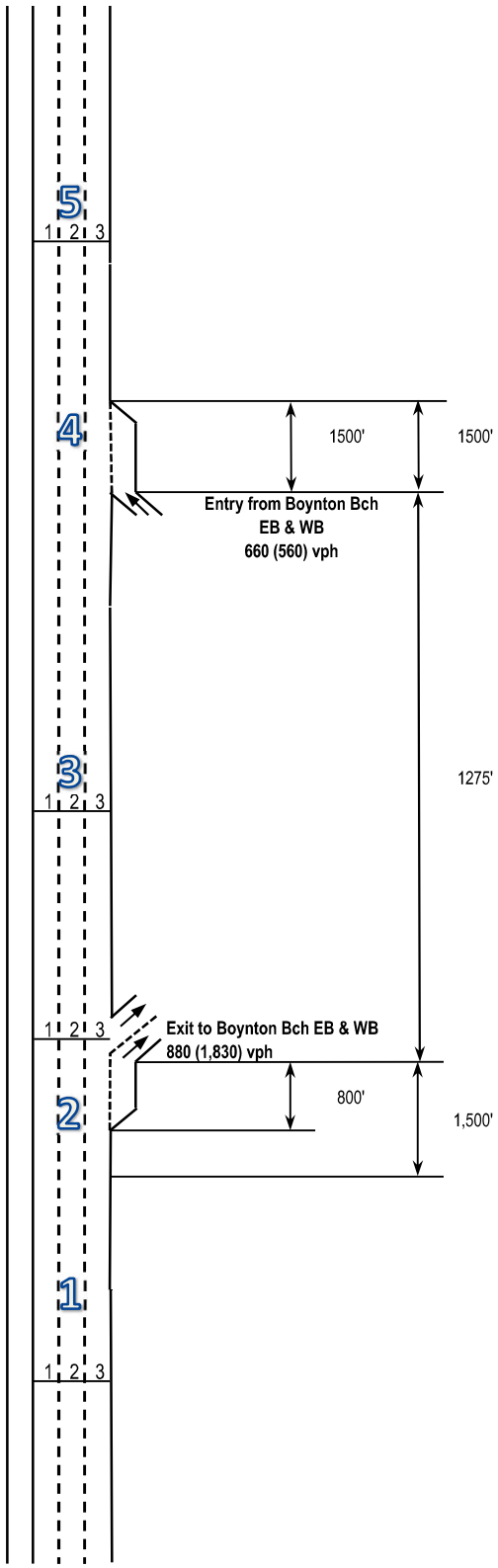
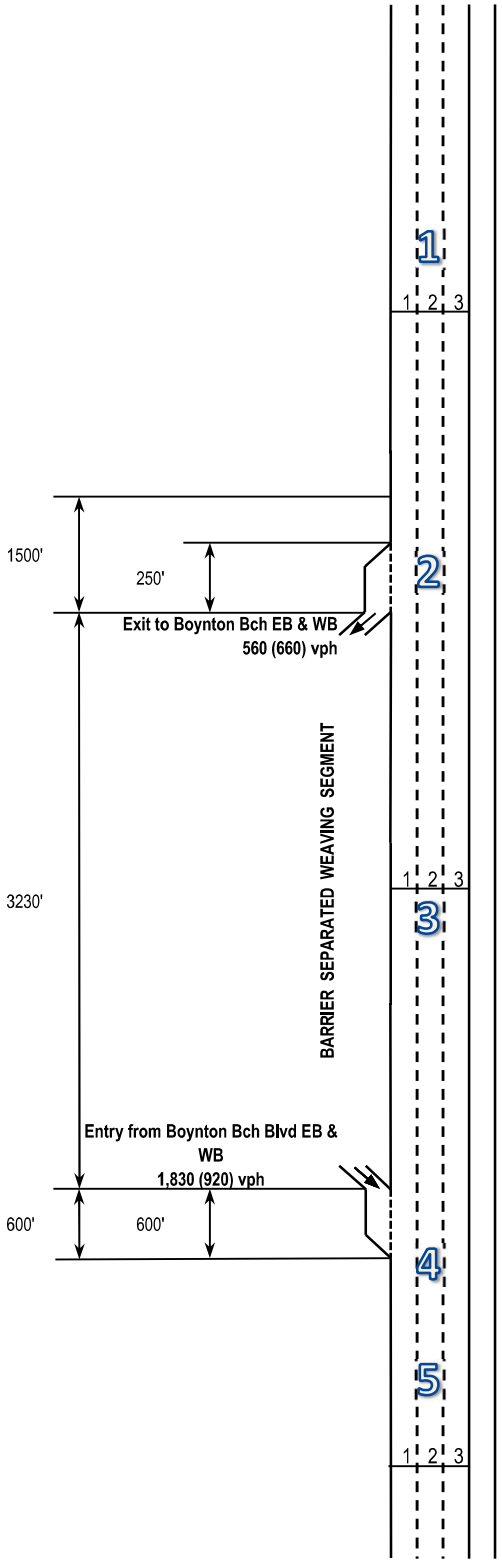


Figure 4.5: 2025 No-Build Freeway Analysis Results - Southbound



Segment	Freeway GPL Vol AM (PM) vph	AM LOS/Density (PC/MI/LN)	PM LOS/Density (PC/MI/LN)
Basic Freeway	5,030 (4,240)	D (30.1)	C (23.9)
Diverge to Boynton Beach Blvd EB and WB	5,030 (4,240)	D (32.5)	D (29.0)
Basic Freeway	4,470 (3,580)	C (25.5)	C (19.7)
Barrier Saparated Weave*	2,390 (1,580)	D (29.3)	C (18.8)
U/S Loop On-Ramp*	1,830 (920)	F (55.4)	D (27.0)
D/S On-Ramp*	1,830 (920)	E (44.6)	C (21.5)
Merge from Boynton Beach Blvd EB and WB	6,300 (4,500)	F (N/A)	C (27.6)
Basic Freeway	6,300 (4,500)	F (N/A)	C (25.8)

* U/S=Upstream, D/S= Downstream, MOEs obtained from CORSIM simulation

Figure 4.6: 2045 No-Build Freeway Analysis Results - Northbound

Segment	Freeway GPL Vol AM (PM) vph	AM LOS/Density (PC/MI/LN)	PM LOS/Density (PC/MI/LN)
Basic Freeway	5,660 (6,570)	E (36.8)	F (N/A)
Merge - Entry from Boynton Beach Blvd EB & WB	5,660 (6,570)	C (27.2)	F (N/A)
Basic Freeway	4,740 (5,790)	D (27.6)	E (38.5)
Diverge to Boynton Beach Blvd EB & WB	5,810 (8,020)	C (22.8)	F (N/A)
Basic Freeway	5,810 (8,020)	E (38.7)	F (N/A)

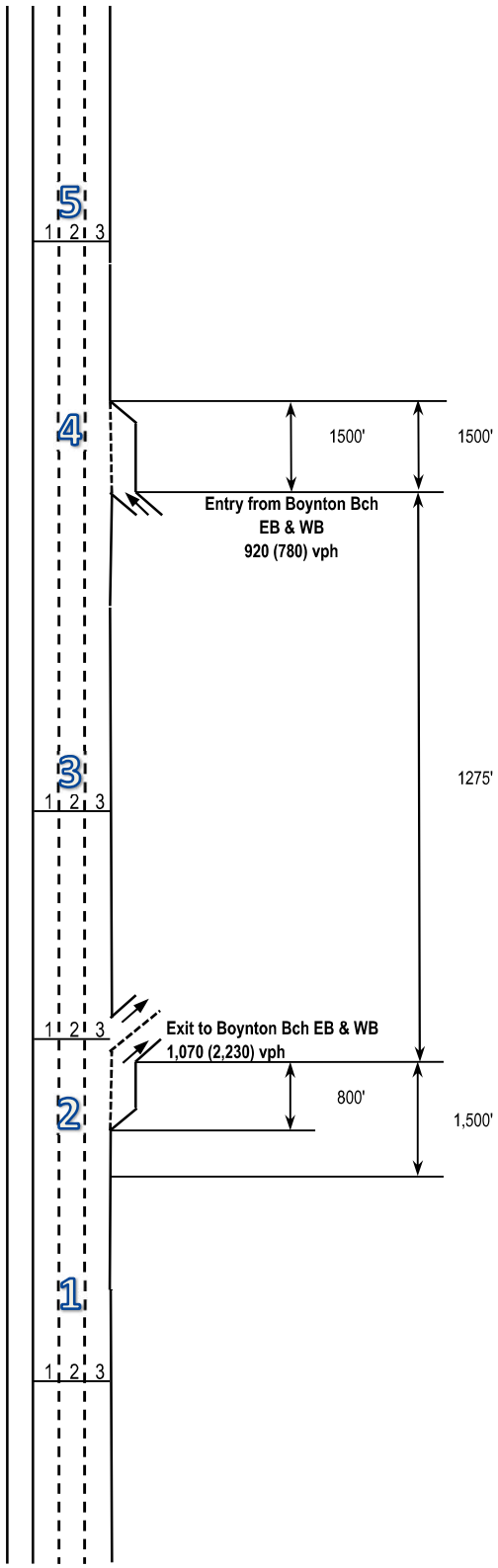
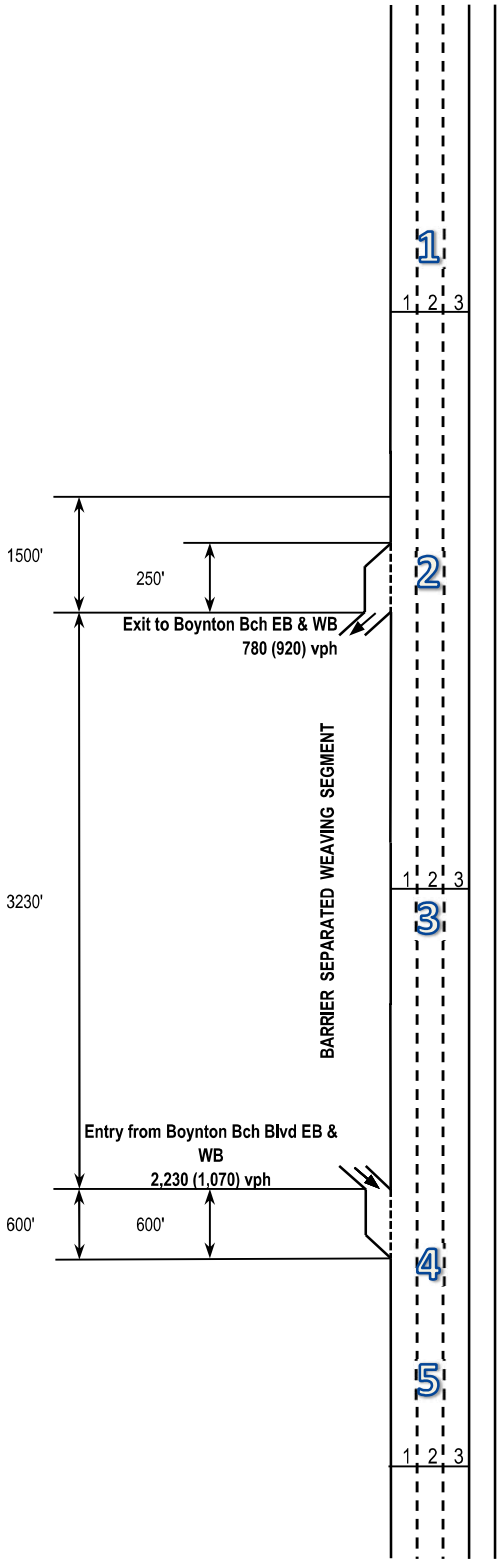


Figure 4.7: 2045 No-Build Freeway Analysis Results - Southbound



Segment	Freeway GPL Vol AM (PM) vph	AM LOS/Density (PC/MI/LN)	PM LOS/Density (PC/MI/LN)
Basic Freeway	6,570 (5,660)	F (N/A)	E (36.8)
Diverge to Boynton Beach Blvd EB and WB	6,570 (5,660)	F (N/A)	E (35.9)
Basic Freeway	5,790 (4,740)	E (38.5)	D (27.6)
Barrier Saparated Weave*	3,010 (1,990)	E (36.8)	C (24.0)
U/S Loop On-Ramp*	2,230 (1,070)	F (67.4)	D (31.5)
D/S On-Ramp*	2,230 (1,070)	F (53.6)	C (25.0)
Merge from Boynton Beach Blvd EB and WB	8,020 (5,810)	F (N/A)	D (34.8)
Basic Freeway	8,020 (5,810)	F (N/A)	E (38.7)

* U/S=Upstream, D/S= Downstream, MOEs obtained from CORSIM simulation

Table 4.3: 2025 No Build – Boynton Beach Boulevard Intersection Analysis Results

AM Peak

Arterial	Signal Controlled Intersections	Measure of Effectiveness (MOE)	Location	AM Movement/Approach LOS (Delay)												Intersection AM LOS (Delay)
				Eastbound			Westbound			Northbound			Southbound			
				Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
Boynton Beach Boulevard	Turnpike Southbound Ramps	LOS (Delay)	Movement	**F (225.7)**	A (5.6)			B (16.5)	**F (160.1)**		**F (128.4)**	A (0.4)				**E (67.4)**
			Approach	**E (62.4)**			**E (76.2)**			D (43.9)						
		Queue Length 95th (ft)	Movement	#1069	221			m373	m#1802		#371	0				
	Turnpike Northbound Ramps	LOS (Delay)	Movement	**F (87.8)**	D (44.4)	A (5.7)	C (29.2)	A (5.1)	A (0.0)	**F (184.5)**	C (26.4)		**E (68.2)**	**F (123.4)**		C (29.4)
			Approach	D (41.0)			A (8.1)			**F (101.7)**			**F (110.5)**			
		Queue Length 95th (ft)	Movement	m47	771	73	m160	232	m0	#195	#106		41	#252		
	Hagen Ranch Road	LOS (Delay)	Movement	**E (69.6)**	B (15.0)	A (1.3)	**F (106.8)**	D (45.0)	A (0.0)	**F (95.2)**	**E (70.3)**	B (15.7)	D (52.7)	**F (93.2)**	D (42.3)	D (40.9)
			Approach	B (17.7)			D (50.3)			**E (70.9)**			**E (64.8)**			
		Queue Length 95th (ft)	Movement	m#141	161	m11	#209	820	0	#325	63	79	64	#294	#401	

PM Peak

Arterial	Signal Controlled Intersections	Measure of Effectiveness (MOE)	Location	PM Movement/Approach LOS (Delay)												Intersection PM LOS (Delay)
				Eastbound			Westbound			Northbound			Southbound			
				Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
Boynton Beach Boulevard	Turnpike Southbound Ramps	LOS (Delay)	Movement	**E (69.9)**	A (9.5)			B (19.8)	A (3.5)		**E (68.6)**	A (0.5)				B (16.7)
			Approach	B (16.1)			B (15.8)			C (22.2)						
		Queue Length 95th (ft)	Movement	#285	297			m603	53		289	0				
	Turnpike Northbound Ramps	LOS (Delay)	Movement	**F (94.5)**	D (51.1)	B (11.5)	C (29.2)	A (4.5)	A (0.3)	**F (173.6)**	**F (170.0)**		**E (75.1)**	D (44.5)		D (48.6)
			Approach	D (47.5)			A (7.4)			**F (172.1)**			**E (63.6)**			
		Queue Length 95th (ft)	Movement	m53	#779	88	m151	222	m2	#519	#651		50	48		
	Hagen Ranch Road	LOS (Delay)	Movement	**E (62.8)**	B (14.1)	A (1.1)	**F (105.5)**	D (43.4)	A (0.1)	**F (86.3)**	**E (68.9)**	C (31.3)	**E (68.6)**	**F (99.6)**	A (0.9)	D (36.9)
			Approach	B (18.6)			D (45.8)			**E (67.3)**			**E (59.3)**			
		Queue Length 95th (ft)	Movement	m208	m255	m11	#141	785	0	#364	165	187	#87	#113	0	

Synchro Version 11 Build 168. *HCM6 output used for unsignalized intersections due to limitations in Synchro.

LOS notes:

Delay is in sec/veh units

:Level Of Service (LOS) E reflecting at capacity operations

:Level Of Service (LOS) F reflecting over capacity operations

Queue notes:

~: Volume exceeds capacity, queue is theoretically infinite

#: 95th percentile volume exceeds capacity

m: Upstream metering is in effect

Intersection	Distance
SB on/off-ramp 1.915 MM	-
NB on/off-ramp 2.204 MM	1,525 ft
Hagen Ranch Road 2.571 MM	1,940 ft

Table 4.4: 2045 No Build – Boynton Beach Boulevard Intersection Analysis Results

AM Peak

Arterial	Signal Controlled Intersections	Measure of Effectiveness (MOE)	Location	AM Movement/Approach LOS (Delay)												Intersection AM LOS (Delay)
				Eastbound			Westbound			Northbound			Southbound			
				Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
Boynton Beach Boulevard	Turnpike Southbound Ramps	LOS (Delay)	Movement	F (376.0)	A (9.0)			C (31.9)	F (291.0)		F (212.3)	A (0.5)				F (123.0)
			Approach	F (109.3)			F (142.3)			F (90.0)						
		Queue Length 95th (ft)	Movement	#1592	366			m704	m#2545		#704	0				
	Turnpike Northbound Ramps	LOS (Delay)	Movement	F (140.0)	D (37.2)	A (6.0)	E (76.4)	C (24.8)	A (0.0)	F (116.5)	F (97.4)		E (77.0)	F (135.7)		D (40.0)
			Approach	C (34.3)			C (31.9)			F (110.4)			F (120.1)			
		Queue Length 95th (ft)	Movement	m#111	900	69	m296	m704	m0	#277	#268		54	#296		
	Hagen Ranch Road	LOS (Delay)	Movement	F (105.2)	C (24.2)	A (2.9)	F (124.7)	E (68.4)	A (0.1)	F (124.3)	E (57.1)	B (17.1)	F (92.1)	F (115.1)	F (87.3)	E (59.1)
			Approach	C (27.6)			E (71.8)			F (89)			F (99.6)			
		Queue Length 95th (ft)	Movement	m#182	505	m63	#236	#1259	0	#399	62	123	81	#355	#639	

PM Peak

Arterial	Signal Controlled Intersections	Measure of Effectiveness (MOE)	Location	PM Movement/Approach LOS (Delay)												Intersection PM LOS (Delay)
				Eastbound			Westbound			Northbound			Southbound			
				Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
Boynton Beach Boulevard	Turnpike Southbound Ramps	LOS (Delay)	Movement	F (80.6)	B (17.5)			E (63.3)	C (26.3)		E (70.6)	A (0.7)				D (40.3)
			Approach	C (24.5)			D (53.4)			C (29.6)						
		Queue Length 95th (ft)	Movement	#343	432			#1092	m423		#566	0				
	Turnpike Northbound Ramps	LOS (Delay)	Movement	F (119.2)	E (74.6)	A (9.1)	F (91.7)	C (24.0)	A (3.8)	F (84.3)	E (76.9)		F (80.7)	E (58.5)		D (54.0)
			Approach	E (66.8)			C (34.2)			F (82.0)			E (70.9)			
		Queue Length 95th (ft)	Movement	m45	#984	226	m#291	m616	m9	#529	#519		53	66		
	Hagen Ranch Road	LOS (Delay)	Movement	E (63.0)	D (36.2)	A (1.8)	F (126.4)	D (52.3)	A (2.4)	F (153.5)	E (74.2)	D (44.1)	E (79.9)	F (110.8)	A (2.7)	D (53.8)
			Approach	D (36.2)			E (55.1)			F (104.4)			E (70.4)			
		Queue Length 95th (ft)	Movement	m216	m510	m24	#153	#975	20	#463	188	#245	84	#139	13	

Synchro Version 11 Build 168. *HCM6 output used for unsignalized intersections due to limitations in Synchro.

LOS notes:

Delay is in sec/veh units

:Level Of Service (LOS) E reflecting at capacity operations

:Level Of Service (LOS) F reflecting over capacity operations

Queue notes:

~: Volume exceeds capacity, queue is theoretically infinite

#: 95th percentile volume exceeds capacity

m: Upstream metering is in effect

Intersection	Distance
SB on/off-ramp 1.915 MM	-
NB on/off-ramp 2.204 MM	1,525 ft
Hagen Ranch Road 2.571 MM	1,940 ft

Table 4.5 summarizes the results of the off-ramp signals back of queue analyses for the AM and PM design hours for the 2045 No-Build conditions. The 95th percentile queues were obtained from Synchro reports. The Synchro reported queue was multiplied by the number of turn lanes and the lane utilization factor to calculate the total queue length. The results present the queue length in feet for each lane group movement. The available storage length was calculated from the stop bar at the ramp terminal intersection to the gore with Turnpike mainline minus the 615 feet required for stopping distance for a design speed of 70 mph per FDOT's 2016 Green book (Table 3-22), and accounting for the changes in number of lanes. For the southbound off-ramp, the storage lengths were estimated similarly with a stopping distance of 385 feet for a design speed of 45 mph on the C - D road weaving area.

Table 4.5
2045 No-Build – Off-Ramp Signals Queuing Analysis Results

Intersection	Approach	Movement	Available Storage (ft)	Queue (ft)	
				AM	PM
2045 No-Build					
Boynton Beach Boulevard at SB Off-Ramp	Northbound	L (WB)	780	#704	#566
		R (EB)	830	0	0
Boynton Beach Boulevard at NB Off-Ramp	Northbound	L (WB)	2,535	#756	#1444
		R (EB)	1,245	#268	#519

Queue Notes:
Synchro queue was multiplied by the number of turn lanes and the lane utilization factor to calculate the total queue length.
#: 95th percentile volume exceeds capacity

5.1 BUILD ALTERNATIVE – TRANSPORTATION NETWORK

The widening for the corridor is planned to include to 10 lanes (5 each direction) south of Boynton Beach Boulevard and 8 lanes (4 each direction) north of the Boynton Beach Boulevard interchange. The consideration of implementation and provision of managed lanes in the future is also currently under evaluation and may require further analysis and documentation be added to this Interchange Modification Report. Future Build alternatives include a planned Turnpike Mainline widening and the modifications of Boynton Beach Boulevard interchange.

5.2 FUTURE BUILD ALTERNATIVE TRAFFIC FORECAST

As previously mentioned under Section 4.2, the demand-based traffic forecasts are used in the analysis of both the No-Build scenario (no widening of the Turnpike Mainline) and Build scenario (widening of the Turnpike Mainline). The AADT forecasts for 2025 and 2045 for the Turnpike Mainline and ramps and Boynton Beach Boulevard are shown in Tables 4.1 and 4.2.

5.3 DEVELOPMENT AND SCREENING OF BUILD ALTERNATIVES

The existing Boynton Beach Boulevard interchange configuration includes a barrier separated weaving zone between the southbound off-ramp and on-ramp traffic within a short distance (less than 1,300 feet) leading to unsafe operations. Three interchange reconfiguration alternatives were proposed to address the existing traffic congestion and related safety issues caused by the short weaving section. The alternatives were evaluated for opening (2025) and design (2045) years as described below:

- ***Alternative 1:*** Includes relocating the southbound off-ramp upstream of Boynton Beach Boulevard, and the southbound on-ramp loop to downstream. A new southbound on-ramp serving the eastbound to southbound traffic is added. The westbound to southbound is provided similar to the existing conditions. These two southbound on-ramps will merge into the southbound mainline traffic. The lane geometry of this alternative is shown on Figure 8.1 of the PDAR included in Appendix F.
- ***Alternative 2:*** Similar to Alternative 1, with the exception that the southbound on-ramp serving the westbound to southbound traffic merges with the mainline upstream of Boynton Beach Boulevard; and the southbound on-ramp serving the eastbound to southbound traffic to downstream. The lane geometry of this alternative is shown on Figure 8.2 of the PDAR included in Appendix F.
- ***Alternative 3:*** Similar to Alternative 2, with the exception that a new northbound on-ramp serving the westbound to northbound traffic is added. The lane geometry of this alternative is shown on Figure 8.3 of the PDAR included in Appendix F.

Each alternative was analyzed with a two-lane northbound off-ramp facility to guarantee a maximum service volume at LOS E or better. Based on the analysis, Alternatives 1 and 2 are comparable to each

other, whereas Alternative 3 shows slightly better overall benefit in the operations at the ramp terminal intersections. The capacity analysis shows all alternatives operating at LOS C or better with no substantial differences between them. Although Alternative 3 shows slightly better operational performance at intersection level, it is not recommended to move forward due to Florida Gas Transmission (FGT) line crossing and right of way constraints. Considering the overall impacts and benefits, Alternative 2 was considered the recommended alternative for Boynton Beach Boulevard interchange. ***This Alternative 2 will be considered as the Build alternative for this IMR.*** Further modification was made at the northbound off ramp terminal by assigning northbound shared left, thru and right turn lane which will stop at the traffic signal and an exclusive northbound right turn lane which will operate under yield condition (part of TSM&O). The proposed improvements under this alternative will address the traffic operation deficiencies by improving or eliminating failing merge, diverge and weaving segments; and may reduce crash rates by reducing congestion. Improvements at the ramp terminal intersections are projected to eliminate queue spillbacks on to the Turnpike mainline and improve the flow of traffic along Boynton Beach Boulevard. The conceptual and signing plans for the Build alternative are included in **Appendix I**.

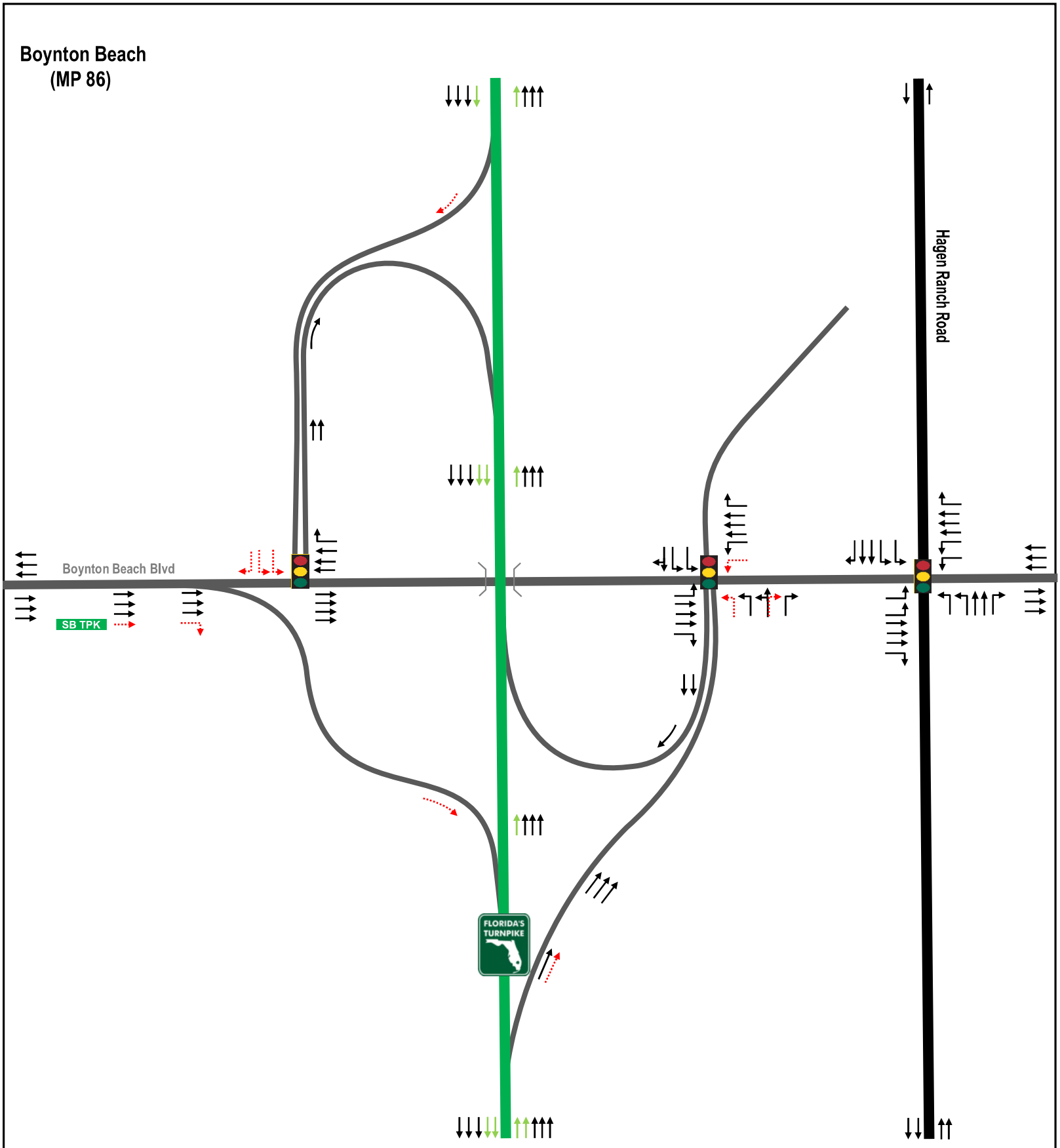
Figure 5.1 shows the Roadway and Intersection Lane Configuration for the Build alternative. The 2025 and 2045 design hour traffic volumes for the Build alternative are shown in **Figures 5.2** and **5.3**, respectively.

5.4 BUILD ALTERNATIVE – TRAFFIC OPERATIONAL ANALYSIS

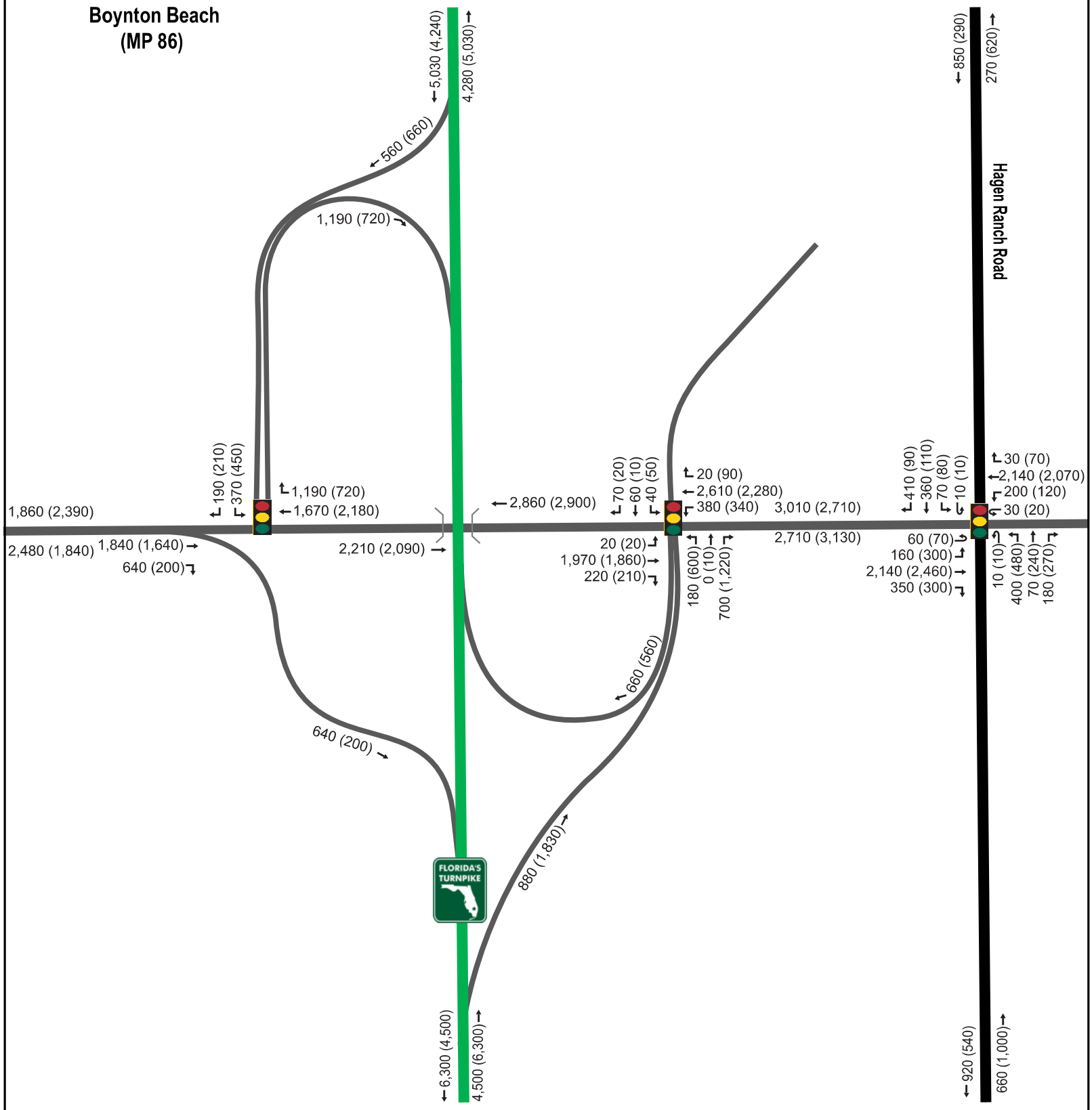
The proposed improvements are expected to provide better operating conditions than the No-Build conditions and prevent any spillbacks from the ramp terminals on to the mainline. These improvements are also likely to improve safety by reducing congestion and the number of conflict points.

5.4.1 2025 and 2045 – Freeway Analysis

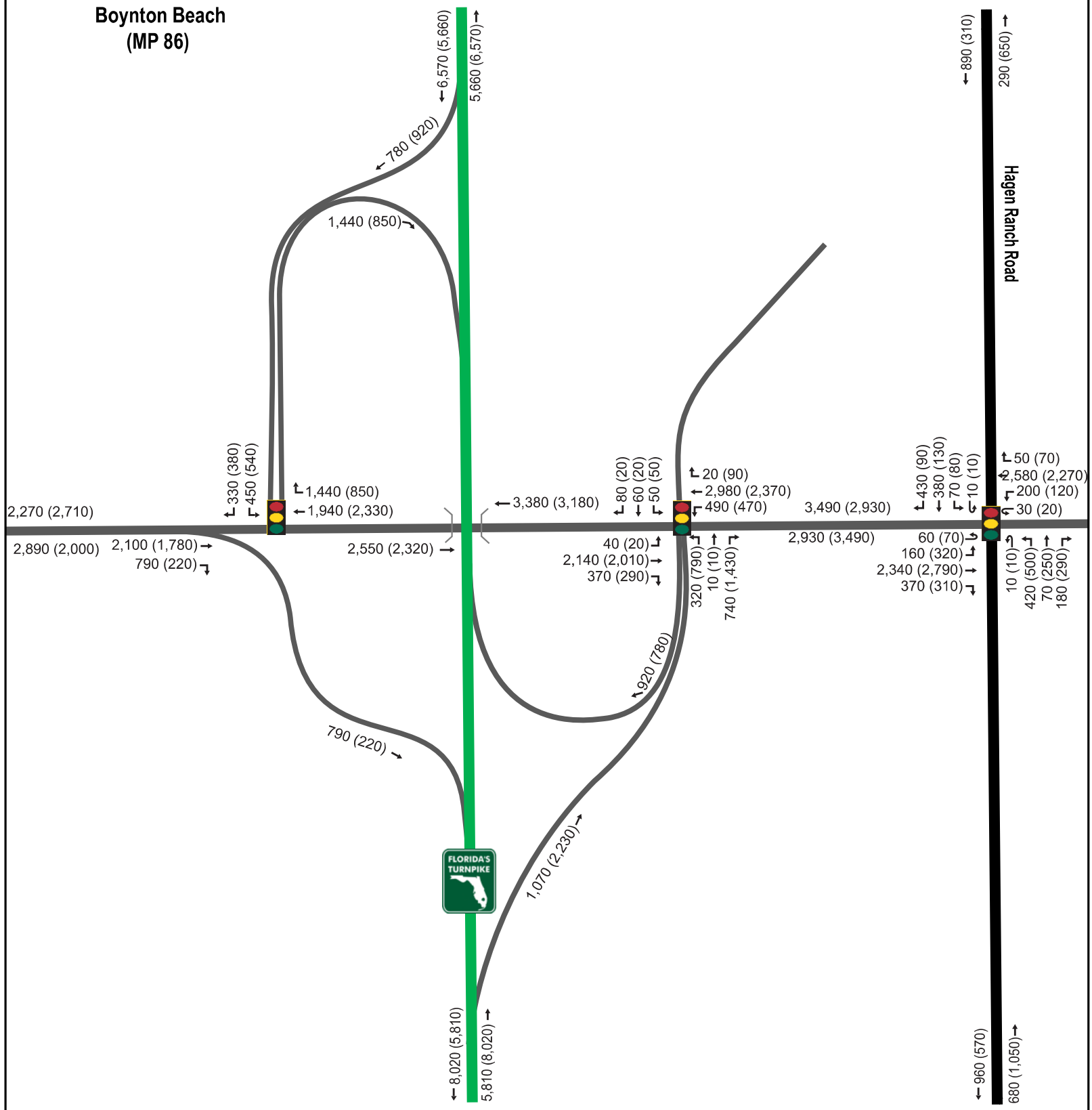
The mainline/basic, weaving, and ramp merge/diverge analysis results for Opening Year 2025 are summarized and depicted on **Figures 5.4** and **5.5** for the NB and SB directions, respectively. The Design Year 2045 analysis results are summarized and depicted on **Figures 5.6** and **5.7** for the NB and SB directions, respectively. Documentation of the 2025 and 2045 Build Alternative traffic freeway operational analysis is provided in **Appendix J**. The Design Year 2045 Build Alternative analysis indicates that all freeway segments are projected to operate at LOS D or better in both directions during both design hours.



FLORIDA'S TURNPIKE	Boynton Beach Boulevard Interchange Modification Report	Build Alternative Roadway & Intersection Lane Configuration Signalized Intersection Existing Lane Geometry Additional Proposed Lanes Planned Improvement	Figure 5.1



FLORIDA'S TURNPIKE	Boynton Beach Boulevard Interchange Modification Report	2025 Build Alternative Design Hour Volumes Signalized Intersection xxx (xxx) AM (PM) Volumes	Figure 5.2



FLORIDA'S TURNPIKE	Boynton Beach Boulevard Interchange Modification Report	2045 Build Alternative Design Hour Volumes Signalized Intersection xxx (xxx) AM (PM) Volumes	Figure 5.3

Figure 5.4: 2025 Build Alternative Freeway Analysis Results - Northbound

Segment	Freeway GPL Vol AM (PM) vph	AM LOS/Density (PC/MI/LN)	PM LOS/Density (PC/MI/LN)
Basic Freeway	4,280 (5,030)	B (17.3)	C (20.8)
Merge - Entry from Boynton Beach Blvd EB & WB	4,280 (5,030)	B (14.0)	B (16.1)
Basic Freeway	3,620 (4,470)	B (14.9)	C (18.4)
Diverge: Lane Drop to Boynton Beach Blvd EB & WB	4,500 (6,300)	B (17.6)	C (24.6)
Basic Freeway	4,500 (6,300)	B (14.9)	C (20.9)

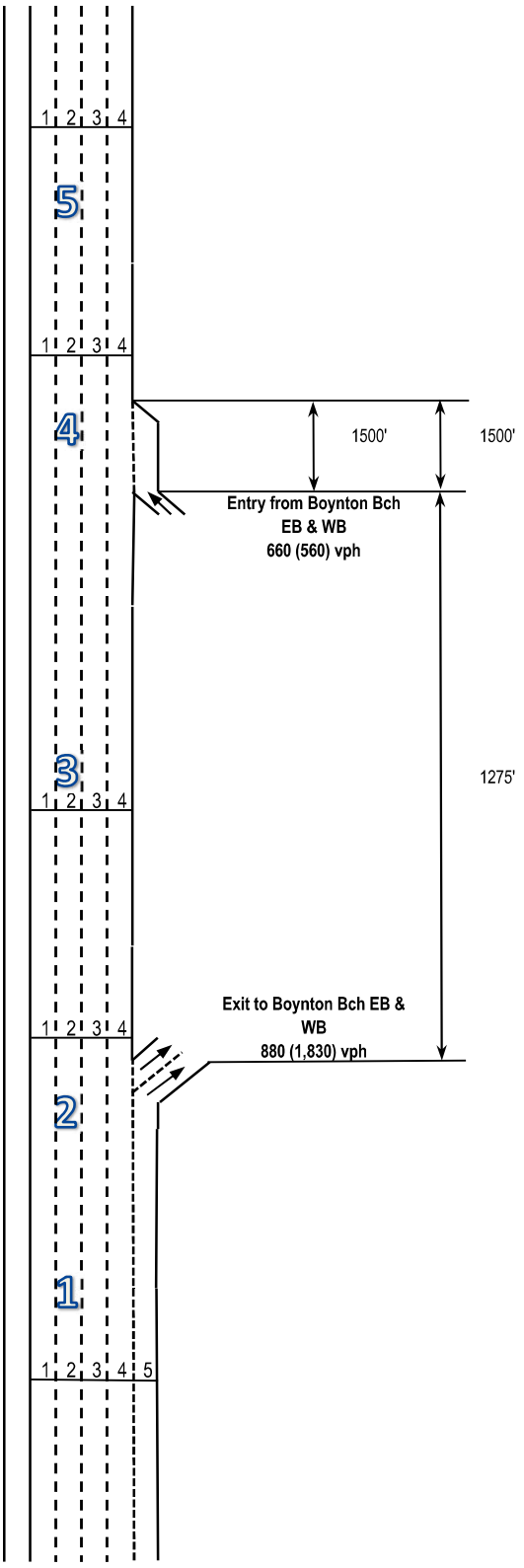
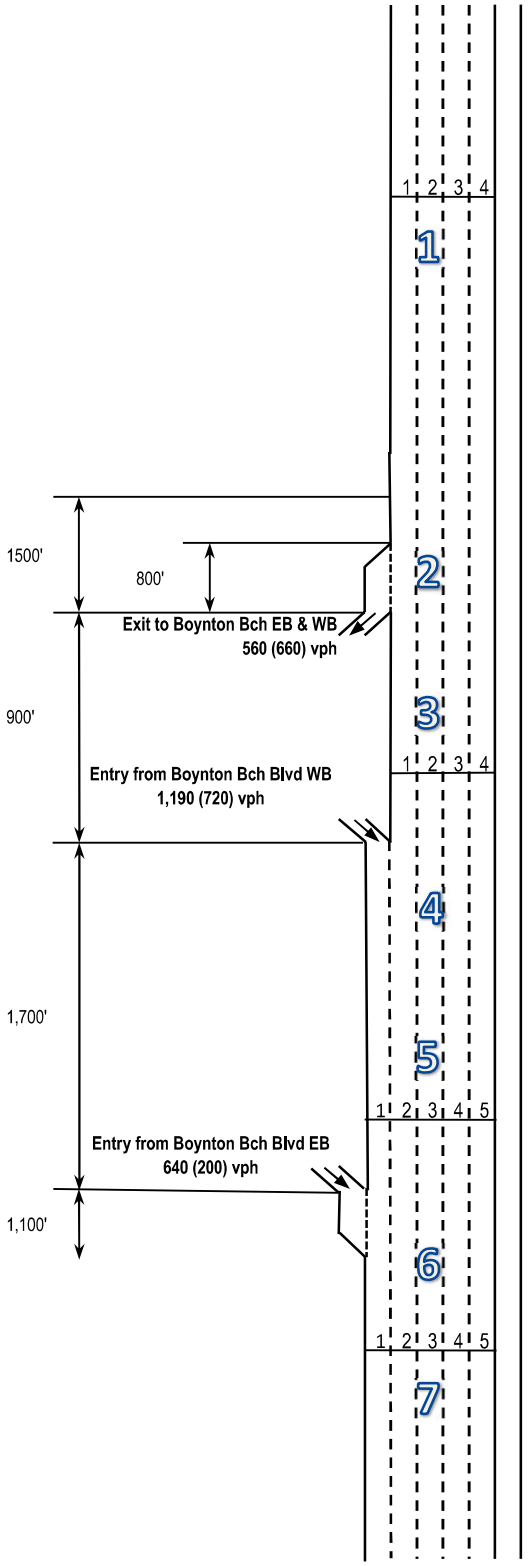


Figure 5.5: 2025 Build Alternative Freeway Analysis Results - Southbound



Segment	Freeway GPL Vol AM (PM) vph	AM LOS/Density (PC/MI/LN)	PM LOS/Density (PC/MI/LN)
Basic Freeway	5,030 (4,240)	C (21.0)	B (17.6)
Diverge to Boynton Beach Blvd EB and WB	5,030 (4,280)	C (20.6)	B (18.3)
Basic Freeway	4,470 (3,580)	C (18.6)	B (14.9)
Lane Add from Boynton Beach Blvd WB	5,660 (4,300)	Under Capacity* v/c: U/S, Ramp, D/S 0.52, 0.63, 0.53	Under Capacity* v/c: U/S, Ramp, D/S 0.42, 0.38, 0.40
Basic Freeway	5,660 (4,300)	C (18.8)	B (14.3)
Merge: Lane Add from Boynton Beach Blvd EB	6,300 (4,500)	B (18.7)	B (11.8)
Basic Freeway	6,300 (4,500)	C (21.0)	B (15.0)

*U/S=Upstream, D/S=Downstream

Figure 5.6: 2045 Build Alternative Freeway Analysis Results - Northbound

Segment	Freeway GPL Vol AM (PM) vph	AM LOS/Density (PC/MI/LN)	PM LOS/Density (PC/MI/LN)
Basic Freeway	5,660 (6,570)	C (23.9)	D (29.2)
Merge - Entry from Boynton Beach Blvd EB & WB	5,660 (6,570)	B (20.0)	C (22.4)
Basic Freeway	4,740 (5,790)	C (19.6)	C (24.6)
Diverge: Lane Drop to Boynton Beach Blvd EB & WB	5,810 (8,020)	C (22.7)	D (31.3)
Basic Freeway	5,810 (8,020)	C (19.2)	D (28.2)

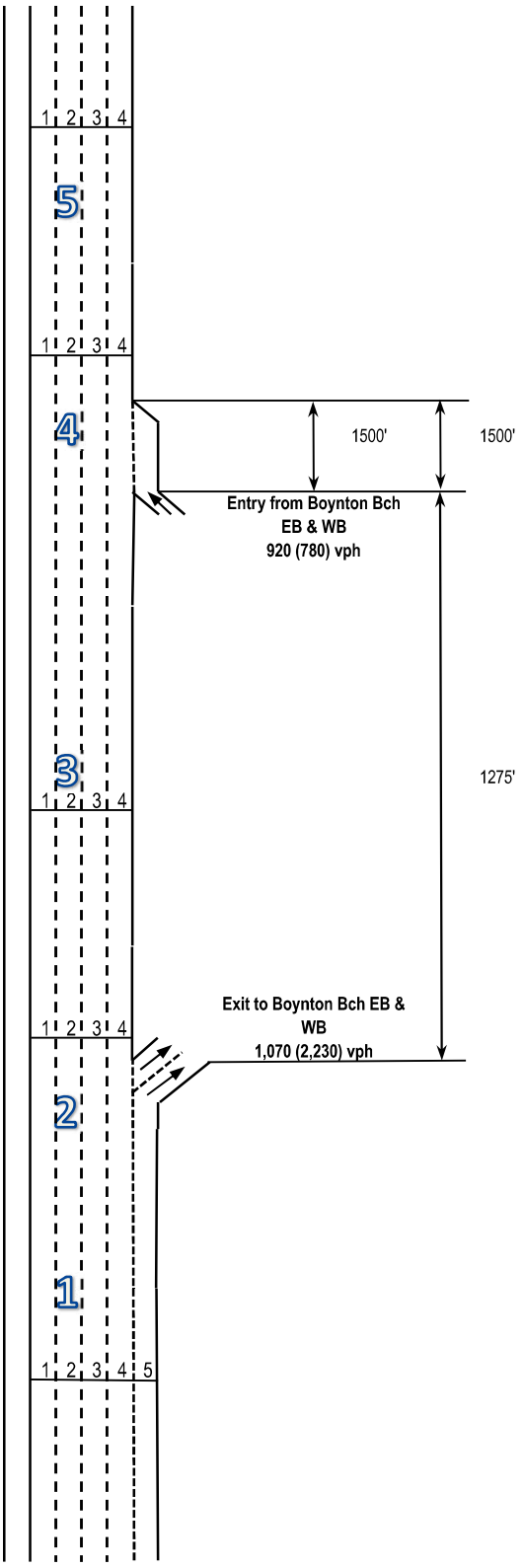
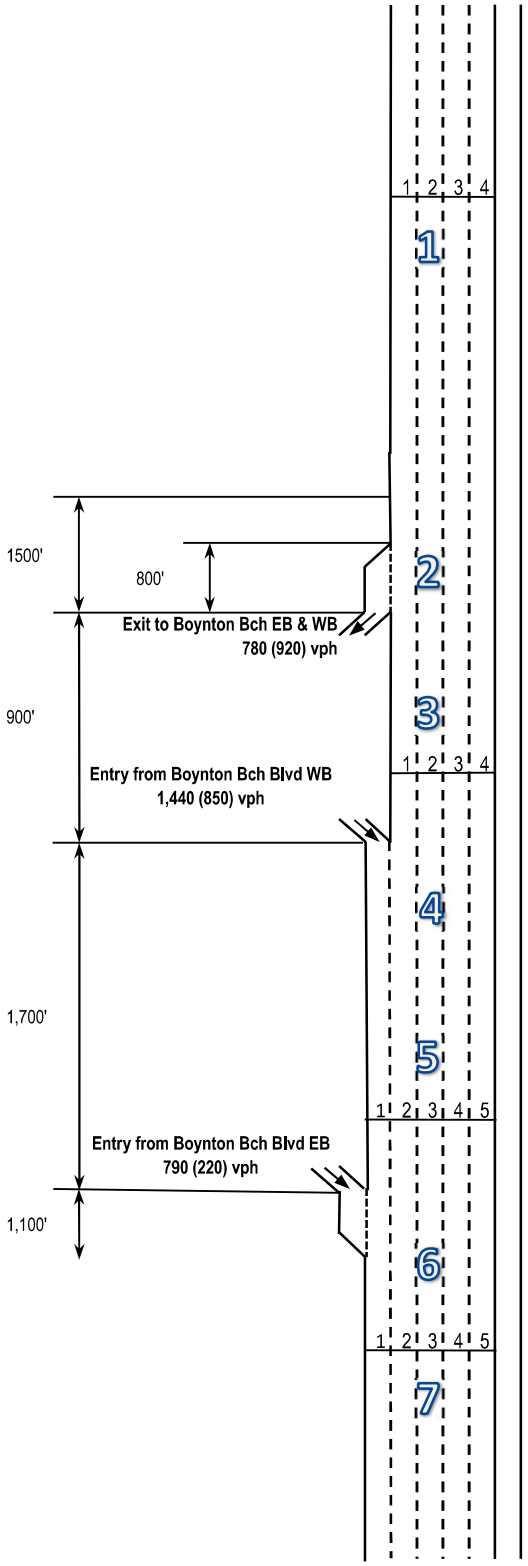


Figure 5.7: 2045 Build Alternative Freeway Analysis Results - Southbound



Segment	Freeway GPL Vol AM (PM) vph	AM LOS/Density (PC/MI/LN)	PM LOS/Density (PC/MI/LN)
Basic Freeway	6,570 (5,660)	D (29.3)	C (24.0)
Diverge to Boynton Beach Blvd EB and WB	6,570 (5,660)	D (28.5)	C (25.4)
Basic Freeway	5,790 (4,740)	C (24.7)	C (19.7)
Lane Add from Boynton Beach Blvd WB	7,230 (5,590)	Under Capacity* v/c: U/S, Ramp, D/S 0.67, 0.76, 0.67	Under Capacity* v/c: U/S, Ramp, D/S 0.55, 0.45, 0.52
Basic Freeway	7,230 (5,590)	C (24.7)	C (18.6)
Merge: Lane Add from Boynton Beach Blvd EB	8,020 (5,810)	C (22.9)	B (15.1)
Basic Freeway	8,020 (5,810)	D (28.3)	C (19.3)

*U/S=Upstream, D/S=Downstream

5.4.2 2025 and 2045 – Intersection Analysis

Tables 5.1 and **5.2** summarize the results of the Boynton Beach Boulevard signalized intersection analyses for the AM and PM design hours for 2025 and 2045 Build Alternative, respectively. Signal timing was optimized for all intersections. An Origin-Destination (O-D) survey was performed for traffic exiting from northbound off-ramp traffic turning eastbound left at Hagen Ranch Road. Based on the O-D matrix, only 60 vph and 160 vph are anticipated to make this movement during AM and PM peak hours, respectively. The results include delays (in seconds per vehicle) and LOS by movement, approach, and the overall intersection. The 95th percentile queue lengths have also been summarized by movement. **Appendix K** presents the intersection analysis worksheets. The intersection analysis results indicate the following for the 2045 Design Year:

- All intersections are projected to operate at LOS D or better except Hagen Ranch Road during PM peak hour (LOS E).
- The distance between the ramp terminals is 1,525 ft and from northbound on/off-ramp to Hagen Ranch Road is 1,940 ft. The eastbound/westbound queues at the three intersections anticipated not to block the ramp terminals.

Following are the key points for traffic operation improvements under Build compared to No-Build:

- The southbound ramp improvements and modifications proposed under the Build condition will improve the Level of Service of the southbound ramp terminal intersection from LOS F under the No-Build condition to LOS B under the Build condition during AM design hour.
- Further modification was made at the northbound off ramp terminal by assigning northbound shared left, thru and right turn lane which will stop at the traffic signal and an exclusive northbound right turn lane which will operate under yield condition (part of TSM&O). This configuration will reduce the weaving issue for the northbound off-ramp traffic turning eastbound left at Hagen Ranch Road.

Table 5.1 2025 Build Alternative – Boynton Beach Boulevard Intersection Analysis Results

AM Peak

Arterial	Signal Controlled Intersections	Measure of Effectiveness (MOE)	Location	AM Movement/Approach LOS (Delay)												Intersection AM LOS (Delay)
				Eastbound			Westbound			Northbound			Southbound			
				Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
Boynton Beach Boulevard	Turnpike Southbound Ramps	LOS (Delay)	Movement		A (8.4)			A (4.3)	B (16.5)				**E (78.7)**		**F (85.9)**	B (16.7)
			Approach		A (8.4)			A (9.4)						**F (81.1)**		
		Queue Length 95th (ft)	Movement		368			m165	m1087				261		282	
	Turnpike Northbound Ramps	LOS (Delay)	Movement	**F (106.2)**	C (34.7)	A (4.3)	D (52.8)	A (9.7)	A (0.0)	**F (82.2)**	**F (272.2)**		**E (77.5)**	**F (142.9)**		C (34.9)
			Approach		C (32.3)			B (15.0)			**F (181.7)**			**F (127.6)**		
		Queue Length 95th (ft)	Movement	m48	724	58	m237	m320	m0	148	#494	#494	45	#285	#285	
	Hagen Ranch Road	LOS (Delay)	Movement	**F (97.9)**	B (14.2)	A (1.5)	**F (135.1)**	D (40.3)	A (0.1)	**F (114.5)**	**E (57.2)**	B (16.5)	**F (91.7)**	**F (104.6)**	**E (75.1)**	D (45.2)
			Approach		B (19.3)			D (48.9)			**F (81.8)**			**F (89.2)**		
		Queue Length 95th (ft)	Movement	m#187	m235	m28	#242	851	0	#372	62	120	80	#327	#519	

PM Peak

Arterial	Signal Controlled Intersections	Measure of Effectiveness (MOE)	Location	PM Movement/Approach LOS (Delay)												Intersection PM LOS (Delay)
				Eastbound			Westbound			Northbound			Southbound			
				Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
Boynton Beach Boulevard	Turnpike Southbound Ramps	LOS (Delay)	Movement		A (9.5)			A (5.3)	A (0.6)				**F (87.0)**		**F (96.7)**	B (16.7)
			Approach		A (9.5)			A (4.1)						**F (90.0)**		
		Queue Length 95th (ft)	Movement		362			315	m0				345		352	
	Turnpike Northbound Ramps	LOS (Delay)	Movement	**F (140.7)**	**E (63.6)**	A (1.3)	**E (64.7)**	B (18.2)	A (1.9)	**E (62.2)**	**F (96.1)**		**F (105.9)**	**E (62.9)**		D (45.2)
			Approach		**E (58.1)**			C (23.5)			**E (76.0)**			**F (89.7)**		
		Queue Length 95th (ft)	Movement	m#73	#987	25	m268	969	m11	415	#767	#767	62	57	57	
	Hagen Ranch Road	LOS (Delay)	Movement	**E (56.4)**	B (15.3)	A (2.0)	**F (165.1)**	D (46.5)	A (0.5)	**F (109.9)**	**E (70.8)**	D (35.8)	**F (113.5)**	**F (93.6)**	A (0.9)	D (41.8)
			Approach		B (18.9)			D (52.3)			**F (80.5)**			**E (71)**		
		Queue Length 95th (ft)	Movement	m247	399	m24	#185	927	4	#458	198	261	#105	114	0	

Synchro Version 11 Build 168. *HCM6 output used for unsignalized intersections due to limitations in Synchro.

LOS notes:

Delay is in sec/veh units

:Level Of Service (LOS) E reflecting at capacity operations

:Level Of Service (LOS) F reflecting over capacity operations

Queue notes:

~: Volume exceeds capacity, queue is theoretically infinite

#: 95th percentile volume exceeds capacity

m: Upstream metering is in effect

Intersection	Distance
SB on/off-ramp 1.915 MM	-
NB on/off-ramp 2.204 MM	1,525 ft
Hagen Ranch Road 2.571 MM	1,940 ft

Table 5.2: 2045 Build Alternative – Boynton Beach Boulevard Intersection Analysis Results

AM Peak

Arterial	Signal Controlled Intersections	Measure of Effectiveness (MOE)	Location	AM Movement/Approach LOS (Delay)												Intersection
				Eastbound			Westbound			Northbound			Southbound			AM LOS (Delay)
				Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
Boynton Beach Boulevard	Turnpike Southbound Ramps	LOS (Delay)	Movement		B (18.9)			B (11.1)	C (29.3)				**E (57.1)**		**F (82.1)**	C (24.9)
			Approach		B (18.9)			B (18.9)					**E (67.6)**			
		Queue Length 95th (ft)	Movement		674			m279	m#1492				270		455	
	Turnpike Northbound Ramps	LOS (Delay)	Movement	**F (129.1)**	D (36.6)	B (11.6)	D (49.9)	B (10.8)	A (0.0)	**F (116.5)**	**F (134.6)**		**E (78.4)**	**F (155.4)**		C (32.9)
			Approach		C (34.4)			B (16.2)		**F (122.3)**			**F (135.0)**			
		Queue Length 95th (ft)	Movement	m#89	619	232	m264	m316	m0	#277	#318	#318	54	#307	#307	
	Hagen Ranch Road	LOS (Delay)	Movement	**F (95.5)**	C (22.4)	A (1.7)	**F (135.1)**	**E (68.4)**	A (0.1)	**F (124.3)**	**E (57.2)**	B (16.5)	**F (91.7)**	**F (115.1)**	**F (88.3)**	**E (58.6)**
			Approach		C (25.2)			**E (72.6)**			**F (88.9)**			**F (100.1)**		
		Queue Length 95th (ft)	Movement	m#172	598	m24	#242	#1259	0	#399	62	120	80	#355	#595	

PM Peak

Arterial	Signal Controlled Intersections	Measure of Effectiveness (MOE)	Location	PM Movement/Approach LOS (Delay)												Intersection
				Eastbound			Westbound			Northbound			Southbound			PM LOS (Delay)
				Left	Through	Right	Left	Through	Right	Left	Through	Right	Left	Through	Right	
Boynton Beach Boulevard	Turnpike Southbound Ramps	LOS (Delay)	Movement		C (21.1)			B (13.4)	A (1.0)				**E (60.2)**		**F (88.8)**	C (23.1)
			Approach		C (21.1)			B (10.1)					**E (72.1)**			
		Queue Length 95th (ft)	Movement		604			430	m0				349		581	
	Turnpike Northbound Ramps	LOS (Delay)	Movement	**F (136.8)**	**E (76.3)**	A (5.2)	**F (127.9)**	B (17.4)	A (1.7)	**E (67.9)**	**E (73.1)**		**F (105.9)**	**F (83.1)**		D (53.1)
			Approach	**E (68.0)**			C (34.6)			**E (69.6)**			**F (95.8)**			
		Queue Length 95th (ft)	Movement	m50	#1110	119	m#407	m979	m8	520	545	545	62	#84	#84	
	Hagen Ranch Road	LOS (Delay)	Movement	D (51.4)	C (32.1)	A (2.3)	**F (165.1)**	D (54.2)	A (0.5)	**F (118.3)**	**E (72.0)**	D (39.6)	**F (107.0)**	**F (97.2)**	A (0.9)	D (50.3)
			Approach		C (31.6)			**E (58.9)**			**F (85.6)**			**E (72.1)**		
		Queue Length 95th (ft)	Movement	m241	m450	m28	#185	1089	4	#488	207	290	97	132	0	

Synchro Version 11 Build 168. *HCM6 output used for unsignalized intersections due to limitations in Synchro.

LOS notes:

Delay is in sec/veh units

:Level Of Service (LOS) E reflecting at capacity operations

:Level Of Service (LOS) F reflecting over capacity operations

Queue notes:

~: Volume exceeds capacity, queue is theoretically infinite

#: 95th percentile volume exceeds capacity

m: Upstream metering is in effect

Intersection	Distance
SB on/off-ramp 1.915 MM	-
NB on/off-ramp 2.204 MM	1,525 ft
Hagen Ranch Road 2.571 MM	1,940 ft

Tables 5.3 summarizes the results of the off-ramp signals back of queue analyses for the AM and PM design hours for the 2045 Build conditions. The Synchro reported queue was multiplied by the number of turn lanes and the lane utilization factor to calculate the total queue length. The results present the queue length in feet for each lane group movement. The available storage length was calculated from the stop bar at the ramp terminal intersection to the gore with Turnpike mainline minus the 615 feet required for stopping distance for a design speed of 70 mph per FDOT's 2016 Green book (Table 3-22), and accounting for the changes in number of lanes. The analysis indicates that the off-ramp queue lengths are not expected to exceed the available storage lengths.

Table 5.3
2045 Build – Off-Ramp Signals Queuing Analysis Results

Intersection	Approach	Movement	Available Storage (ft)	Queue (ft)	
				AM	PM
2045 Build					
Boynton Beach Boulevard at SB Off-Ramp	Southbound	L (EB)	840	523	677
		R (WB)	740	455	581
Boynton Beach Boulevard at NB Off-Ramp	Northbound	L (WB)	2,535	#756	1419
		R (EB)	1,245	#318	545

Queue Notes:
Synchro queue was multiplied by the number of turn lanes and the lane utilization factor to calculate the total queue length.
#: 95th percentile volume exceeds capacity

Table 5.4 provides a comparison of the intersection analysis results for the No-Build and Build conditions. It is evident from this summary table that the Build alternative is projected to provide better operating conditions than the No-Build in Design Year 2045. Considering the overall operations along Florida's Turnpike, ramp terminals, and along Boynton Beach Boulevard, the Build alternative is projected to provide better operating conditions than the No-Build.

Table 5.4
Comparison of No-Build and Build – Intersection Analysis Results

Arterial	Signal Controlled Intersections	2025		2045	
		No-Build	Build	No-Build	Build
		LOS (Delay)	LOS (Delay)	LOS (Delay)	LOS (Delay)
AM Peak					
Boynton Beach Blvd.	Turnpike SB Ramp Approach	E (67.4)	B (16.7)	F (123.0)	C (24.9)
	Turnpike NB Ramp Approach	C (29.4)	C (34.9)	D (40.0)	C (32.9)
	Hagen Ranch Road Intersection	D (40.9)	D (45.2)	E (59.1)	E (58.6)
PM Peak					
Boynton Beach Blvd.	Turnpike SB Ramp Approach	B (16.7)	B (16.7)	D (40.3)	C (23.1)
	Turnpike NB Ramp Approach	D (48.6)	D (45.2)	D (54.0)	D (53.1)
	Hagen Ranch Road Intersection	D (36.9)	D (41.8)	D (53.8)	D (50.3)

5.5 SAFETY ANALYSIS OF THE 2045 NO-BUILD AND BUILD ALTERNATIVES

5.5.1 HSM Analysis

A safety analysis was conducted to study the impacts of the proposed Build Alternative on local street network within the AOI. The study area focused on the Florida's Turnpike freeway segments, ramp terminals and ramp segments, Boynton Beach Boulevard arterial segment and major intersection along the arterial. The analysis was conducted using the predictive methods in Chapters 12 and 19 of the HSM, where available, and the Enhanced Interchange Safety Analysis Tool (ISATe), which apply a combination of Safety Performance Functions (SPFs), CMFs, and calibration factors to estimate frequency and cost of crashes for each segment and intersection.

It is important to note that the current edition of the HSM does not include a predictive method for arterial segments with six or more lanes. A research effort under the NCHRP Project 17-58 is underway to develop predictive methods for six-lane urban and suburban arterials and will be included in the next edition of the HSM (Chapter 12). The analysis was conducted assuming the predictive methods for four-lane divided arterials for both the No-Build and Build Alternatives.

No-Build scenario assumes no widening on the Florida's Turnpike Mainline. Under the Build Alternative, the widening for this corridor is planned to include 10 lanes (5 each direction) to the south and 8 lanes (4 each direction) north of the Boynton Beach interchange. The Build Alternative has an additional merge segment along the southbound freeway when compared to the No-Build, which may result in a higher number of crashes but the reduction in congestion may result in fewer number of crashes. Also, the provision of added turn lanes on the interchange crossroad and removal of southbound weaving section between the southbound off-ramp and the southbound on-ramp are expected to reduce crashes.

The No-Build and Build Alternatives were evaluated, and the predicted number of crashes and associated costs were compared for the 2025 to 2045 analysis period. The results of the safety analysis are summarized in **Table 5.5**. It is important to note that the safety analysis tools available to date are deterministic in nature and estimate future crashes mainly based on AADTs and roadway characteristics. These tools do not account for vehicle interactions. The overall predicted crashes are lower for Build compared to the No-Build. Based on these results, the Build Alternative is predicted to have a 20-year crash cost savings of approximately $46 Million compared to the No-Build Alternative, in 2020 present value. Detailed analysis tables are provided in **Appendix L**.

Table 5.5
2025 to 2045 Predicted Number of Crashes and Cost Saving

Site	No-Build		Build	
	$N_{predicted*}$	2020 Present Value	$N_{predicted*}$	2020 Present Value
Boynton Beach Boulevard Intersection				
Hagen Ranch Road	405.16	$47,356,856	405.16	$47,356,856
Boynton Beach Boulevard Segment				
Northbound Ramp Terminal and Hagen Ranch Road	140.61	$16,449,720	140.61	$16,449,720
Florida's Turnpike				
Freeway segments	1,536.25	$139,214,729	1,242.33	$112,930,182
Ramp segments	272.41	$20,838,574	161.07	$12,343,942
Ramp Terminals	700.82	$74,791,318	607.32	$63,696,545
Subtotal	**2,509.47**	**$234,844,620**	**2,010.72**	**$188,970,669**
Total	**3,055.24**	**$298,651,196**	**2,556.49**	**$252,777,245**
Crash Cost Saving	**$45,873,951**			

*Predicted Crashes

6.1 POTENTIAL DESIGN EXCEPTIONS AND VARIATIONS

The mainline widening and the modifications of the Boynton Beach Boulevard interchange requires design variations, exceptions, and memorandums due to the constrained right-of-way. Auxiliary lanes are needed along the Turnpike Mainline for acceleration and deceleration. The following exceptions/variations have been identified and are listed below:

- ***Border Width:*** The proposed border width is less than standard border width on both the east side and the west side of the Turnpike Mainline through the interchange limits due to the proximity of the canals. The addition of auxiliary lanes for ramp acceleration/deceleration lanes further reduces the border widths. Shoulder barriers will be used to mitigate hazards.
- ***Lane Width:*** The proposed 11-foot travel lane widths for Turnpike auxiliary lanes are less than the minimum AASHTO freeway lane width of 12 feet.
- ***Curve Length:*** Some of the proposed interchange ramp curve lengths will be less than the FDOT standard minimum required length of 15 times the design speed (15V).

A discussion of the access modifications with respect to conformance with the Federal Highway Administration (FHWA) policy points related to access is provided below. The Florida's Turnpike is not, however, part of the interstate system.

7.1 FHWA'S POLICY ON ACCESS TO THE INTERSTATE SYSTEM

The Federal Highway Administration's (FHWA's) newly adopted policy on *Access to the Interstate System* became effective on May 22, 2017 and replaces the policy of August 27, 2009 on *Access to the Interstate System*, published at 74 Federal Register 43743. The changes in this policy are made to ensure this policy focuses on safety, operational, and engineering issues. The consideration of social, economic, and environmental impacts discussed in the 2009 policy are removed from this policy. However, the removal from this policy does not eliminate the need to consider those matters. Those issues will be addressed under the National Environmental Policy Act and other statutes and regulations applicable to the approval process.

This policy is effective as of May 22, 2017.

It is in the national interest to preserve and enhance the Interstate System to meet the needs of the 21st Century by assuring that it provides the highest level of service in terms of safety and mobility. Full control of access along the Interstate mainline and ramps, along with control of access on the crossroad at interchanges, is critical to providing such service. Therefore, the Federal Highway Administration's (FHWA) decision to approve new or revised access points to the Interstate System under Title 23, United States Code (U.S.C.), Section 111, must be supported by substantiated information justifying and documenting that decision. The FHWA's decision to approve a request is dependent on the proposal satisfying and documenting the following requirements:

Considerations and Requirements

1. *An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes mainline lanes, existing, new, or modified ramps, and ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections. The analysis should, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access (Title 23, Code of Federal Regulations (CFR), paragraphs 625.2(a), 655.603(d) and 771.111(f)). The crossroads and the local street network, to at least the first major intersection on either side of the proposed change in access, should be included in this analysis to the extent necessary to fully evaluate the safety and operational impacts that the proposed change in access and other transportation improvements may have on the local street network (23 CFR 625.2(a) and 655.603(d)). Requests for a proposed change in access should include a description and assessment of the impacts and ability of the proposed changes to safely and efficiently collect, distribute, and accommodate traffic on the Interstate facility, ramps, intersection of ramps with crossroad, and local street network (23 CFR 625.2(a) and 655.603(d)). Each request should also include a conceptual plan of the type and*

location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d)).

The operational analysis conducted for the IMR confirmed that the proposed interchange modifications are not expected to have any adverse impacts on safety and operations on the interstate facility (Florida's Turnpike). The proposed elimination of the barrier separated southbound weaving segment between the southbound off-ramp and the southbound on-ramp will significantly improve the safety and flow of traffic along the Turnpike mainline. The proposed two-lane exit for the northbound off-ramp with a lane-drop under the Build condition will significantly improve the ramp junction Level of Service from LOS F under the No-Build to LOS D under the Build condition. The southbound ramp improvements and modifications proposed under the Build condition will improve the Level of Service of the southbound ramp terminal intersection from LOS F under the No-Build condition to LOS B under the Build condition during the AM design hour. In addition, all mainline and ramp freeway segments projected to operate at LOS E or worse under the No-Build condition are expected to operate at LOS D or better under the Build condition.

The projected failing conditions under the No-Build Alternative are expected to increase future crash risk within the project corridor. This potential for increased crash risk is alleviated by the capacity improvements proposed in the Build Alternative. The predictive crash analysis comparison between No-Build and Build Alternatives shows that the overall predicted number crashes are lower for Build compared to the No-Build. The Build Alternative is predicted to have a 20-year crash cost savings of approximately $46 Million compared to the No-Build Alternative, in 2020 present value.

2. *The proposed access connects to a public road only and will provide for all traffic movements. Less than "full interchanges" may be considered on a case-by-case basis for applications requiring special access, such as managed lanes (e.g., transit or high occupancy vehicle and high occupancy toll lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards (23 CFR 625.2(a), 625.4(a)(2), and 655.603(d)). In rare instances where all basic movements are not provided by the proposed design, the report should include a full-interchange option with a comparison of the operational and safety analyses to the partial-interchange option. The report should also include the mitigation proposed to compensate for the missing movements, including wayfinding signage, impacts on local intersections, mitigation of driver expectation leading to wrong-way movements on ramps, etc. The report should describe whether future provision of a full interchange is precluded by the proposed design.*

   This IMR does not propose any new interchanges along Florida's Turnpike. The existing interchange provides access to public roads only. The improvements proposed at the interchange will maintain full access to the existing cross streets and accommodate all movements.

The PD&E reevaluation is concurrent with ongoing Turnpike projects and is expected to be completed in 2022. Design and construction of the ultimate Boynton Beach Boulevard interchange are expected to be completed by 2024 and 2025, respectively. Design and construction of the Turnpike Mainline widening and the modifications of the Boynton Beach Boulevard interchange are currently outside FTE's five-year work program.

The primary purpose of the Boynton Beach Boulevard IMR project is to identify the long-term needs through 2045 and to develop design concepts to address existing traffic congestion and related capacity deficiencies caused by the short weaving section which is currently operating at LOS F during AM peak hour. As traffic demand increases in the future, traffic operations are expected to deteriorate within the interchange weaving section and thus impacting the freeway mainline. This IMR evaluates the traffic operations of the No-Build and Build alternatives.

The information and analysis indicate that several of the merge, diverge, and weaving areas along Florida's Turnpike and ramp intersections along Boynton Beach Boulevard are projected to experience operational failures in 2045. Proposed modifications to the mainline, ramps, and the interchange are recommended to address projected deficiencies in the future. Listed below are specific modifications and projected benefits:

- The proposed Build Alternative includes relocating the southbound off-ramp upstream of Boynton Beach Boulevard. The southbound on-ramp serving the westbound to southbound traffic merges with the mainline upstream of Boynton Beach Boulevard as a lane-add. A new southbound on-ramp serving the eastbound to southbound traffic is added and merges with the mainline. The two-lane exit for the northbound off-ramp will have a lane-drop under the Build condition. The Build alternative lane configuration is depicted on **Figure 5.1**.
- Under the 2045 No-Build condition, all freeway mainline segments are projected to operate at LOS E or worse in both the northbound and southbound directions either during one or both design hours. The proposed Build alternative with a 10-lane section south of Boynton Beach Boulevard and an 8-lane section north of Boynton Beach Boulevard will provide LOS D or better operations for all freeway mainline segments.
- Under 2045 No-Build, the failure of the existing barrier separated southbound weaving section between the southbound off-ramp and the southbound on-ramp is expected to cause operational and safety problems on the Turnpike mainline. The proposed elimination of this weaving section under the Build condition will significantly improve the safety and flow of traffic along the Turnpike mainline.
- The proposed two-lane exit for the northbound off-ramp with a lane-drop under the Build condition will significantly improve the ramp junction Level of Service from LOS F under the No-Build condition to LOS D under the Build condition.
- The southbound ramp improvements and modifications proposed under the Build condition will improve the Level of Service of the southbound ramp terminal intersection from LOS F under the No-Build condition to LOS B under the Build condition during AM design hour.
- All mainline and ramp freeway segments projected to operate at LOS E or worse under the No-Build condition are expected to operate at LOS D or better under the Build condition.

These improvements address the traffic operation deficiencies by eliminating or improving the failing conditions within the interchange influence area and improving safety by reducing congestion and improving operating conditions along Boynton Beach Boulevard. A comparison of the Design Year

2045 intersection analysis results shows that the Build alternative is projected to provide better operating conditions than the No-Build in Design Year 2045. Considering the overall operations along Florida's Turnpike, ramp terminals, and along Boynton Beach Boulevard, the Build alternative is projected to provide better operating conditions than the No-Build. The HSM safety analysis shows that the Build condition is expected to have approximately 499 fewer crashes than the No-Build with a saving of approximately $46 million in 2020 present value.

APPENDIX A

Methodology Letter of Understanding (MLOU)

APPENDIX B

Raw Traffic Data and Signal Timing Data

APPENDIX C

2018 Existing Freeway HCS & CORSIM Operational Analysis

APPENDIX D

2018 Existing Synchro Intersection Analysis

APPENDIX E

2013 – 2017 Existing Crash Data

APPENDIX F

Project Design Analysis Report (PDAR), December 2019

APPENDIX G

2025 and 2045 No-Build Freeway HCS & CORSIM Operational Analysis

APPENDIX H

2025 and 2045 No-Build Synchro Intersection Analysis

APPENDIX I

Build Alternative Conceptual and Signing Plan

APPENDIX J

2025 and 2045 Build Freeway HCS Operational Analysis

APPENDIX K

2025 and 2045 Build Synchro Intersection Analysis

APPENDIX L

Safety Benefits Analysis