

FLORIDA DEPARTMENT OF TRANSPORTATION  
DISTRICT FOUR

OFFICE OF PLANNING AND ENVIRONMENTAL MANAGEMENT

**I-95 (SR 9) Interchange at Northlake Boulevard  
in Palm Beach County**

**Interchange Concept Development Report**

Prepared For:  
Florida Department of Transportation, District Four  
3400 W. Commercial Boulevard  
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Date: June 2014

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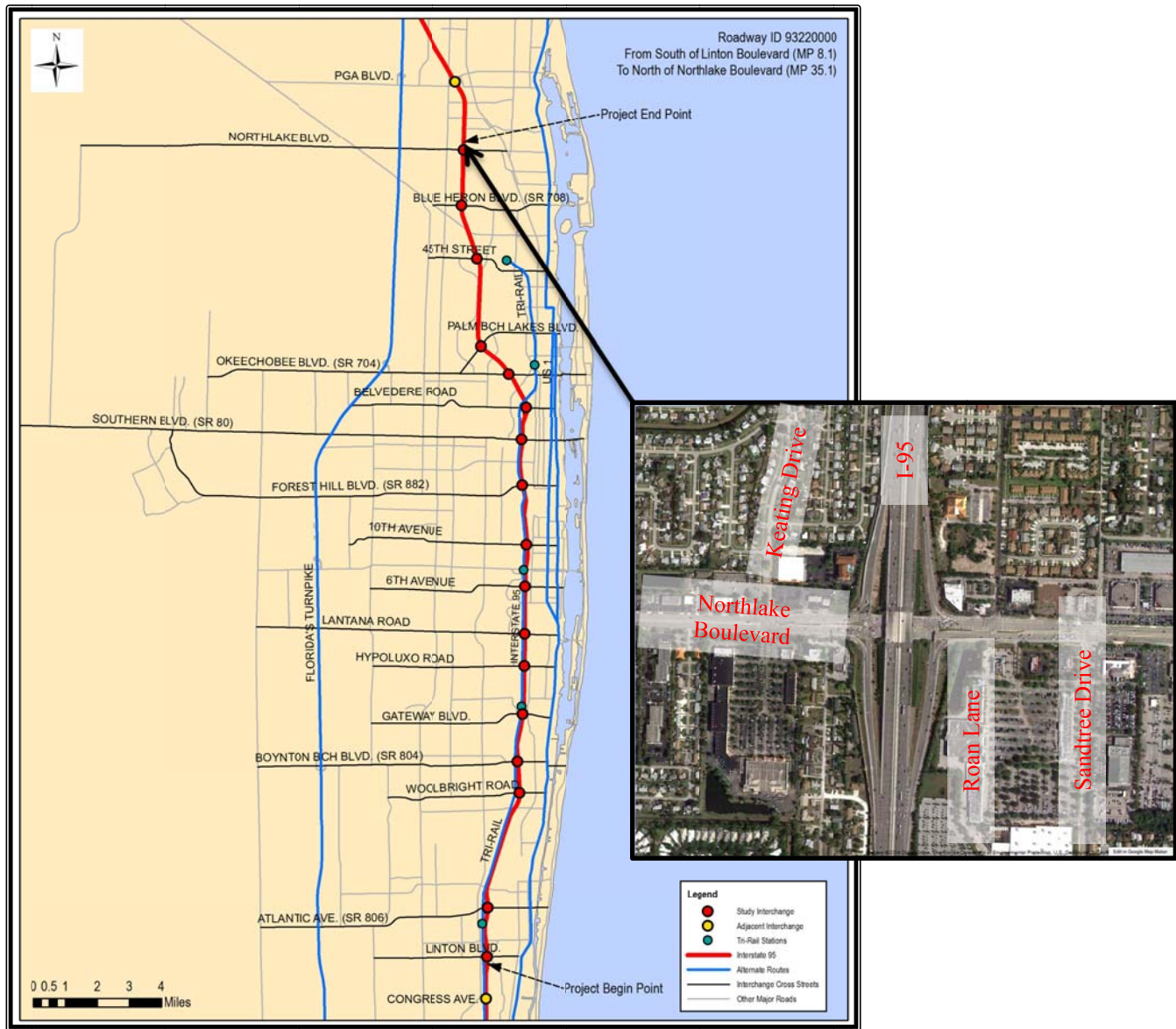
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## 1 Introduction

The Florida Department of Transportation (FDOT) made improvements to the Interstate 95 (I-95) mainline, adding a High Occupancy Vehicle (HOV) lane and auxiliary lanes from south of Linton Boulevard to north of PGA Boulevard in Palm Beach County in the 1990s and 2000s. Minor interchange improvements were also made to eight (8) of the existing 18 interchanges along this section of the corridor. At the time of that project, FDOT committed to re-examining the need for short-term and long-term interchange improvements at the interchanges not improved as a part of this previous I-95 mainline project. FDOT District Four also identified the need to reexamine the 2003 I-95 Master Plan Study for Palm Beach County to develop new improvements to interchanges based on changes in traffic volumes and updated design standards since the Master Plan was developed a decade ago.

The purpose of this study is to identify short-term and long-term needs and develop design concepts to address traffic spillback onto I-95, improve interchange operations, reduce congestion, and increase safety at the study interchange through the 2040 design year horizon. The study also considered Strategic Intermodal System (SIS) connector improvements needed within the project area and is consistent with plans for the I-95 mainline, including the potential extension of I-95 Express lanes through Palm Beach County. This report documents the evaluation of the Northlake Boulevard interchange and is one of 17 interchange reports that will make up the I-95 Interchange Master Plan (IMP). The location of Northlake Boulevard interchange, which is the focus of this report, in relation to the overall IMP study area is shown in Figure 1.

**Figure 1: I-95 Interchange Master Plan Study Area and Project Location Map**



## 2 Project Location

The interchange of I-95 at Northlake Boulevard is located in the City of Palm Beach Gardens in Palm Beach County. The interchange is situated between the PGA Boulevard (1.73 miles to the north) and Blue Heron Boulevard (1.76 miles to the south) interchanges. The adjacent accessible signalized intersections along Northlake Boulevard relative to the I-95 interchange are at Keating Drive (west) and at Roan Lane (east). The second signalized intersection to the east of the I-95 Northbound Ramps is Sandtree Drive/Sunrise Drive, which is located approximately 670 feet from Roan Lane; this intersection was also included in the analysis because Roan Lane is a partial signal. The interchange location is shown in Figure 1.

Commercial retail/office and residential land uses are located adjacent to the interchange. Commercial retail/office uses flank Northlake Boulevard west of I-95 southbound ramps. These developments are accessed via Keating Drive, which intersects Northlake Boulevard approximately 680 feet from the I-95 southbound ramps. Predominantly residential uses are located to the west of Congress Avenue.

Predominantly residential and commercial retail uses are located to the east of I-95. The first signalized intersection to the east of I-95 is Roan Lane, located approximately 430 feet from the I-95 northbound ramps. Roan Lane serves commercial and residential uses to the north. Sunrise Drive/Sandtree Drive is the second intersection to the east, located approximately 670 feet from Roan Lane. Sunrise Drive serves commercial and residential uses to the north of Northlake Boulevard, and Sandtree Drive serves commercial and residential uses to the south of Northlake Boulevard.

### 3 Land Use Plans

The intersection falls within the City of Palm Beach Gardens and Unincorporated Palm Beach County. According to the Palm Beach County and City of Palm Beach Gardens Zoning District Maps, the area northeast of the project is zoned residential low density (RL2, RL3), mixed use (MXD), general commercial (CG1), and public or institutional (P/I); southeast is zoned general commercial (CG1), residential medium density (RM), professional office (PO), and industrial. The area northwest of the project is zoned residential low density (RL3), general commercial (CG1), and intensive commercial (CG2). The area southwest of the interchange is zoned general commercial (CG), residential medium density (RM), and residential low density (RL3).

According to the Future Land Use Map for Palm Beach County and the City of Palm Beach Gardens, the area east of Interstate 95 (I-95) consists of high density and medium density residential, commercial, mixed use, recreation open space, and public land uses, while the west side consists of commercial, medium and low density residential land uses.

## 4 Existing Conditions

### 4.1 Roadway and Intersection Characteristics

#### 4.1.1 Functional Classifications

I-95 in the vicinity of Northlake Boulevard interchange is a ten-lane divided interstate freeway. The ten-lane segment of I-95 extends from north of the Congress Avenue interchange to north of the PGA Boulevard interchange. Northlake Boulevard, in the vicinity of I-95, is a six-lane divided roadway classified as an urban other principal arterial and maintained by Palm Beach County. Keating Drive is a two-lane undivided roadway maintained by Palm Beach County to the north of Northlake Boulevard and a private roadway to the south. Roan Lane is a two-lane undivided roadway maintained by Palm Beach County. Sandtree Drive is a two-lane undivided local roadway maintained by Palm Beach Gardens. Sunrise Drive is two-lane roadway maintained by Palm Beach County.

### 4.1.2 Typical Sections

I-95 is a ten-lane divided interstate freeway providing four general purpose lanes and one HOV lane in each direction. North of Northlake Boulevard, I-95 southbound provides one auxiliary lane between PGA Boulevard and Northlake Boulevard for a total of six southbound lanes. South of Northlake Boulevard, I-95 provides one auxiliary lane in each direction between Blue Heron Boulevard and Northlake Boulevard for a total of six lanes in both the northbound and southbound directions.

Northlake Boulevard is currently a six-lane urban divided roadway with a raised landscaped median in the interchange area. Underneath the I-95 overpass, the eastbound and westbound lanes are separated by a 12-foot wide median containing a raised concrete barrier wall and support piers for the I-95 overpass. Dual left-turn lanes are provided along Northlake Boulevard both eastbound and westbound serving the I-95 on-ramps. A single right-turn lane is provided both eastbound and westbound along Northlake Boulevard serving the I-95 on-ramps.

### 4.1.3 Lighting

Dual arm, conventional cobrahead lighting is provided in the median of the I-95 mainline. Conventional cobrahead lighting is provided along the outside shoulder of the on- and off-ramps. High mast overhead lighting is provided on both sides of Northlake Boulevard within the interchange area.

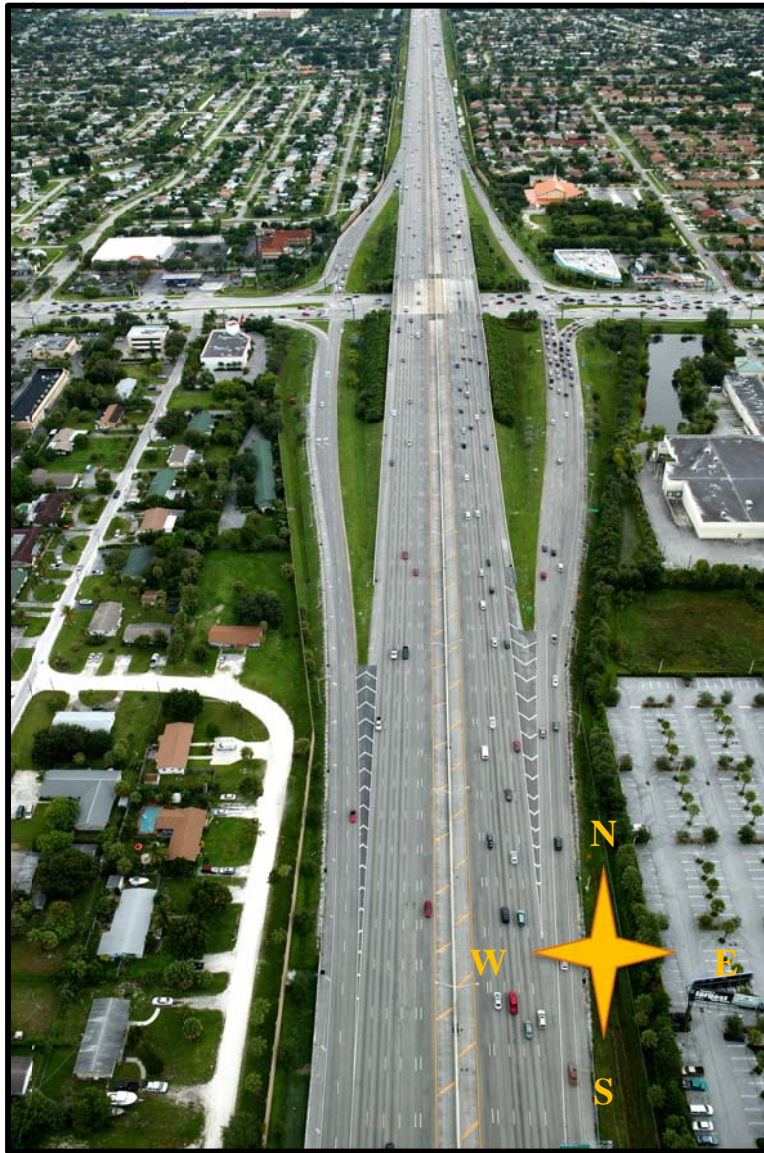
### 4.1.4 Interchange/Ramp Design

The study interchange is a typical diamond interchange design. The northbound and southbound off-ramps provide two exit lanes from I-95 and transition into four-lane approaches at the ramp intersections with Northlake Boulevard. The four-lane off-ramp approaches consist of two left-turn lanes and two channelized right-turn lanes, all under signal control. An aerial photograph of the interchange taken in October 2012 is provided in Figure 2.

The northbound on-ramp provides two receiving lanes at the Northlake Boulevard intersection that merge to one lane approximately 450 feet north of the intersection. The remaining on-ramp lane merges with I-95 approximately 1,000 feet north of the gore area. The northbound on-ramp accommodates two receiving lanes for the eastbound Northlake Boulevard dual left-turn movement and a single, yield-controlled, channelized right-turn lane. The southbound on-ramp provides two lanes along the entire length of the ramp. The two lanes merge to one lane past the gore area with I-95 and the remaining ramp lane becomes an auxiliary lane between the Northlake Boulevard and the Blue Heron Boulevard interchanges. The southbound on-ramp accommodates two receiving lanes for the westbound Northlake Boulevard dual left-turn movement and a single free-flow channelized right-turn lane. The three lanes merge to two prior to the gore area of the I-95 southbound mainline.

Landscaping is provided on both sides of the northbound and southbound on- and off-ramps, with additional right-of-way available on both sides of the interchange's ramps. However, the right-of-way is limited along the west side of the southbound off-ramp. Shoulders are provided on the outside of all on- and off-ramps. Raised landscaped islands are also provided at all channelized right-turn lanes.

**Figure 2: I-95 at Northlake Boulevard Interchange Geometry**



#### 4.1.5 Intelligent Transportation Systems

No Intelligent Transportation Systems (ITS) devices are present along Northlake Boulevard within the vicinity of the interchange.

ITS components within the I-95 IMP limits include Closed Circuit Television (CCTV) cameras, Road Weather Information System (RWIS), and Highway Advisory Radio (HAR) transmitters with beacons typically spaced at 1.5-mile intervals and generally located on the east side of the corridor. Non-intrusive vehicle detectors are installed along the corridor and are spaced at one-mile intervals generally on the east side of the corridor.

Dynamic Message Signs (DMS) exist on overhead sign structures on both the northbound and southbound travel directions of I-95. Within the vicinity of the Northlake Boulevard interchange,

a DMS is currently provided along I-95 northbound approximately 0.7 miles north of the interchange. Wireless components are installed on the CCTV/Microwave Vehicle Detection System (MVDS)/Voice over IP (VoIP) concrete poles to provide communications for Road Ranger mobile access and VoIP applications. These field elements are connected to District Four's SMART SunGuide® Transportation Management Center (TMC) via the fiber optic based Ethernet communication network along I-95. The existing underground infrastructure consists of one 144-count single-mode fiber optic cable in one 2" High Density Polyethylene (HDPE) conduit, one 2" HDPE spare conduit, and one 2" HDPE conduit with electrical service conductors.

#### 4.1.6 Utilities

Overhead utilities are provided along the north side of Northlake Boulevard both east and west of the interchange within the area of influence (AOI). No overhead utilities are provided between the I-95 northbound and southbound ramps intersections.

#### 4.1.7 Merge and Diverge Areas

The northbound off-ramp is a 1,440-foot section that functions as a two-lane off-ramp from I-95 and is located approximately 1.4 miles north of the Blue Heron Boulevard northbound on-ramp merge point with I-95. The outside off-ramp lane is a dedicated exit lane from I-95 transitioning from an auxiliary lane, while the inside off-ramp lane diverges from the outside through lane along I-95 operating as a "choice" lane. The two-lane off-ramp transitions into a 4-lane intersection approach approximately 715 feet from Northlake Boulevard. The two exit lanes continue to the intersection as left-turn lanes and the two right-turn lanes are added to the section.

The northbound on-ramp is an 1,850-foot section that functions as a one-lane on-ramp to I-95 and is located approximately 1.7 miles south of the PGA Boulevard northbound off-ramp diverge point from I-95. Access to the northbound on-ramp is provided via two left-turn lanes from eastbound Northlake Boulevard and a single yield-controlled westbound channelized right-turn lane that merges with the two-lane ramp approximately 75 feet north of Northlake Boulevard. The two lane on-ramp section merges to one lane approximately 450 feet north of Northlake Boulevard. The one remaining northbound on-ramp lane merges with I-95 approximately 1,000 feet north of the gore area.

The southbound off-ramp is a 1,300-foot section that functions as a two-lane off-ramp from I-95 and is located approximately 1.7 miles south of the PGA Boulevard southbound on-ramp merge point with I-95. The two-lane off-ramp transitions into a four-lane approach approximately 360 feet from Northlake Boulevard. The two exit lanes continue to the intersection as left-turn lanes and the two right-turn lanes are added to the section.

The southbound on-ramp is an 1,880-foot section that functions as a two-lane on-ramp to I-95 and is located approximately 1.4 miles north of the Blue Heron Boulevard southbound off-ramp diverge point from I-95. Access to the southbound on-ramp is provided via two left-turn lanes from westbound Northlake Boulevard and a single free-flow eastbound channelized right-turn lane that merges with the two-lane ramp approximately 550 feet south of Northlake Boulevard. Although an additional (third) lane is provided along the on-ramp for the westbound right-turn

movement, allowing free-flow turns, a yield sign is provided for the right-turning traffic. The two southbound on-ramp lanes merge down to a single auxiliary lane approximately 1,400 feet south of the gore area.

#### 4.1.8 Posted Speed and Design Speed

The posted speed limits for the roadways within the project limits are as follows:

- I-95: 65 miles per hour (mph)
- I-95 ramps: 35 mph (advisory)
- Northlake Boulevard: 45 mph
- Keating Drive: 30 mph
- Roan Lane: 30 mph
- Sunrise Drive: 30 mph
- Sandtree Drive: 25 mph

The design speed of I-95 is 70 mph. The design speed of Northlake Boulevard is 45 mph. The design speed of Keating Drive, Roan Lane, and Sunrise Drive is 35 mph. The design speed of Sandtree Drive is 30 mph. The design speed of the ramps ranges from 30 mph to 50 mph.

#### 4.1.9 Pavement Conditions

FDOT Office of Transportation Statistics Road Data Shape Files in GIS were reviewed and field observations confirmed the existing condition of the pavement. Based upon the research, the following values were obtained.

<b>Roadway</b>	<b>Score</b>
Northlake Boulevard	3.5
Northbound off-ramp	4.5
Northbound on-ramp	3.0
Southbound off-ramp	4.0
Southbound on-ramp	3.5

The value depicted is based upon an overall pavement condition score as follows:

<1.0	Very Poor (Virtually impassable)
1.0 to 2.0	Poor (Large potholes, deep cracks exists)
2.0 to 3.0	Fair (Rutting, cracking and extensive patching)
3.0 to 4.0	Good (First class ride, slight deterioration)
4.0 to 5.0	Very Good (New or nearly new)

Based upon these values, the pavement is in good to very good condition.

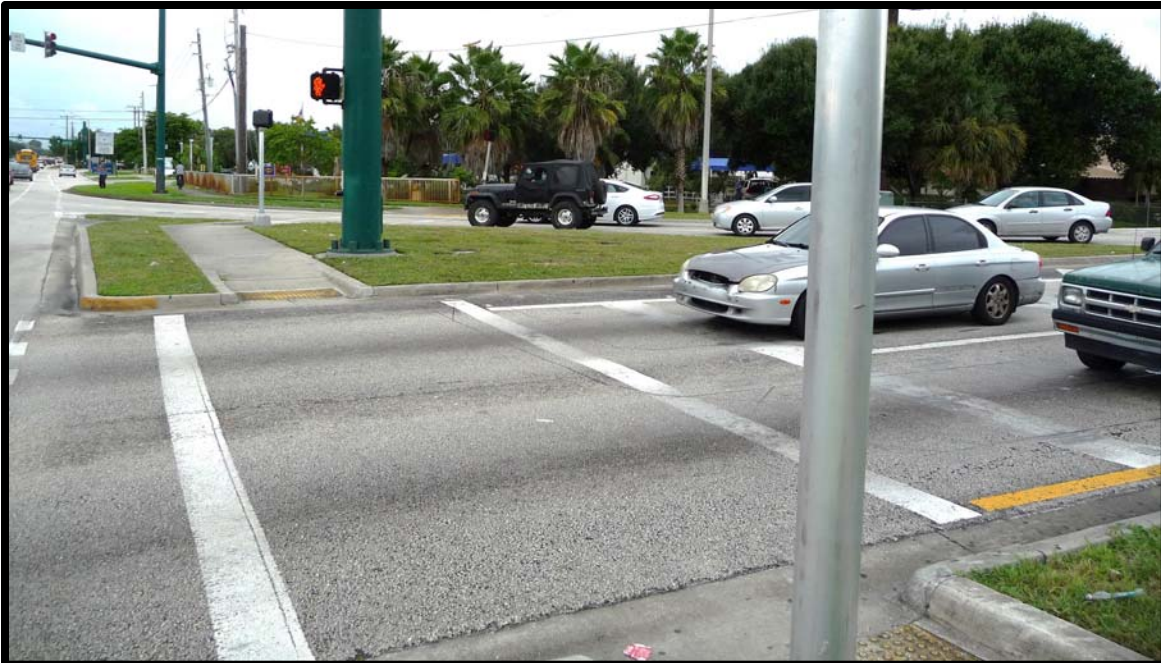
#### 4.1.10 Bicycle and Pedestrian Facilities/Safe Routes to Schools

Northlake Boulevard provides designated bicycle lanes in the eastbound and westbound directions from Keating Drive to Sunrise Drive/Sandtree Drive. Designated bicycle lanes are not provided west of Keating Drive or east of Sunrise Drive/Sandtree Drive.

East-west sidewalks are provided along the north and south sides of Northlake Boulevard through the project AOI, extending west of Keating Drive and east of Sunrise Drive/Sandtree Drive.

At the I-95 interchange, crosswalks are provided between all sidewalks crossing the I-95 on- and off-ramps. Crosswalks at the off-ramp islands are two-stage, providing a travel way across the off-ramp left-turn lanes to a raised concrete island then across the off-ramp right-turn lanes to the sidewalk along Northlake Boulevard. Crosswalks at the on-ramps are also two-stage, providing a travel way across the channelized right-turn lanes and then across the two left-turn receiving lanes. Pedestrian signal heads are provided at the crosswalks across the left-turn lanes for both the on- and off-ramps and at the crosswalks across the right-turn lanes at off-ramps. The crosswalks across the channelized right-turn lanes at the on-ramps are not signal controlled.

**Figure 3: Two-Stage Westbound Pedestrian Crossing at I-95 Southbound Off-Ramp**



The intersection of Northlake Boulevard and Keating Drive provides crosswalks on the north, south, and west legs to the intersection. Non-countdown pedestrian signal heads are provided at all crosswalks. Tactile domes are cast into the concrete for most of the sidewalk ramps connections to the crosswalks; however, in the southwest corner of the intersection only a crosshatch texture has been cast into the concrete ramps.

The intersection of Northlake Boulevard and Roan Lane provides a crosswalk on the north leg. North-south pedestrian crossing is not permitted at this intersection; therefore crosswalks are not provided along the east and west legs. There is no south leg to the intersection; therefore, a crosswalk is not needed. Countdown pedestrian signal heads are provided for the north leg crosswalk. Tactile domes are cast into the concrete for both sidewalk ramps connections to the crosswalks

The intersection of Northlake Boulevard and Sunrise Drive/Sandtree Drive provides crosswalks and non-countdown pedestrian signal heads on all four legs. Tactile domes are cast into the concrete for most of the sidewalk ramps connections to the crosswalks; however, in the northwest corner and for the east-west approach in the northeast corner of the intersection only a crosshatch texture has been cast into the concrete ramps.

**Figure 4: North-South Crosswalk Ramp in the Northwest Corner at Sunrise Drive**



Two schools are located within approximately one mile of the interchange. Howell L. Watkins Middle School is located approximately 0.9 miles northeast of the interchange with access being provided via MacArthur Boulevard, to the east of Sunrise Drive/Sandtree Drive. Grove Park Elementary School is located approximately one mile southwest of the interchange with access being provided via Military Trail, to the west of Keating Drive. Sidewalks are provided along both sides of Northlake Boulevard, Military Trail, and MacArthur Boulevard. Crosswalks are also provided on all four legs of the Northlake Boulevard intersection with Military Trail and on the north, south, and east legs of the Northlake Boulevard intersection with MacArthur Boulevard. Figure 5 illustrates the locations of the schools.

**Figure 5: School Locations Aerial**

#### 4.1.11 Traffic Signals

The intersection of Keating Drive and Northlake Boulevard is a four-leg actuated-coordinated signalized intersection. The intersection utilizes mast arm assemblies. The mast arm poles are located in the northwest corner (mast arms oriented east and south) and the southeast corner (mast arms oriented west and north).

The I-95 southbound ramps intersection is a four-leg actuated-coordinated signalized intersection. The intersection utilizes mast arm assemblies. The mast arm poles are located in the northwest corner (mast arms oriented east and south), the southeast corner (mast arm oriented west and north), and the west side of the southbound channelized right-turn lanes (mast arm oriented southeast).

The I-95 northbound ramps intersection is a four-leg actuated-coordinated signalized intersection. The intersection utilizes mast arm assemblies. The mast arm poles are located in the northwest corner (mast arms oriented east and south), the southeast corner (mast arm oriented west and north), and the east side of the northbound channelized right-turn lanes (mast arm oriented northwest).

The Roan Lane intersection is a three-leg actuated-coordinated signalized intersection; however, only the eastbound left-turn movement and westbound approach are under signal control, while the southbound approach is stop-controlled. Although signal heads are provided for the eastbound through movement, there is no conflicting movement; therefore, the eastbound

through movement is provided with a continuous green ball and does not stop. The intersection utilizes mast arm assemblies. The mast arm poles are located in the northwest corner (mast arm oriented south) and on the south section (mast arm oriented north).

The Sunrise Drive/Sandtree Drive intersection is a four-leg actuated-coordinated signalized intersection. The intersection utilizes mast arm assemblies. The mast arm poles are located in the northwest corner (mast arms oriented east and south) and in the southeast corner (mast arms oriented west and north).

The four easternmost study intersections are located within the same coordinated control section of the traffic signal system, while the westernmost intersection, Keating Drive, is part a different control section to the west. Signal timing plans, obtained from Palm Beach County, are included in Appendix A.

#### 4.1.12 Emergency Evacuation Routes

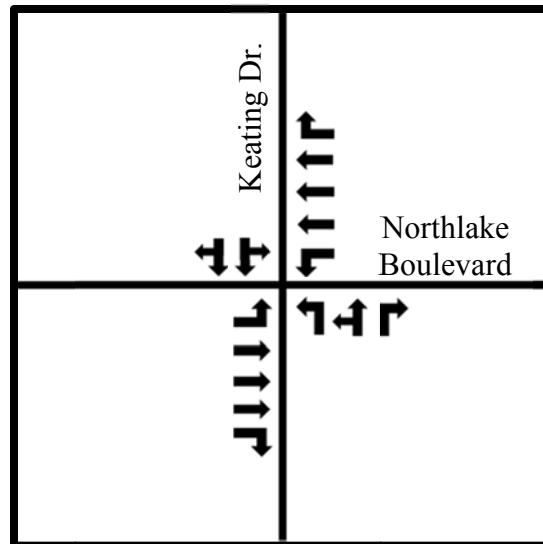
The Florida Division of Emergency Management designates specific routes that residents and visitors can use in case of emergency situations to vacate specific areas. Based on Palm Beach County's Evacuation Routes and Zones Map, Northlake Boulevard is classified as an evacuation route from I-95 to SR A1A, which includes the a section of Northlake Boulevard within the AOI, from I-95 to Sunrise Drive/Sandtree Drive. Designation as an emergency evacuation route was considered when prioritizing the interchanges to determine the grouping of interchanges.

### 4.1.13 Intersection Geometry

The signalized intersection of Keating Drive at Northlake Boulevard is located approximately 680 feet west of the I-95 southbound ramps. The intersection has the following lane configuration.

- Northbound: one left-turn lane, one shared through/left-turn lane, and one right-turn lane
- Southbound: one shared through/left-turn lane, and one shared through/right-turn lane
- Eastbound: one left-turn lane, three through lanes, and one right-turn lane
- Westbound: one left-turn lane, three through lanes, and one right-turn lane

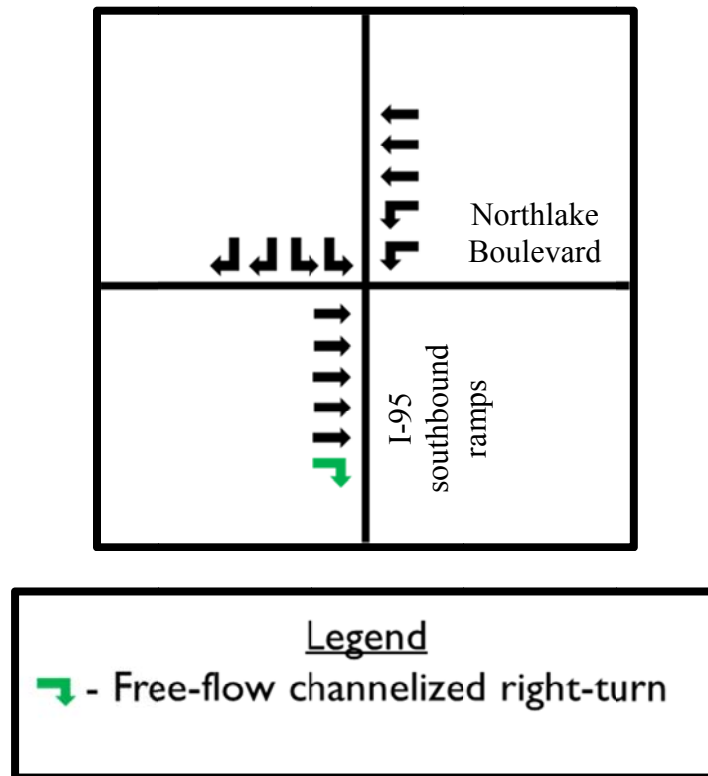
**Figure 6: Northlake Boulevard at Keating Drive – Laneage Configuration**



The signalized intersection of Northlake Boulevard at the I-95 southbound ramps has the following configuration.

- Southbound: two left-turn lanes and two channelized right-turn lanes
- Eastbound: two auxiliary through lanes which align with the eastbound left-turn lanes at the I-95 northbound ramps intersection, three through lanes, and one channelized free-flow right-turn lane
- Westbound: two left-turn lanes and three through lanes

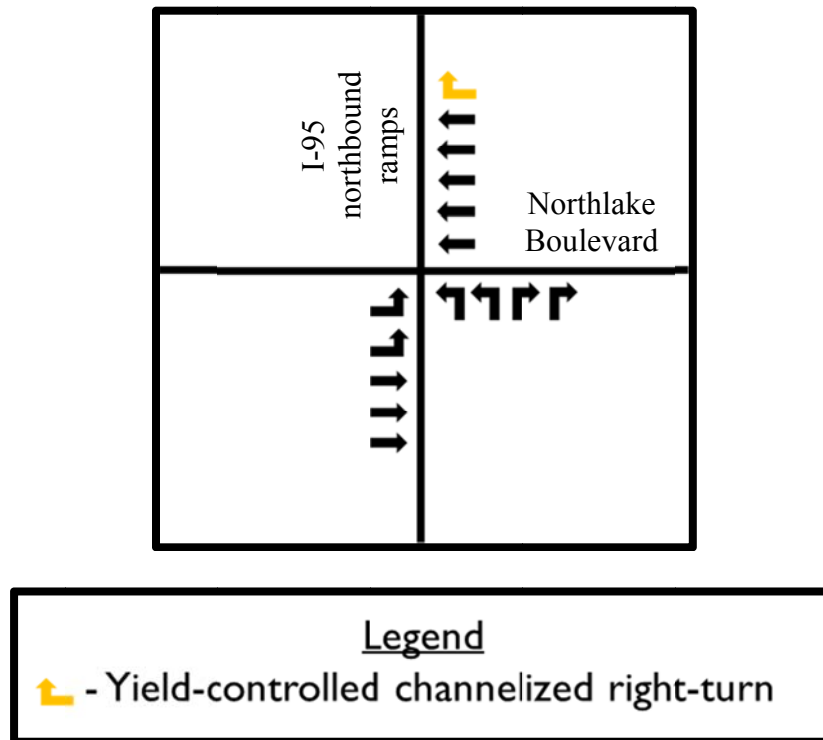
**Figure 7: Northlake Boulevard at I-95 Southbound Ramps – Laneage Configuration**



The signalized intersection of Northlake Boulevard at the I-95 northbound ramps has the following lane configuration.

- Northbound: two left-turn lanes and two channelized right-turn lanes
- Eastbound: two left-turn lanes and three through lanes
- Westbound: two auxiliary/through lanes which align with the westbound left-turn lanes at the I-95 southbound ramps intersection, three through lanes, and one channelized yield-controlled right-turn lane

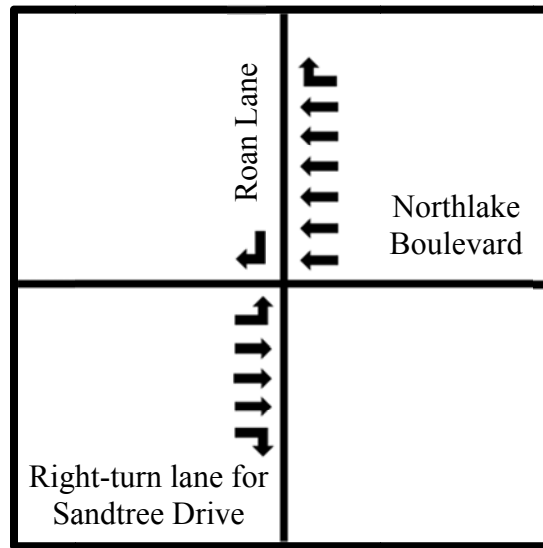
**Figure 8: Northlake Boulevard at I-95 Northbound Ramps – Laneage Configuration**



The signalized intersection of Roan Lane at Northlake Boulevard is located approximately 430 feet east of the I-95 northbound ramps. The intersection has the following lane configuration.

- Southbound: one right-turn only lane
- Eastbound: one left-turn lane, three through lanes, and one right-turn lane which serves Sandtree Drive
- Westbound: two auxiliary through lanes which align with the westbound left-turn lanes at the I-95 southbound ramps intersection, three through lanes, one auxiliary through lane which aligns with the right-turn lane at the I-95 northbound ramps intersection, and one right-turn lane

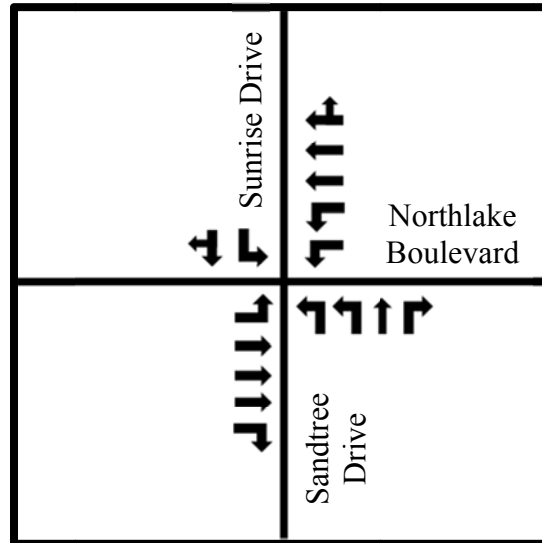
**Figure 9: Northlake Boulevard at Roan Lane – Laneage Configuration**



The signalized intersection of Sunrise Drive/Sandtree Drive is located approximately 670 feet east of the Roan Lane intersection. The intersection has the following lane configuration.

- Northbound: two left-turn lanes, one through lane, and one right-turn lane
- Southbound: one left-turn lane and one shared through/right-turn lane
- Eastbound: one left-turn lane, three through lanes, and one right-turn lane
- Westbound: two left-turn lanes, two through lanes, and one shared through/right-turn lane

**Figure 10: Northlake Boulevard at Sunrise Drive/Sandtree Drive – Laneage Configuration**



## 4.2 Bridge, Waterway, Interchange or Grade Separation Structures

### 4.2.1 Typical Section

The I-95 overpass includes four general purpose lanes and one HOV lane in each direction providing for a 10-lane divided freeway with inside and outside shoulders.

### 4.2.2 Structures

There is one existing bridge within this interchange, I-95 over Northlake Boulevard (Bridge #930516)

### 4.2.3 Bridge Inspection/Condition

The Bridge Inspection Report (BIR) was obtained from the District Structures and Facilities library for the structure.

The existing bridge I-95 over Northlake Boulevard (Bridge # 930516), constructed in 2005, is a prestressed concrete – stringer/girder type structure. It is comprised of two spans with maximum span length of 102 feet. The overall length of the bridge is 204 feet. The total bridge width is 183 feet 1 inch. The bridge currently carries five through lanes, with approximately a 10 foot outside shoulder and a 15 foot inside shoulder in each direction. Each side is contained by

concrete bridge railing, and the two directions are divided by a raised concrete barrier. The minimum vertical clearance is 17 feet, 3 inches. The report also provided descriptions and pictures of the deficiencies that exist on this bridge. District IV's Structures and Facility Maintenance Offices Bridge Inspection Report indicates a very good to excellent overall NBI ratings for bridge # 930516. The sufficiency rating is 98.0 out of a possible 100, whereas the health index is 99.42 out of a possible 100.

## 4.3 Transit Facilities and Services

### 4.3.1 Transit Services

The northernmost Tri-Rail station is the Mangonia Park Station on 45<sup>th</sup> Street; therefore, there are no Tri-Rail stations located within the vicinity of the Northlake Boulevard interchange.

Northlake Boulevard, in the vicinity of the I-95 interchange, is directly served by Palm Tran Route 20. Palm Tran Route 20 serves Northlake Boulevard from Prosperity Farms Road to Military Trail. Two bus stops servicing Palm Tran Route 20 are located just west of Keating Drive, one along the south side for the eastbound route and one along the north side for the westbound route. Two bus stops servicing Palm Tran Route 20 are also located just east of Sunrise Drive/Sandtree Drive, one along the south side for the eastbound route and one along the north side for the westbound route.

The Palm Tran Route 20 Map has been included in Appendix B.

### 4.3.2 Van-Pool/Car-Pool Activities

No designated van-pool/car-pool activities or areas are provided in the interchange area.

### 4.3.3 Park-and-Ride Facilities

No designated park-and-ride facilities or areas are provided in the vicinity of the interchange.

### 4.3.4 Connection and Access to Seaport and Airport

No direct connection or access to a nearby seaport or airport is available.

## 4.4 Planned and Programmed Transportation Projects

A review was conducted of planned and programmed transportation projects occurring in the vicinity of the I-95 at Northlake Boulevard interchange. The planned and programmed transportation projects are summarized below.

### 4.4.1 Metropolitan Planning Organization Plans

To identify the projects recommended within the Northlake Boulevard interchange's AOI, the following Metropolitan Planning Organization (MPO) plans were reviewed.

#### 4.4.1.1 Long Range Transportation Plan Cost Feasible and Needs Plans

The Palm Beach MPO's 2035 Long Range Transportation Plan (LRTP) Cost Feasible Plan includes all highway, transit, bicycle, and pedestrian projects committed for construction within the County's Five Year Road Program and the MPO's TIP. The LRTP Cost Feasible Plan also includes financially feasible projects out to the year 2035. The 2035 Cost Feasible Plan – Highway Component did not identify any projects within the Northlake Boulevard interchange AOI. The 2035 Cost Feasible Plan Map – Transit Component identified one transit improvement consisting of a new Palm Tran bus route along Northlake Boulevard extending east and west of the interchange AOI.

The LRTP Needs Plan includes projects to address an identified need out to the year 2035. The 2035 Needs Plan – Highway Component identifies two needs projects within the interchange AOI.

1. Widening of Northlake Boulevard to eight lanes from Military Trail to SR A1A
2. Implementation of Managed Lanes on I-95 from the Palm Beach County/Broward County Line to Indiantown Road.

The 2035 Needs Plan – Transit Component identifies three transit improvements within the Northlake Boulevard interchange AOI.

1. Proposed E-W Palm Tran Bus Grid System (Along Northlake Boulevard both east and west of the I-95 interchange).
2. Proposed Bus Rapid Transit (BRT) (Along Northlake Boulevard both east and west of the I-95 interchange).
3. Proposed N-S Palm Tran Bus Grid System (Along I-95 both north and south of Northlake Boulevard).

The LRTP Cost Feasible Plan and Needs Plan Text and Maps are included in Appendix C.

#### 4.4.1.2 Master Comprehensive Bicycle Transportation Plan

The MPO Master Comprehensive Bicycle Transportation Plan (MCBTP) includes bicycle facilities improvement recommendations throughout the county. The MCBTP Bicycle Facility Recommendations Map designates Northlake Boulevard within the interchange AOI as "Re-Stripe Candidate." The MCBTP Bicycle Facilities Needs Map designates Northlake Boulevard within the interchange AOI as "Enhanced Priority, Needs Improvement (Bike LOS "C"). These designations should be considered during the design phase when determining bicycle lane improvements.

The MCBTP Text and Map are included in Appendix D.

#### 4.4.2 County and Local Agency Plans and Projects

No county or local agency plans or projects were identified within the vicinity of the interchange.

### 4.4.3 Department Plans and Projects

A review was conducted of the FDOT Five-Year Work Program. While there are no capacity projects programmed within the Northlake Boulevard interchange AOI, an adaptive traffic control system project (432883.1) has been programmed for implementation along Northlake Boulevard between SR 809 (Military Trail) and US 1 (Federal Highway). The implementation of the adaptive traffic control project is scheduled for FY 2014.

## 4.5 Traffic Data

Existing (2012/2013) traffic data for the study area was collected from several sources including:

- Kittelson and Associates, Inc. (Kittelson) I-95 Interchange Master Plan 2012 AADT and Peak Hour Volumes Memorandum, dated March 2013 (Kittelson Report)
- Palm Beach County
- FDOT
- Field collected data

### 4.5.1 Traffic Counts

Existing (2012/2013) traffic data for the interchange ramp terminal intersections and the signalized intersections immediately adjacent to the east and west were obtained from the Kittelson Report. The Kittelson Report provided 2012 Annual Average Daily Traffic (AADT) and peak hour intersection traffic volumes collected for this project. Corridor specific A.M. and P.M. peak hours of 7:30 – 8:30 A.M. and 4:45 – 5:45 P.M. along I-95 were identified in the Kittelson Report. The traffic counts collected for the I-95 Interchange Master Plan are summarized below.

- Turning movement counts (TMCs) were conducted during the weekday morning (7 A.M. – 9 A.M.) and weekday evening (4 P.M. – 6 P.M.) at the following intersections relative to the I-95 at Northlake Boulevard interchange.
  - Keating Drive at Northlake Boulevard, Tuesday, February 5, 2013
  - I-95 southbound ramps at Northlake Boulevard, Tuesday, February 5, 2013
  - I-95 northbound ramps at Northlake Boulevard, Tuesday, February 5, 2013
  - Roan Lane at Northlake Boulevard, Wednesday June 12, 2013
  - Sunrise Drive/Sandtree Drive at Northlake Boulevard, Wednesday, February 5, 2013

The TMCs include pedestrians, bicycles, and heavy vehicle percentages. The turning movement worksheets and summaries are included in Appendix E.

- Bi-directional link counts were conducted on each approach of the study intersections in 15-minute intervals.
- Bi-directional vehicle classification counts were conducted east and west of the northbound and southbound ramp intersections in 1-hour increments.
- I-95 mainline data was obtained from FDOT traffic count information.

A lane utilization count was conducted for the eastbound approach at the I-95 southbound ramps intersection during the A.M. peak hour to verify field conditions observed during the site visit.

The lane utilization data was utilized to calibrate the Synchro operational analysis. The lane utilization worksheets and summaries are included in Appendix E.

## 4.5.2 Field Reviews

Field reviews were conducted to evaluate the existing operating conditions for vehicles and bicyclists/pedestrians in the vicinity of the interchange. The field reviews were used to provide a reference for calibrating the Synchro model applied in the operations analysis. Field reviews were conducted during the morning (A.M.) and evening (P.M.) peak hours. The field review observations are summarized below.

The Keating Drive intersection operates with protected left-turn phases for all approaches. The eastbound and westbound approaches have right-turn overlap phases. The northbound and southbound approaches have a shared through/right-turn lane and, therefore, do not operate with a right-turn overlap. During the A.M. and P.M. peak hours all approaches operated with minimal queues, with the exception of the westbound approach which experienced longer queues. All vehicle queues cleared the intersection during one cycle of the traffic signal during the observation periods.

**Figure 11: Northlake Boulevard at Keating Drive Westbound Queue – P.M. Peak Hour**



The I-95 southbound ramps intersection operates with protected left turns and signal-controlled channelized right turns on the southbound approach. The westbound approach also operates with protected left turns. The eastbound approach has a free-flow channelized right-turn lane. Although the eastbound right-turn operates under free-flow conditions with a dedicated receiving lane along the southbound on-ramp, a yield sign is provided along the outside of the right-turn lane. The southbound approach experienced long queues, which did not totally clear during any signal cycle during the A.M. and P.M. peak hours. The eastbound and westbound approaches experienced minimal queues, which cleared during each signal cycle in both the A.M. and P.M. peak hours.

**Figure 12: Northlake Boulevard at I-95 Southbound Ramps – Southbound Queue - A.M. Peak Hour**



The I-95 northbound ramps intersection operates with protected left turns and signal-controlled channelized right turns on the northbound approach. The eastbound approach also operates with protected left turns. The westbound approach has a yield-controlled channelized right-turn lane. The northbound and westbound approaches experienced long queues during both the A.M. and P.M. peak hours. The westbound queues cleared during each signal cycle, but the northbound queues did not clear during multiple signal cycles.

**Figure 13: Northlake Boulevard at I-95 Northbound Off-Ramp - Northbound Queue - A.M. Peak Hour**



The Roan Lane intersection operates with a protected left-turn movement for the eastbound approach. The eastbound left-turn movement experienced long queues, and the movement was observed to be blocked by the westbound through vehicles from the I-95 northbound ramps intersection. The eastbound left-turn movement queue during the A.M. peak hour did not clear every cycle during the observation period. Due to the long eastbound left-turn queue, northbound right-turning vehicles from the I-95 northbound off-ramp destined for Roan Lane were witnessed making an “S” movement, first making a left-turn to head westbound (against traffic flow) for a short distance then turning back eastbound to join the back of queue. It should be noted that this movement was made during a protected right-turn phase; therefore, there were no conflicting eastbound vehicles at the time these “S” turning vehicles were making this movement. Minimal queues were observed during the P.M. peak hour.

**Figure 14: Northlake Boulevard at Roan Lane - Eastbound Queue - A.M. Peak Hour**



The Sunrise Drive/Sandtree Drive intersection operates with protected left-turn phases for all approaches. The eastbound approach operates with a right-turn overlap phase. The westbound and southbound approaches have a shared through/right-turn lane and, therefore, do not operate with a right-turn overlap. The northbound approach has a separate right-turn lane; however, it does not operate with a right-turn overlap. During the A.M. and P.M. peak hours all approaches operated with minimal queues, with the exception of the eastbound approach which experienced longer queues. All vehicle queues cleared the intersection during one cycle of the traffic signal during the observation periods.

**Figure 15: Northlake Boulevard at Sunrise Drive/Sandtree Drive - Eastbound Queue - P.M. Peak Hour**



### 4.5.3 Crash Data

Crash data was collected from the FDOT Crash Analysis Reporting System (CARS) for the ramp terminal intersections and approaches at the I-95 and Northlake Boulevard interchange. Based on the data collected, the following is a summary of the crashes that occurred from 2010 to 2012.

**Table 1: Crash Summary**

Year	Number of Crashes
2010	51
2011	54
2012	48

Based on the FDOT Crash Data, the following observations were made.

- Crash Type
  - Predominant: Rear End (54 percent)
  - Second: Angle (12 percent)
- Light Condition
  - Predominant: Daylight (71 percent)
  - Second: Dark (SL) (26 percent)
- Surface Condition
  - Predominant: Dry (74 percent)
  - Second: Wet (26 percent)
- Time of Day
  - Predominant: 7:00 P.M. – 6:00 A.M. (26 percent)
  - Second: 2:00 – 4:00 P.M. (20 percent)

A further discussion of crash patterns and potential countermeasures are provided in Section 6.2. The percentage of wet pavement crashes exceeds the statewide average (14 percent). While the identification of specific countermeasures to address wet pavement crashes is beyond the scope of the IMP, further analyses were conducted to identify specific ramps with a high proportion of wet pavement crashes. Based on the review, 29 percent of crashes (10 out of 34 crashes) on the northbound off-ramp occurred during wet pavement conditions. This information was provided to the Traffic Operations Office to decide if a detailed safety study is warranted to address wet pavement crashes on the subject ramp.

The raw data from Palm Beach County and a summary of the FDOT data is provided in Appendix F. Based on FDOT's high crash locations report, I-95, within the AOI, appeared as a high crash location/segment as follows:

- Location
  - I-95 northbound off-ramp – 2011

- Segment
  - I-95 mainline between mileposts 34.600 and 34.800 - 2010

Inclusion on FDOT's high crash location reports reflects a crash rate at a higher statistical significance as compared to crash rates of similar statewide roadways. Recommended countermeasures to reduce the potential for crashes in the study area are included in Section 6.2.

Note: 2012 FDOT high crash location data was not available at the time of this analysis; therefore, the latest three-year period available (2009-2011) was reviewed.

## 5 Design Performance Criteria, Policies, and Procedures

As summarized in the Methodology Letter of Understanding (MLOU), analyses of the I-95 system, including the mainline and the interchange ramps, were based on criteria and policies detailed in the FDOT Interchange Handbook, 2002 Edition. FDOT Topic No. 525-000-006 provides Level of Service (LOS) standards for the State Highway System (SHS). Freeway and ramp operations analyses were conducted utilizing Highway Capacity Software (HCS2010).

As outlined in the MLOU, factors for analyzing the signalized intersections and arterial segments were consistent with the values provided by the Palm Beach County Traffic Division in the document titled "HCM Default Inputs." The Palm Beach County document provides guidance on default values to be utilized in analyses and minimum operational criteria for signalized intersections in Palm Beach County. Input criteria includes traffic factors along with minimums and standards for non-coordinated and coordinated traffic signals. Operational criteria include maximum volume-to-capacity (v/c) ratios and maximum delays. The Palm Beach County Traffic Performance Standards Ordinance (TPSO) specifies Test 1 standards that require that all intersections and roadways satisfy the LOS D threshold using the Highway Capacity Manual Planning Methodology. Palm Beach County TPSO also specifies a Test 2-five year analysis standards that require all intersections and roadways to satisfy the LOS E threshold at the end of the fifth year of the Florida Department of Transportation Five-Year Transportation Improvement program in effect at the time of the traffic analysis. The following LOS criteria were utilized for the signalized intersections.

- FDOT (Strategic Intermodal System)
  - Urbanized – LOS D
- Palm Beach County
  - LOS D (existing) and LOS E (future years – 2020 and 2040)

The interchange ramps intersections are considered to be a part of the SIS system; therefore, the FDOT SIS LOS criteria (LOS D) were utilized in the analysis.

Signalized intersection analyses were conducted utilizing Trafficware's *Synchro 8.0* software package. The HCM2000 reports were utilized for output results.

The FDOT Design Standards (Standard Indexes), 2013, were utilized in the design of the roadway improvements.

## 6 Existing (2012/2013) Operational and Safety Analysis

### 6.1 Existing Traffic Operational Analysis

#### 6.1.1 Intersection Analysis

Traffic operational analyses were conducted to evaluate the existing conditions for the I-95 at Northlake Boulevard interchange and the adjacent signalized intersections along Northlake Boulevard. A.M. and P.M. peak hour operational analyses were performed at the five study intersections to determine the existing delay and LOS. The Synchro worksheets for the intersection analyses are included in Appendix G. Tables 2 and 3 summarize the results of the operational analysis for the existing A.M. and P.M. peak hour conditions at the five study intersections.

**Table 2: A.M. Peak Hour Intersection LOS Summary – Existing (2012/2013) Conditions**

Northlake Boulevard Intersection	Approach LOS				Overall LOS	Overall Delay (seconds per vehicle)
	EB	WB	NB	SB		
Keating Drive	C	B	E	E	C	23.4
I-95 southbound ramps	C	A	-	E	C	28.3
I-95 northbound ramps	A	D	F	-	D	53.2
Roan Lane	A	A	-	-	A	2.4
Sunrise Drive/Sandtree Drive	C	C	E	F	D	35.6

**Table 3: P.M. Peak Hour Intersection LOS Summary – Existing (2012/2013) Conditions**

Northlake Boulevard Intersection	Approach LOS				Overall LOS	Overall Delay (seconds per vehicle)
	EB	WB	NB	SB		
Keating Drive	D	D	E	E	D	47.9
I-95 southbound ramps	D	A	-	F	C	29.3
I-95 northbound ramps	A	C	F	-	D	36.0
Roan Lane	A	A	-	-	A	2.2
Sunrise Drive/Sandtree Drive	D	F	F	E	F	80.7

The Keating Drive intersection currently operates at LOS C with an overall delay of 23.4 seconds per vehicle during the A.M. peak hour and at LOS D with an overall delay of 47.9 seconds per vehicle during the P.M. peak hour. During the A.M. peak hour, all approaches and movements operate at LOS E or better. During the P.M. peak hour, all approaches and movements operate at LOS E or better except the westbound left-turn, northbound through/left-turn, and northbound right-turn movements.

The I-95 southbound ramps intersection currently operates at LOS C with an overall delay of 28.3 seconds per vehicle during the A.M. peak hour and at LOS C with an overall delay 29.3 seconds per vehicle during the P.M. peak hour. During the A.M. peak hour the southbound left-turn movement operates at LOS F; however, all other movements and approaches operate at LOS E or better. During the P.M. peak hour the southbound left-turn movement operates at LOS F resulting in the southbound approach operating at LOS F; however, all other movements and approaches operate at LOS E or better.

The I-95 northbound ramps intersection currently operates at LOS D with an overall delay of 53.2 seconds per vehicle during the A.M. peak hour and at LOS D with an overall delay of 36.0 seconds per vehicle during the P.M. peak hour. During the A.M. peak hour, the northbound left-turn and right-turn movements operate at LOS F resulting in the northbound approach operating at LOS F; however, all other movements and approaches operate at LOS D or better. During the P.M. peak hour, the northbound left-turn movement operates at LOS F resulting in the northbound approach operating at LOS F; however, all other movements and approaches operate at LOS D or better.

The Roan Lane intersection currently operates at LOS A during the A.M. peak hour with 2.4 seconds of delay per vehicle and at LOS A during the P.M. peak hour with 2.2 seconds of delay per vehicle. During the A.M. and P.M. peak hours, the eastbound left-turn movement operates at LOS F; however, all other movements and approaches operate at LOS A. This intersection operates with a partial signal, providing continuous green time for the eastbound through movement and signal control for the eastbound left-turn and westbound through movements. The eastbound left-turn movement is operating with a v/c ratio of 0.51 during the A.M. peak hour and 0.72 during the P.M. peak hour; therefore, the poor LOS can be attributed to the minimal green time afforded the turning movement (actuated g/C ratio of 0.05 during the A.M. peak hour and 0.11 during the P.M. peak hour) and is not reflective of a capacity issue.

The Sunrise Drive/Sandtree Drive intersection currently operates at LOS D with an overall delay of 35.6 seconds per vehicle during the A.M. peak hour and at LOS F with an overall delay of 80.7 seconds per vehicle during the P.M. peak hour. During the A.M. peak hour, the eastbound left-turn movement, southbound left-turn movement, and southbound approach operate at LOS F; however, all other movements and approaches operate at LOS E or better. During the P.M. peak hour, the westbound through movement, westbound approach, northbound left-turn movement, northbound right-turn movement, northbound approach, and southbound left-turn movement operate at LOS F; resulting in the intersection operating at LOS F.

## 6.1.2 Ramps Analysis

Merge and diverge ramps analyses will be conducted as part of the overall I-95 mainline analysis in order to account for the effects of upstream and downstream ramps at the adjacent intersections.

## 6.2 Crash Analysis

A crash analysis was conducted to determine the types of crashes that occurred within the vicinity of the I-95 at Northlake Boulevard interchange (ramp terminal intersections and approaches). Based on the crash data, GIS based collision diagrams were prepared. The collision diagrams were then used to determine crash patterns in the vicinity of the interchange and identify potential countermeasures. The collision diagrams are provided in Appendix F. Below is a summary of the crash patterns and potential countermeasures.

**Table 4: Crash Patterns and Potential Countermeasures**

<b>Crash Patterns</b>	<b>Potential Countermeasures</b>
Rear-end crashes on Northlake Boulevard at I-95 northbound and southbound ramps*	<ul style="list-style-type: none"> <li>• Add one eastbound through lane and one westbound through lane on Northlake Boulevard.<sup>(1)</sup></li> <li>• Provide one signal head per through lane on Northlake Boulevard.</li> </ul>
Rear-end crashes on northbound off-ramp	<ul style="list-style-type: none"> <li>• Add one northbound left-turn lane.<sup>(1)</sup></li> <li>• Add pedestal mounted signal heads facing right-turn lanes.</li> </ul>
Angle and left-turn crashes at northbound and southbound ramps <sup>(2)</sup>	<ul style="list-style-type: none"> <li>• Add one eastbound through lane and one westbound through lane on Northlake Boulevard.<sup>(1)</sup></li> <li>• Add one northbound left-turn lane.<sup>(1)</sup></li> <li>• Add two southbound left-turn lanes<sup>(1)</sup></li> <li>• Add backplates and yellow retroreflective tape.</li> <li>• Ensure yellow and all red clearance times are adequate.</li> </ul>
Wet pavement crashes (on northbound off-ramp)	<ul style="list-style-type: none"> <li>• Coordinate with Traffic Operations Office to determine the need for additional analysis of wet pavement crashes on the northbound off-ramp.</li> </ul>

Notes: (1) Indicates a countermeasure identified through operational analyses which also provide safety benefits.

(2) Individual police reports were not reviewed; therefore, specific approaches/locations cannot be identified.

The field review also identified the following safety enhancements which are not correlated with crash patterns observed with historical data:

- Upgrade existing crosswalk signage to meet current MUTCD standards.
- Refurbish/replace ‘Do Not Enter’ signs on the northbound off-ramp.
- Upgrade the crosswalk on the west leg of the Northlake Boulevard and Keating Drive intersection with high emphasis/ladder-type markings as there is no crosswalk on the east leg.
- Review/verify “Wrong Way” signs and pavements markings at the I-95 ramps intersections and install new treatments, per the guidelines provided in the most recent MUTCD, if necessary.

## 7 Traffic Forecasting

The enhanced SERPM version 6.5 Managed Lanes model, developed as part of the I-95 PD&E Study (Stirling Road to Linton Boulevard) is the most appropriate model for the Palm Beach County Interchange Master Plan (IMP). This travel demand forecasting model was enhanced based on the SERPM Version 6.5 Time of Day Model with I-95 subarea-specific improvements.

### 7.1 Land Use Changes

A review of the SERPM employment and population data revealed the following trends for changes in the future land use in the project area.

- Minimal overall population growth with population increases primarily between 0% - 10% from 2005 to 2035. One noticeable exception is the southeast quadrant of the interchange, which is anticipated to have a 31% increase in population.
- Significant changes in employment both east and west of the interchange; however, growth to the east is anticipated to be higher.

Maps depicting the percentage growth for population and employment from 2005 to 2035 are included in Appendix H.

### 7.2 Analysis Years and Model Runs

The following are the analysis years for this I-95 IMP project.

- Design Year: 2040 - Forecasts developed from 2040 baseline model run
- Opening Year: 2020 - Forecasts developed by interpolating between 2012/2013 traffic counts and 2040 forecasts
- Validation Year: 2010

#### 7.2.1 DDHV Development

##### 7.2.1.1 2040 DDHV

The 2040 baseline model produced the 2040 A.M. peak period, P.M. peak period, and off-peak volumes for the ramps, arterials, and I-95 mainline. These A.M. and P.M. peak period volumes

represent 3-hour peak periods and the model's off-peak consists of an 18-hour period. The A.M. and P.M. peak period volumes were converted to A.M. and P.M. directional design hour volumes (DDHVs) using diurnal factors of 0.395 and 0.365, respectively. These diurnal factors were calculated for the I-95 corridor utilizing data obtained from 24-hour counts along I-95. First, the total volume for the peak three hour periods were calculated (6:30 – 9:30 A.M. and 3:30 – 6:30 P.M.). Next, the total volume for the peak one-hour within the peak three-hour period was calculated. The diurnal factor was then calculated by dividing the peak one-hour period volume by the peak three-hour period volume.

### 7.2.1.2 2020 DDHV Estimation

The 2020 DDHVs were interpolated between the 2040 DDHV and the existing 2012/2013 traffic counts.

## 7.2.2 Estimating and Balancing Future Year Turning Movement Forecasts

The 2040 travel demand model was refined to produce turning movement forecasts for the intersections within the study limits. These turning movement forecasts were extracted from the model to an excel spreadsheet for processing. The processing step was conducted to adjust the forecasts as follows:

- The estimated turning movements were reviewed to ensure the forecasts were not less than the existing volumes. If the 2040 forecasts were lower than the existing volumes, adjustments were performed using a growth rate method. An annual growth rate of 0.89 percent was applied to the existing volumes to estimate the 2040 volumes. This growth rate is the weighted annual growth rate estimated from the overall Palm Beach County population and employment growth.
- Manual corrections were applied to movements to balance volumes along the network of intersections.
- The forecasts were reviewed to ensure each leg of the study intersections presented logical growth. A combination of manual correction for balancing and the growth rate method was applied to develop the refined forecasts.

The balanced 2020 and 2040 volumes for the study interchange and adjacent intersections are included in Appendix H.

### 7.2.3 Model Volumes Review

A calibration effort using Cube Analyst produced satisfactory model validation results. The reasonableness checks indicated fairly consistent growth across the corridor. Post-processing adjustments were performed to adjust volumes for ramps with negative growth.

## 8 Opening Year (2020) No-Build Conditions Traffic Operational Analysis

### 8.1 Intersection Analysis

Traffic operational and queuing analyses were conducted to evaluate the 2020 No-Build conditions (without roadway improvements) for the I-95 at Northlake Boulevard interchange AOI. The purpose of the 2020 No-Build analysis was to identify anticipated short-term deficiencies and needs at the study intersections that could be addressed prior to the implementation of the long-term improvements identified for the 2040 Design Year. Utilizing the results of these intersection and queuing analyses, recommended roadway improvements and corresponding Conceptual Design Alternatives (CDAs) could then be developed to address the long-term travel demand at the Northlake Boulevard interchange and adjacent signalized intersections.

A.M. and P.M. peak hour operational analyses were performed for the five study intersections to estimate future delay and LOS. It was assumed that signal timings would be updated to address future deficiencies; therefore, the signal timings were optimized for the No-Build conditions. The Synchro worksheets for the intersections analyses are included in Appendix G. Tables 5 and 6 summarize the results of the operational analyses for the A.M. and P.M. peak hour conditions for the five study intersections.

**Table 5: A.M. Peak Hour Intersection LOS Summary – 2020 No-Build Conditions**

Northlake Boulevard Intersection	Approach LOS				Overall LOS	Overall Delay (seconds per vehicle)
	EB	WB	NB	SB		
Keating Drive	C	B	E	E	C	27.3
I-95 southbound ramps	E	A	-	E	D	37.9
I-95 northbound ramps	A	F	E	-	E	57.9
Roan Lane	A	A	-	-	A	1.5
Sunrise Drive/Sandtree Drive	C	C	F	E	C	34.5

**Table 6: P.M. Peak Hour Intersection LOS Summary – 2020 No-Build Conditions**

Northlake Boulevard Intersection	Approach LOS				Overall LOS	Overall Delay (seconds per vehicle)
	EB	WB	NB	SB		
Keating Drive	D	D	F	E	D	50.5
I-95 southbound ramps	E	A	-	E	C	33.5
I-95 northbound ramps	A	E	D	-	D	41.6
Roan Lane	A	A	-	-	A	4.0
Sunrise Drive/Sandtree Drive	D	D	F	F	E	60.6

The Keating Drive intersection is anticipated to operate at LOS C with an overall delay of 27.3 seconds per vehicle during the A.M. peak hour and at LOS D with an overall delay of 50.5 seconds per vehicle during the P.M. peak hour. All movements and approaches are anticipated to operate at LOS E or better during the A.M. peak hour. During the P.M. peak hour the eastbound left-turn movement, westbound left-turn movement, northbound left-turn movement, northbound left-turn/through movement, northbound right-turn movement, and northbound approach are anticipated to operate at LOS F. All other movements and approaches are anticipated to operate at LOS E or better during the P.M. peak hour.

The I-95 southbound ramps intersection is anticipated to operate at LOS D with an overall delay of 37.9 seconds per vehicle during the A.M. peak hour and at LOS C with an overall delay 33.5 seconds per vehicle during the P.M. peak hour. During the A.M. and P.M. peak hours, the eastbound through movement is anticipated to operate at LOS F. All other movements and approaches are anticipated to operate at LOS E or better.

The I-95 northbound ramps intersection is anticipated to operate at LOS E with an overall delay of 57.9 seconds per vehicle during the A.M. peak hour and at LOS D with an overall delay of 41.6 seconds per vehicle during the P.M. peak hour. During the A.M. peak hour, the westbound through movement, westbound approach, and northbound left-turn movement are anticipated to operate at LOS F. All other movements and approaches are anticipated to operate at LOS E or better during the A.M. peak hour. All movements and approaches are anticipated to operate at LOS E or better during the P.M. peak hour.

The Roan Lane intersection is anticipated to operate at LOS A during the A.M. peak hour with 1.5 seconds of delay per vehicle and at LOS A during the P.M. peak hour with 4.0 seconds of delay per vehicle. All movements and approaches are anticipated to operate at LOS E or better during the A.M. peak hour. During the P.M. peak hour, the eastbound left-turn movement is anticipated to operate at LOS F. All other movements and approaches are anticipated to operate at LOS A. This intersection operates with a partial signal, providing continuous green time for the eastbound through movement and signal control for the eastbound left-turn and westbound movements. The eastbound left-turn movement is anticipated to operate with a v/c ratio of 0.50

during the A.M. peak hour and 0.74 during the P.M. peak hour; therefore, the poor LOS can be attributed to the minimal green time afforded to the turning movement (actuated g/C ratio of 0.05 during the A.M. peak hour and 0.10 during the P.M. peak hour) and is not reflective of a capacity issue.

The Sunrise Drive/Sandtree Drive intersection is anticipated to operate at LOS C with an overall delay of 34.5 seconds per vehicle during the A.M. peak hour and at LOS E with an overall delay of 60.6 seconds per vehicle during the P.M. peak hour. During the A.M. peak hour, the eastbound left-turn movement, northbound left-turn movement, and northbound approach are anticipated to operate at LOS F. All other movements and approaches are anticipated to operate at LOS E or better during the A.M. peak hour. During the P.M. peak hour, the eastbound left-turn movement, westbound left-turn movement, northbound left-turn movement, northbound right-turn movement, northbound approach, southbound left-turn movement, and southbound approach are anticipated to operate at LOS F.

A.M. and P.M. peak hour queuing analysis were performed for the five study intersections to estimate whether existing storage would accommodate anticipated vehicle queues. The Synchro worksheets for the queuing analyses are included in Appendix G. Table 7 summarizes the results of the queuing analyses for the 2020 No-Build A.M. and P.M. peak hour conditions for the five study intersections.

**Table 7: A.M. and P.M. Peak Hour 95<sup>th</sup> Percentile Queuing Analysis – 2020 No-Build Conditions**

Northlake Boulevard Cross Street	Approach	Movement	AM Peak Hour			PM Peak Hour		
			Existing Storage Per Lane (feet)	95th Percentile Queue Per Lane (feet)	Queue in Excess of Storage Per Lane (feet)	Existing Storage Per Lane (feet)	95th Percentile Queue Per Lane (feet)	Queue in Excess of Storage Per Lane (feet)
Keating Drive	EB	Left	170	48	0	170	170	0
		Through <sup>(1)</sup>	-	877	707	-	759	589
		Right	205	0	0	205	69	0
	WB	Left	490	188	0	490	522	32
		Through <sup>(1)</sup>	-	322	0	-	752	382
		Right	370	8	0	370	71	0
	NB	Left	155	73	0	155	331	176
		Through <sup>(1)</sup>	-	73	0	-	324	224
		Right	100	58	0	100	305	205
	SB	Through/Left	-	187	0	-	196	0
Through/Right		375	72	0	375	196	0	
I-95 southbound ramps	EB	Auxiliary	403	452	49	403	480	77
		Through <sup>(1)</sup>	-			-		
		Right <sup>(2)</sup>	-	-	-	-		
	WB	Left	280	0	0	280	0	0
		Through <sup>(1)</sup>	-	4	0	-	9	0
	SB	Left	1,300	471	0	1,300	325	0
		Right	433	239	0	433	401	0
I-95 northbound ramps	EB	Left	280	440	160	280	0	0
		Through <sup>(1)</sup>	-	506	226	-	502	222
	WB	Auxiliary	688	481	0	688	655	0
		Through <sup>(1)</sup>	-			-		
		Right	940	357	0	940	1,078	138
	NB	Left	1,415	377	0	1,415	492	0
		Right	748	596	0	748	636	0
Roan Lane	EB	Left	280	58	0	280	183	0
		Through <sup>(1)</sup>	-	0	0	-	0	0
	WB	Through <sup>(1)</sup>	-	95	0	-	112	0
		Right	275	9	0	275	22	0
Sunrise Drive / Sandtree Drive	EB	Left	375	220	0	375	358	0
		Through <sup>(1)</sup>	-	757	382	-	748	373
		Right	730	77	0	730	106	0
	WB	Left	253	100	0	253	201	0
		Through <sup>(1)</sup>	-	524	271	-	1,054	801
	NB	Left	270	209	0	270	445	175
		Through <sup>(1)</sup>	-	34	0	-	33	0
		Right	150	73	0	150	450	300
	SB	Left	175	226	51	175	154	0
		Through <sup>(1)</sup>	-	151	0	-	186	11

Note: (1) – Through lane queue compared to left-turn, right-turn, and auxiliary lane lengths to determine if the through lane queue is anticipated to exceed the turn lane length potentially blocking access to the turn lane.  
 (2) – Right-turn lane operates under free-flow conditions; therefore, no queuing occurs for this movement

The Keating Drive intersection is not anticipated to experience any turn lane queues that exceed the existing turn lane storage lengths during the A.M. peak hour; however, the eastbound through queue is anticipated to exceed both the left-turn and right-turn lane lengths potentially blocking access to the turn lanes. During the P.M. peak hour the anticipated queues for the westbound left-turn, northbound left-turn, and northbound right-turn movements are anticipated to exceed the existing turn lane storage lengths. Additionally, the eastbound through, westbound through, and northbound through movements are anticipated to exceed both the left-turn and right-turn lane lengths at each approach, respectively, potentially blocking access to the turn lanes.

The I-95 southbound ramps intersection is not anticipated to have turn lane queues that exceed any of the existing storage lengths. However, the eastbound through/auxiliary queue is anticipated to exceed the auxiliary lane storage during the A.M. and P.M. peak hours, potentially resulting in either spillback from the auxiliary lanes or the queue from the through lanes blocking access to the auxiliary lanes.

The I-95 northbound ramps intersection is anticipated to experience queues that exceed the existing turn lane storage length for the eastbound left-turn lane during the A.M. peak hour and the westbound right-turn lane during the P.M. peak hour. Additionally, the eastbound through queue is anticipated to exceed the left-turn lane length during the A.M. and P.M. peak hours, potentially blocking access to the turn lane.

The Roan Lane intersection is not anticipated to experience any queues that exceed the existing turn lane storage lengths during the A.M. peak hour or P.M. peak hour.

The Sunrise Drive/Sandtree Drive intersection is anticipated to experience queues that exceed the existing turn lane length storage for the southbound left-turn movement during the A.M. peak hour and the northbound left-turn and right-turn movements during the P.M. peak hour. Additionally, the eastbound through queue is anticipated to exceed the left-turn and right-turn lane lengths during the A.M. and P.M. peak hours, potentially blocking access to the turn lanes. The westbound through queue is anticipated to exceed the left-turn lane length during the A.M. and P.M. peak hours, potentially blocking access to the left-turn lane. The southbound through queue is anticipated to exceed the left-turn lane length during the P.M. peak hour, potentially blocking access to the left-turn lane.

## 8.2 Ramps Analysis

Merge and diverge analyses will be conducted for the I-95 on- and off-ramps as part of the I-95 mainline analysis to account for the effects of upstream and downstream ramps serving the adjacent interchanges.

### 8.3 Projected 2020 Operational Deficiencies

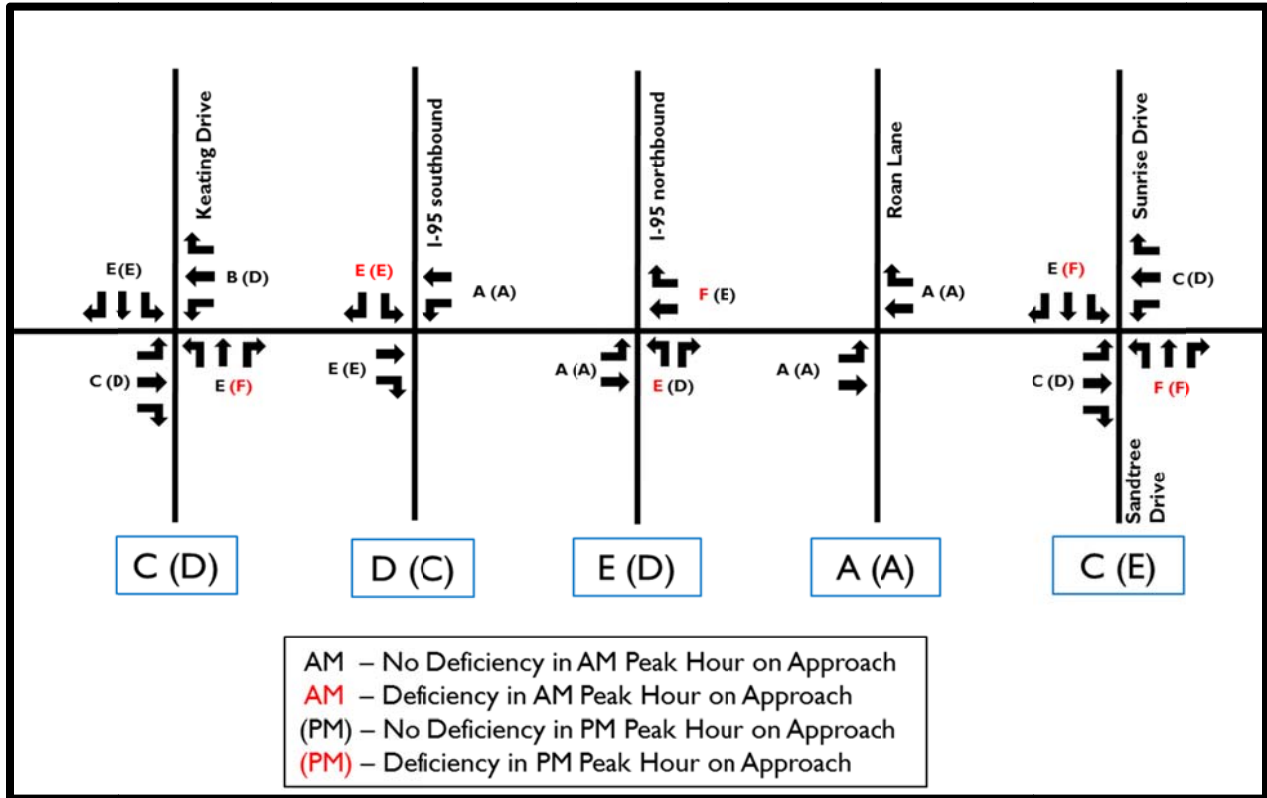
As previously stated, the purpose of this study is to identify short-term and long-term needs within the I-95 at Northlake Boulevard interchange AOI and to develop design concepts to address existing and/or potential future operational deficiencies. The I-95 ramp intersections were considered to be deficient at LOS E, the adjacent signalized intersections were considered to be deficient at LOS F, and the movements and approaches for all intersections were considered deficient at LOS F. The 2020 No-Build analysis identified the following operational deficiencies at the study intersections along Northlake Boulevard within the AOI.

- Keating Drive
  - Eastbound left-turn movement during the P.M. peak hour
  - Eastbound through queue anticipated to exceed the left-turn and right-turn lanes storage during the A.M. and P.M. peak hours
  - Westbound left-turn movement during the P.M. peak hour
  - Westbound left-turn queue anticipated to exceed storage during the P.M. peak hour
  - Westbound through queue anticipated to exceed the left-turn and right-turn lane storage during the P.M. peak hour
  - Northbound left-turn movement during the P.M. peak hour
  - Northbound through movement during the P.M. peak hour
  - Northbound right-turn movement during the P.M. peak hour
  - Northbound approach during the P.M. peak hour
  - Northbound left-turn queue anticipated to exceed storage during the P.M. peak hour
  - Northbound through queue anticipated to exceed the left-turn and right-turn lane storage during the P.M. peak hour
  - Northbound right-turn queue anticipated to exceed storage during the P.M. peak hour
- I-95 southbound ramps
  - Eastbound through movement during the A.M. and P.M. peak hours
  - Eastbound through/auxiliary queue anticipated to exceed auxiliary lanes storage during the A.M. and P.M. peak hours.
  - Southbound approach during the A.M. and P.M. peak hours
- I-95 northbound ramps
  - Overall intersection during the A.M. peak hour
  - Eastbound left-turn queue anticipated to exceed storage during the A.M. peak hour
  - Eastbound through queue anticipated to exceed left-turn lane storage during the A.M. and P.M. peak hours
  - Westbound through movement during the A.M. peak hour
  - Westbound right-turn queue anticipated to exceed storage during the P.M. peak hour
  - Westbound approach during the A.M. peak hour
  - Northbound left-turn movement during the A.M. peak hour
  - Northbound approach during the A.M. peak hour

- Roan Lane
  - Eastbound left-turn movement during the P.M. peak hour
- Sunrise Drive/Sandtree Drive
  - Eastbound left-turn movement during the A.M. and P.M. peak hours
  - Eastbound through queue anticipated to exceed left-turn and right-turn lane storage during the A.M. and P.M. peak hours
  - Westbound left-turn movement during the P.M. peak hour
  - Westbound through queue anticipated to exceed left-turn lane storage during the A.M. and P.M. peak hours
  - Northbound left-turn movement during the A.M. and P.M. peak hours
  - Northbound right-turn movement during the P.M. peak hour
  - Northbound approach during the A.M. and P.M. peak hours
  - Northbound left-turn queue anticipated to exceed storage during the P.M. peak hour
  - Northbound right-turn queue anticipated to exceed storage during the P.M. peak hour
  - Southbound left-turn during the P.M. peak hour
  - Southbound approach during the P.M. peak hour
  - Southbound left-turn queue anticipated to exceed storage during the A.M. peak hour
  - Southbound through queue anticipated to exceed left-turn lane storage during the P.M. peak hour

Figure 16 illustrates the projected 2020 deficiencies by approach for the I-95 at Northlake Boulevard interchange AOI.

Figure 16: Northlake Boulevard – Projected 2020 Deficiencies by Intersection Approaches



## 9 Opening Year (2020) Build Conditions Traffic Operational Analysis (With Improvements)

Short-term, interim improvements were developed for the 2020 opening year. Table 8 below shows considerations from the roadway design perspective for these recommended improvements.

**Table 8: 2020 Recommended Improvements**

<b>Recommended Improvements Based on Traffic Operations Analysis</b>	<b>Roadway Design Considerations</b>
Widen I-95 northbound off-ramp left-turn movement to provide triple (3) left-turn lanes	<ul style="list-style-type: none"> <li>• Widen ramp to inside to accommodate triple (3) left-turn lanes</li> <li>• Additional lane design length: 750'</li> <li>• Adequate receiving throat is provided on Northlake Boulevard under I-95 bridge to receive triple (3) left-turn lanes. I-95 bridge structure is to remain</li> </ul>
Widen I-95 northbound on-ramp to accommodate free-flow westbound to northbound right-turn	<ul style="list-style-type: none"> <li>• Widen ramp to inside and outside to accommodate an additional outside lane</li> <li>• Provide two-lane ramp entering I-95 mainline</li> <li>• Widen northbound I-95 to receive an additional auxiliary lane</li> </ul>
Widen I-95 southbound off-ramp to provide triple (3) left-turn lanes	<ul style="list-style-type: none"> <li>• Widening of ramp to the inside to accommodate the triple (3) left-turn lanes and the ultimate design of quadruple (4) left-turn lanes needed in 2040 (see Table 17)</li> <li>• Additional lane design length: 425'</li> <li>• Adequate receiving throat is provided on Northlake Boulevard under I-95 bridge to receive triple (3) left-turn lanes. I-95 bridge structure is to remain</li> </ul>

<p>Widen Northlake Boulevard westbound approach to accommodate dual (2) left-turn lanes at Keating Drive</p>	<ul style="list-style-type: none"> <li>• Shift the median to the south to accommodate dual (2) left-turn lanes.</li> <li>• Additional lane design length: 440’</li> <li>• Widen Gardens Towne Square driveway to west to accommodate receiving throat for dual (2) left-turn lanes from Northlake Boulevard</li> <li>• Modify signal heads to accommodate the proposed lane geometry</li> </ul>
<p>Restripe northbound approach of Gardens Towne Square (Keating Drive) to provide dual (2) left-turn lanes and one shared through plus right-turn lane</p>	<ul style="list-style-type: none"> <li>• Modify the signal heads and phasing to accommodate the proposed lane geometry</li> </ul>
<p>Build retention pond to account for additional impervious area</p>	<ul style="list-style-type: none"> <li>• Retention pond site will require right-of-way acquisition adjacent to I-95 northbound on-ramp</li> </ul>
<p>Replace/modify all affected existing overhead sign structures</p>	<ul style="list-style-type: none"> <li>• As required to provide positive guidance to motorists</li> </ul>
<p>Construct all affected sidewalk crossings per ADA standards</p>	<ul style="list-style-type: none"> <li>• Maintain ADA compliance for all sidewalk crossings</li> </ul>

### 9.1 2020 Build Conditions (With Improvements)

Traffic operational analyses were conducted to evaluate the 2020 future conditions (with improvements) for the I-95 at Northlake Boulevard interchange and adjacent signalized intersections. A.M. and P.M. peak hour operational analyses were performed for the five study intersections to determine the anticipated future delay and LOS. The Synchro worksheets for the intersections analyses are included in Appendix G. Tables 9 and 10 summarize the results of the operational analyses for the A.M. and P.M. peak hours at the five intersections. Tables 11 and 12 provide a summary of the reduction in delay anticipated in 2020 with the implementation of the recommended improvements.

**Table 9: A.M. Peak Hour Intersection LOS Summary – 2020 Build Conditions**

Northlake Boulevard Intersection	Approach LOS				Overall LOS	Overall Delay (seconds per vehicle)
	EB	WB	NB	SB		
Keating Drive	C	B	E	E	C	25.2
I-95 southbound ramps	D	A	-	D	C	33.5
I-95 northbound ramps	A	D	D	-	C	33.9
Roan Lane	A	A	-	-	A	1.4
Sunrise Drive/Sandtree Drive	C	C	F	E	D	36.7

**Table 10: P.M. Peak Hour Intersection LOS Summary – 2020 Build Conditions**

Northlake Boulevard Intersection	Approach LOS				Overall LOS	Overall Delay (seconds per vehicle)
	EB	WB	NB	SB		
Keating Drive	D	D	F	E	D	43.9
I-95 southbound ramps	D	A	-	D	C	27.7
I-95 northbound ramps	A	D	D	-	D	35.6
Roan Lane	A	A	-	-	A	4.2
Sunrise Drive/Sandtree Drive	D	E	F	E	E	62.7

**Table 11: 2020 A.M. Peak Hour Intersection Operational Benefit Summary**

Northlake Boulevard Intersection	Overall Delay (seconds per vehicle)		
	2020 No-Build	2020 Build	Change in Delay
Keating Drive	27.3	25.2	- 2.1
I-95 southbound ramps	37.9	33.5	- 4.4
I-95 northbound ramps	57.9	33.9	- 24.0
Roan Lane	1.5	1.4	- 0.1
Sunrise Drive/Sandtree Drive	34.5	36.7	+ 2.2

**Table 12: 2020 P.M. Peak Hour Intersection Operational Benefit Summary**

Northlake Boulevard Intersection	Overall Delay (seconds per vehicle)		
	2020 No-Build	2020 Build	Change in Delay
Keating Drive	50.5	43.9	- 6.6
I-95 southbound ramps	33.5	27.7	- 5.8
I-95 northbound ramps	41.6	35.6	- 6.0
Roan Lane	4.0	4.2	+ 0.2
Sunrise Drive/Sandtree Drive	60.6	62.7	+ 2.1

The Keating Drive intersection is anticipated to operate at LOS C with an overall delay of 25.2 seconds per vehicle during the A.M. peak hour and at LOS D with an overall delay of 43.9 seconds per vehicle during the P.M. peak hour. All movements and approaches are anticipated to operate at LOS E or better during the A.M. peak hour, except the northbound left-turn movement. During the P.M. peak hour the eastbound left-turn movement, westbound left-turn movement, northbound left-turn movement, northbound through movement, northbound approach, and southbound left-turn movement are anticipated to operate at LOS F. However, all movements are anticipated to operate with a v/c ratio of less than 1.0. The recommended improvements are anticipated to reduce the delay by 2.1 seconds per vehicle during the A.M. peak hour and 6.6 seconds per vehicle during the P.M. peak hour.

The I-95 southbound ramps intersection is anticipated to operate at LOS C with an overall delay of 33.5 seconds per vehicle during the A.M. peak hour and at LOS C with an overall delay 27.7 seconds per vehicle during the P.M. peak hour. All movements and approaches are anticipated to operate at LOS E or better during the A.M. and P.M. peak hours. The recommended improvements are anticipated to reduce the delay by 4.4 seconds per vehicle during the A.M. peak hour and 5.8 seconds per vehicle during the P.M. peak hour.

The I-95 northbound ramps intersection is anticipated to operate at LOS C with an overall delay of 33.9 seconds per vehicle during the A.M. peak hour and at LOS D with an overall delay of 35.6 seconds per vehicle during the P.M. peak hour. All movements and approaches are anticipated to operate at LOS E or better during the A.M. and P.M. peak hours. The recommended improvements are anticipated to reduce the delay by 24.0 seconds per vehicle during the A.M. peak hour and 6.0 seconds per vehicle during the P.M. peak hour.

The Roan Lane intersection is anticipated to operate at LOS A with an overall delay of 1.4 seconds per vehicle during the A.M. peak hour and at LOS A with an overall delay of 4.2 seconds per vehicle during the P.M. peak hour. All movements and approaches are anticipated to operate at LOS E or better during the A.M. and P.M. peak hours, except for the eastbound left-turn movement during the A.M. and P.M. peak hours. Although the eastbound left-turn movement is anticipated to operate at LOS F, the v/c ratio is anticipated to be less than 1.0. The

recommended improvements are not anticipated to significantly affect the delay at the intersection.

The Sunrise Drive/Sandtree Drive intersection is anticipated to operate at LOS D with an overall delay of 36.7 seconds per vehicle during the A.M. peak hour and at LOS E with an overall delay of 62.7 seconds per vehicle during the P.M. peak hour. All movements and approaches are anticipated to operate at LOS E or better during the A.M. peak hour, except for the eastbound left-turn movement, northbound left-turn movement, northbound right-turn movement, and northbound approach. However, all movements are anticipated to operate with a v/c ratio less than 1.0 during the A.M. peak hour. All movements and approaches are anticipated to operate at LOS E or better during the P.M. peak hour, except for the eastbound left-turn movement, westbound left-turn movement, northbound left-turn movement, and northbound approach. All movements are anticipated to operate with a v/c ratio less than 1.0 during the P.M. peak hour except for the northbound left-turn movement; however, this movement is not associated with traffic exiting I-95 and should not impact I-95 off-ramp traffic. The recommended improvements are anticipated to increase the delay by 2.2 seconds per vehicle during the A.M. peak hour and increase the delay by 2.1 seconds per vehicle during the P.M. peak hour.

A.M. and P.M. peak hour queuing analyses were performed for the five study intersections to estimate whether existing and/or recommended storage would accommodate anticipated vehicle queues. The Synchro worksheets for the queuing analyses are included in Appendix G. Table 13 summarizes the results of the queuing analyses for the 2020 Build A.M. and P.M. peak hour conditions for the five study intersections.

**Table 13: A.M. and P.M. Peak Hour 95<sup>th</sup> Percentile Queuing Analysis – 2020 Build Conditions**

Northlake Boulevard Cross Street	Approach	Movement	AM Peak Hour			PM Peak Hour		
			Existing/ Recommended Storage Per Lane (feet)	95th Percentile Queue Per Lane (feet)	Queue in Excess of Storage Per Lane (feet)	Existing/ Recommended Storage Per Lane (feet)	95th Percentile Queue Per Lane (feet)	Queue in Excess of Storage Per Lane (feet)
Keating Drive	EB	Left	170	47	0	170	149	0
		Through <sup>(1)</sup>	-	785	615	-	642	472
		Right	205	0	0	205	141	0
	WB	Left <sup>(3)</sup>	465	85	0	465	216	0
		Through <sup>(1)</sup>	-	322	0	-	722	352
		Right	370	8	0	370	169	0
	NB	Left <sup>(3)</sup>	233	55	0	233	210	0
		Through <sup>(1)</sup>	-	78	0	-	516	416
		Right	100	0	0	100	0	0
	SB	Left	-	193	0	-	240	0
Through <sup>(1)</sup>		375	69	0	375	179	0	
I-95 southbound ramps	EB	Auxiliary	403	523	120	403	438	35
		Through <sup>(1)</sup>	-			-		
		Right <sup>(2)</sup>	-	-	-	-		
	WB	Left	280	0	0	280	0	0
		Through <sup>(1)</sup>	-	1	0	-	2	0
	SB	Left	1,008	301	0	1,008	208	0
Right		433	225	0	433	380	0	
I-95 northbound ramps	EB	Left	280	0	0	280	0	0
		Through <sup>(1)</sup>	-	2	0	-	1	0
	WB	Auxiliary	688	552	0	688	712	24
		Through <sup>(1)</sup>	-			-		
		Right <sup>(2)</sup>	-	14	0	-	0	0
	NB	Left <sup>(3)</sup>	1,193	231	0	1,193	310	0
Right		748	637	0	748	638	0	
Roan Lane	EB	Left	280	61	0	280	212	0
		Through <sup>(1)</sup>	-	0	0	-	0	0
	WB	Through <sup>(1)</sup>	-	78	0	-	158	0
Right		275	6	0	275	30	0	
Sunrise Drive / Sandtree Drive	EB	Left	375	219	0	375	356	0
		Through <sup>(1)</sup>	-	857	482	-	712	337
		Right	730	80	0	730	191	0
	WB	Left	253	100	0	253	201	0
		Through <sup>(1)</sup>	-	503	250	-	1,054	801
	NB	Left	270	256	0	270	445	175
		Through <sup>(1)</sup>	-	34	0	-	33	0
		Right	150	75	0	150	301	151
	SB	Left	175	226	51	175	154	0
Through <sup>(1)</sup>		-	150	0	-	186	11	

Notes: (1) – Through lane queue compared to left-turn, right-turn, and auxiliary lane lengths to determine if the through lane queue is anticipated to exceed the turn lane length potentially blocking access to the turn lane  
 (2) – Lane operates under free-flow conditions; therefore, no queue forms for this movement  
 (3) – Recommended design storage length

The Keating Drive intersection is not anticipated to experience any queues that exceed the existing turn lane storage lengths during the A.M. or P.M. peak hours. However, the eastbound through queue is anticipated to exceed both the left-turn and right-turn lane lengths at during the A.M. peak hour, potentially blocking access to the turn lanes. Additionally, the eastbound

through, westbound through, and northbound through queues are anticipated to exceed both the left-turn and right-turn lane lengths at each approach during the P.M. peak hour, potentially blocking access to the turn lanes.

The I-95 southbound ramps intersection is not anticipated to have turn lane queues that exceed any of the existing or recommended storage lengths during the A.M. peak hour or P.M. peak hour. However, the eastbound through/auxiliary queue is anticipated to exceed the auxiliary lane storage during the A.M. and P.M. peak hours, potentially resulting in either spillback from the auxiliary lanes or the queue from the through lanes blocking access to the auxiliary lanes.

The I-95 northbound ramps intersection is not anticipated to have peak hour turn lane queues that exceed any of the existing storage lengths during the A.M. peak hour or P.M. peak hour.

The Roan Lane intersection is not anticipated to experience any queues that exceed the existing or recommended turn lane storage lengths during the A.M. peak hour or P.M. peak hour.

The Sunrise Drive / Sandtree Drive intersection is anticipated to experience queues that exceed the existing turn lane length storage for the southbound left-turn movement during the A.M. peak hour and the northbound left-turn and northbound right-turn movements during the P.M. peak hour. Additionally, the eastbound through queue is anticipated to exceed the left-turn lane length during the A.M. peak hour and the left-turn and right-turn lane lengths during the P.M. peak hour, potentially blocking access to the turn lanes. The westbound through queue is anticipated to exceed the left-turn lane length during the A.M. and P.M. peak hours, potentially blocking access to the left-turn lane. The southbound through queue is anticipated to exceed the left-turn lane length during the P.M. peak hour, potentially blocking access to the left-turn lane.

## 10 Design Year (2040) No-Build Conditions Traffic Operational Analysis

### 10.1 Intersection Analysis

Traffic operational and queuing analyses were conducted to evaluate the 2040 No-Build conditions (without roadway improvements) for the I-95 at Northlake Boulevard interchange AOI. The purpose of the 2040 No-Build analysis was to identify anticipated long-term deficiencies and needs at the study intersections. Utilizing the results of these intersection and queuing analyses, recommended roadway improvements and corresponding CDAs could then be developed to address the long-term travel demand at the Northlake Boulevard interchange and adjacent signalized intersections.

A.M. and P.M. peak hour operational analyses were performed for the five study intersections to estimate future delay and LOS. It was assumed that signal timings would be updated to address future deficiencies; therefore, the signal timings were optimized for the No-Build conditions. The Synchro worksheets for the intersections analyses are included in Appendix G. Tables 14 and 15 summarize the results of the operational analyses for the A.M. and P.M. peak hour conditions for the five study intersections.

**Table 14: A.M. Peak Hour Intersection LOS Summary – 2040 No-Build Conditions**

Northlake Boulevard Intersection	Approach LOS				Overall LOS	Overall Delay (seconds per vehicle)
	EB	WB	NB	SB		
Keating Drive	F	C	E	E	E	59.1
I-95 southbound ramps	F	A	-	F	E	80.0
I-95 northbound ramps	A	F	F	-	E	60.4
Roan Lane	A	A	-	-	A	2.8
Sunrise Drive/Sandtree Drive	F	D	F	E	F	83.2

**Table 15: P.M. Peak Hour Intersection LOS Summary – 2040 No-Build Conditions**

Northlake Boulevard Intersection	Approach LOS				Overall LOS	Overall Delay (seconds per vehicle)
	EB	WB	NB	SB		
Keating Drive	F	E	F	E	F	102.2
I-95 southbound ramps	F	A	-	E	D	53.0
I-95 northbound ramps	B	F	E	-	E	78.5
Roan Lane	A	A	-	-	A	1.0
Sunrise Drive/Sandtree Drive	D	F	F	F	F	103.8

The Keating Drive intersection is anticipated to operate at LOS E with an overall delay of 59.1 seconds per vehicle during the A.M. peak hour and at LOS F with an overall delay of 102.2 seconds per vehicle during the P.M. peak hour. During the A.M. peak hour, the eastbound left-turn movement, eastbound through movement, eastbound approach, and westbound left-turn movement are anticipated to operate at LOS F. All other movements and approaches are anticipated to operate at LOS E or better. During the P.M. peak hour, the eastbound left-turn movement, eastbound through movement, eastbound approach, westbound left-turn movement, northbound left-turn movement, northbound left-turn/through movement, northbound right-turn movement, and northbound approach are anticipated to operate at LOS F. All other movements and approaches are anticipated to operate at LOS E or better.

The I-95 southbound ramps intersection is anticipated to operate at LOS E with an overall delay of 80.0 seconds per vehicle during the A.M. peak hour and at LOS D with an overall delay 53.0 seconds per vehicle during the P.M. peak hour. During the A.M. peak hour, the eastbound through movement, eastbound approach, southbound left-turn movement, and southbound

approach are anticipated to operate at LOS F. All other movements and approaches are anticipated to operate at LOS D or better during the A.M. peak hour. During the P.M. peak hour, the eastbound through movement, eastbound approach, and southbound left-turn movement are anticipated to operate at LOS F. All other movements and approaches are anticipated to operate at LOS E or better during the P.M. peak hour.

The I-95 northbound ramps intersection is anticipated to operate at LOS E with an overall delay of 60.4 seconds per vehicle during the A.M. peak hour and at LOS E with an overall delay of 78.5 seconds per vehicle during the P.M. peak hour. During the A.M. peak hour, the westbound through movement, westbound approach, northbound left-turn movement, and northbound approach are anticipated to operate at LOS F. All other movements and approaches are anticipated to operate at LOS E or better during the A.M. peak hour. During the P.M. peak hour, the westbound through movement, westbound approach, and northbound left-turn movement are anticipated to operate at LOS F. All other movements and approaches are anticipated to operate at LOS E or better during the P.M. peak hour.

The Roan Lane intersection is anticipated to operate at LOS A during the A.M. peak hour with 2.8 seconds of delay per vehicle and at LOS A during the P.M. peak hour with 1.0 second of delay per vehicle. During the A.M. peak hour, all movements and approaches are anticipated to operate at LOS E or better. During the P.M. peak hour, the eastbound left-turn movement is anticipated to operate at LOS F; however, all other movements and approaches are anticipated to operate at LOS A. This intersection operates with a partial signal, providing continuous green time for the eastbound through movement and signal control for the eastbound left-turn and westbound through movements. The eastbound left-turn movement is anticipated to operate with a v/c ratio of 0.58 during the P.M. peak hour; therefore, the poor LOS can be attributed to the minimal green time afforded the turning movement (actuated g/C ratio of 0.05) and is not reflective of a capacity issue.

The Sunrise Drive/Sandtree Drive intersection is anticipated to operate at LOS F with an overall delay of 83.2 seconds per vehicle during the A.M. peak hour and at LOS F with an overall delay of 103.8 seconds per vehicle during the P.M. peak hour. During the A.M. peak hour, the eastbound left-turn movement, eastbound through movement, eastbound approach, northbound left-turn movement, northbound approach, and southbound through movement are anticipated to operate at LOS F. All other movements and approaches are anticipated to operate at LOS E or better during the A.M. peak hour. During the P.M. peak hour, all movements and approaches are anticipated to operate at LOS F except for the eastbound through movement, eastbound right-turn movement, eastbound approach, and northbound through movement.

A.M. and P.M. peak hour queuing analysis were performed for the five study intersections to estimate whether existing storage would accommodate anticipated vehicle queues. The Synchro worksheets for the queuing analyses are included in Appendix G. Table 16 summarizes the results of the queuing analyses for the A.M. and P.M. peak hour conditions for the five study intersections.

**Table 16: A.M. and P.M. Peak Hour 95<sup>th</sup> Percentile Queuing Analysis – 2040 No-Build Conditions**

Northlake Boulevard Cross Street	Approach	Movement	AM Peak Hour			PM Peak Hour		
			Existing Storage Per Lane (feet)	95th Percentile Queue Per Lane (feet)	Queue in Excess of Storage Per Lane (feet)	Existing Storage Per Lane (feet)	95th Percentile Queue Per Lane (feet)	Queue in Excess of Storage Per Lane (feet)
Keating Drive	EB	Left	170	66	0	170	237	67
		Through <sup>(1)</sup>	-	1,147	977	-	1,176	1,006
		Right	205	0	0	205	86	0
	WB	Left	490	295	0	490	707	217
		Through <sup>(1)</sup>	-	484	114	-	1,097	727
		Right	370	11	0	370	75	0
	NB	Left	155	122	0	155	424	269
		Through <sup>(1)</sup>	-	115	15	-	427	327
		Right	100	133	33	100	653	553
	SB	Through/Left	-	207	0	-	233	0
Through/Right		375	83	0	375	233	0	
I-95 southbound ramps	EB	Auxiliary	403	714	311	403	653	250
		Through <sup>(1)</sup>	-			-		
		Right	-	-	-	-	-	
	WB	Left	280	0	0	280	0	0
		Through <sup>(1)</sup>	-	9	0	-	8	0
	SB	Left	1,300	898	0	1,300	463	0
Right		433	244	0	433	588	155	
I-95 northbound ramps	EB	Left	280	529	249	280	501	221
		Through <sup>(1)</sup>	-	11	0	-	537	257
	WB	Auxiliary	688	674	0	688	860	172
		Through <sup>(1)</sup>	-			-		
	Right	940	405	0	940	1,438	498	
		NB	Left	1,415	579	0	1,415	563
Right	748		786	38	748	688	0	
Roan Lane	EB	Left	280	60	0	280	65	0
		Through <sup>(1)</sup>	-	0	0	-	0	0
	WB	Through <sup>(1)</sup>	-	386	111	-	38	0
		Right	275	0	0	275	4	0
Sunrise Drive / Sandtree Drive	EB	Left	375	249	0	375	526	151
		Through <sup>(1)</sup>	-	1,578	1,203	-	962	587
		Right	730	241	0	730	251	0
	WB	Left	253	114	0	253	257	4
		Through <sup>(1)</sup>	-	892	639	-	1,526	1,273
	NB	Left	270	369	99	270	508	238
		Through <sup>(1)</sup>	-	30	0	-	33	0
		Right	150	65	0	150	605	455
SB	Left	175	308	133	175	169	0	
	Through <sup>(1)</sup>	-	286	111	-	444	269	

Notes: (1) – Through lane queue compared to left-turn, right-turn, and auxiliary lane lengths to determine if the through lane queue is anticipated to exceed the turn lane length, potentially blocking access to the turn lane

The Keating Drive intersection is anticipated to experience a northbound right-turn lane queue that exceeds the existing turn lane storage length during the A.M. peak hour. Additionally, the eastbound through and westbound through queues are anticipated to exceed both the left-turn and right-turn lane lengths at each approach, respectively, potentially blocking access to the turn lanes. The northbound through queue is also anticipated to exceed the right-turn lane length, potentially blocking access to the right-turn lane. During the P.M. peak hour the anticipated queues for the eastbound left-turn, westbound left-turn, northbound left-turn, and northbound right-turn movements are anticipated to exceed the existing turn lane storage lengths. Additionally, the eastbound through, westbound through, and northbound through movements are anticipated to exceed both the left-turn and right-turn lane lengths at each approach, respectively, potentially blocking access to the turn lanes.

The I-95 southbound ramps intersection is not anticipated to have turn lane queues that exceed any of the existing storage lengths, except the southbound right-turn lane during the P.M. peak hour. However, the eastbound through/auxiliary queue is anticipated to exceed the auxiliary lane storage during the A.M. and P.M. peak hours, potentially resulting in either spillback from the auxiliary lanes or the queue from the through lanes blocking access to the auxiliary lanes.

The I-95 northbound ramps intersection is anticipated to have eastbound left-turn and northbound right-turn queues that exceed the existing turn lane storage lengths during the A.M. peak hour. During the P.M. peak hour, the anticipated queues for the eastbound left-turn and westbound right-turn movements are anticipated to exceed the existing turn lane storage lengths. Additionally, the eastbound through queue is anticipated to exceed the left-turn lane length during the P.M. peak hour, potentially resulting in either spillback from the left-turn lane or the queue from the through lane blocking access to the left-turn lane. The westbound through/auxiliary queue is anticipated to exceed the auxiliary lane storage during the P.M. peak hour, potentially resulting in either spillback from the left-turn lane and auxiliary lanes or the queue from the through lanes blocking access to the auxiliary lanes.

The Roan Lane intersection is not anticipated to experience any queues that exceed the existing turn lane storage lengths during the A.M. or P.M. peak hours. However, the westbound through queue is anticipated to exceed the right-turn lane length during the A.M. peak hour, potentially blocking access to the turn lane.

The Sunrise Drive/Sandtree Drive intersection is anticipated to experience queues that exceed the existing turn lane length storage for the northbound left-turn and southbound right-turn movements during the A.M. peak hour, and eastbound left-turn, westbound left-turn, northbound left-turn, and northbound right-turn movements during the P.M. peak hour. Additionally, the eastbound through queue is anticipated to exceed the left-turn and right-turn lane lengths during the A.M. and P.M. peak hours, potentially blocking access to the turn lanes. The westbound through and southbound through queues are anticipated to exceed the left-turn lane lengths at each approach during the A.M. and P.M. peak hours, potentially blocking access to the turn lanes.

## 10.2 Ramps Analysis

Merge and diverge ramps analyses will be conducted as part of the overall I-95 mainline analysis in order to account for the effects of upstream and downstream ramps at the adjacent intersections.

## 10.3 Projected 2040 Operational Deficiencies

As previously stated, the purpose of this study is to identify short-term and long-term needs within the I-95 at Northlake Boulevard interchange AOI and develop design concepts to address existing and/or potential future operational deficiencies. The I-95 ramps intersections were considered to be deficient at LOS E, the adjacent signalized intersections were considered to be deficient at LOS F, and the movements and approaches for all intersections were considered deficient at LOS F. The 2040 No-Build analysis identified the following deficiencies at the study intersections along Northlake Boulevard.

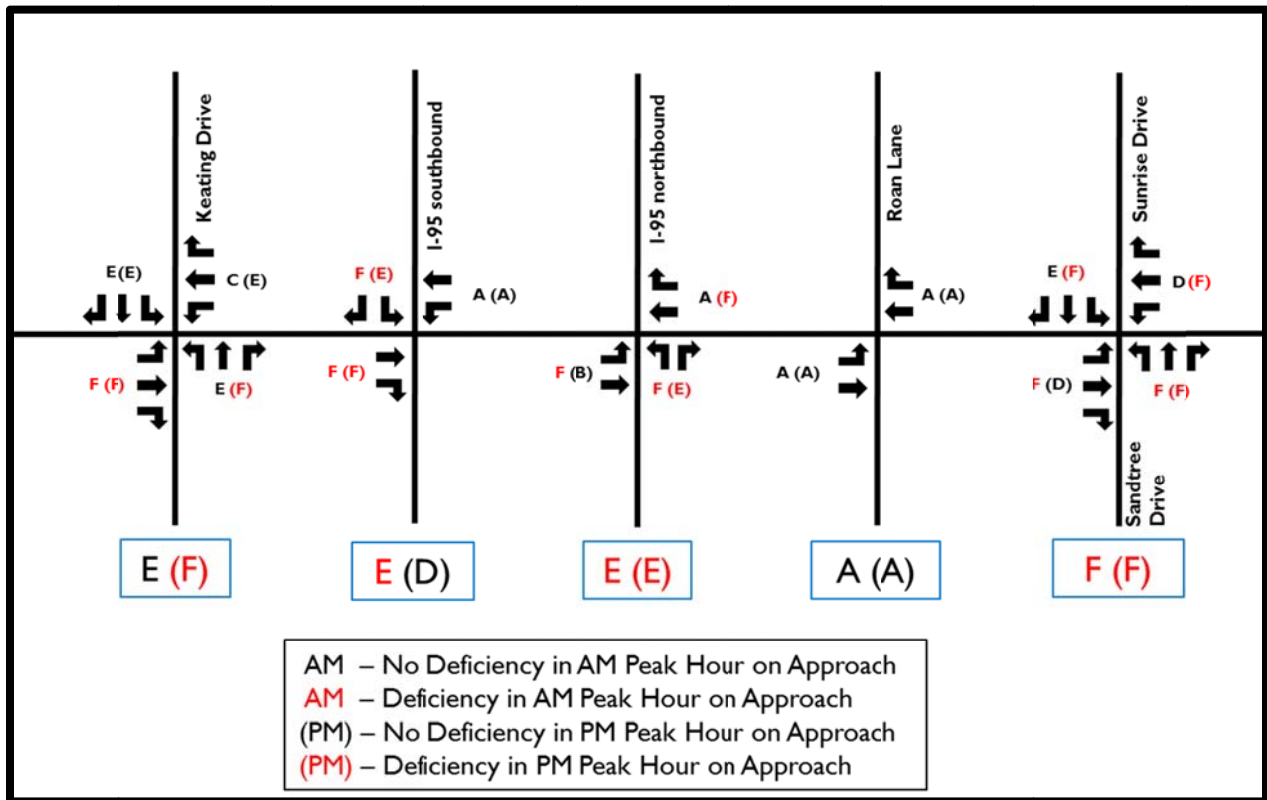
- Keating Drive
  - Overall intersection during the P.M. peak hour
  - Eastbound left-turn movement during the A.M. and P.M. peak hours
  - Eastbound through movement during the A.M. and P.M. peak hours
  - Eastbound approach during the A.M. and P.M. peak hours
  - Eastbound left-turn queue anticipated to exceed storage during the P.M. peak hour
  - Eastbound through queue anticipated to exceed the left-turn and right-turn lanes storage during the A.M. and P.M. peak hours
  - Westbound left-turn movement during the A.M. and P.M. peak hours
  - Westbound left-turn queue anticipated to exceed storage during the P.M. peak hour
  - Westbound through queue anticipated to exceed the left-turn and right-turn lane storage during the A.M. and P.M. peak hours
  - Northbound left-turn movement during the P.M. peak hour
  - Northbound through/left-turn movement during the P.M. peak hour
  - Northbound right-turn movement during the P.M. peak hour
  - Northbound approach during the P.M. peak hour
  - Northbound left-turn queue anticipated to exceed storage during the P.M. peak hour
  - Northbound through queue anticipated to exceed the right-turn lane storage during the A.M. peak hour
  - Northbound through queue anticipated to exceed the left-turn and right-turn lane storage during the P.M. peak hour
  - Northbound right-turn queue anticipated to exceed storage during the A.M. and P.M. peak hours
- I-95 southbound ramps
  - Overall intersection during the A.M. peak hour
  - Eastbound through movement during the A.M. and P.M. peak hours
  - Eastbound approach during the A.M. and P.M. peak hours
  - Eastbound through/auxiliary queue anticipated to exceed auxiliary lanes storage during the A.M. and P.M. peak hours
  - Southbound left-turn movement during the A.M. and P.M. peak hours

- Southbound approach during the A.M. and P.M. peak hours
- Southbound right-turn queue anticipated to exceed storage during the P.M. peak hour
- I-95 northbound ramps
  - Overall intersection during the A.M. and P.M. peak hours
  - Eastbound left-turn queue anticipated to exceed storage during the A.M. and P.M. peak hours
  - Eastbound through queue anticipated to exceed left-turn lane storage during the P.M. peak hour
  - Westbound through/auxiliary queue anticipated to exceed auxiliary lanes storage during the P.M. peak hour
  - Westbound through movement during the A.M. and P.M. peak hours
  - Westbound approach during the A.M. and P.M. peak hours
  - Westbound right-turn queue anticipated to exceed storage during the P.M. peak hour
  - Northbound left-turn movement during the A.M. and P.M. peak hours
  - Northbound approach during the A.M. and P.M. peak hours
  - Northbound right-turn queue anticipated to exceed storage during the A.M. peak hour
- Roan Lane
  - Eastbound left-turn movement during the P.M. peak hour
  - Westbound through queue anticipated to exceed right-turn lane storage during the A.M. peak hour
- Sunrise Drive/Sandtree Drive
  - Overall intersection during the A.M. and P.M. peak hours
  - Eastbound left-turn movement during the A.M. and P.M. peak hours
  - Eastbound through movement during the A.M. peak hour
  - Eastbound approach during the A.M. peak hour
  - Eastbound left-turn queue anticipated to exceed storage during the P.M. peak hour
  - Eastbound through queue anticipated to exceed left-turn and right-turn lane storage during the A.M. and P.M. peak hours
  - Westbound left-turn movement during the P.M. peak hour
  - Westbound through movement during the P.M. peak hour
  - Westbound approach during the P.M. peak hour
  - Westbound left-turn queue anticipated to exceed storage during the P.M. peak hour
  - Westbound through queue anticipated to exceed left-turn lane storage during the A.M. and P.M. peak hours
  - Northbound left-turn movement during the A.M. and P.M. peak hours
  - Northbound right-turn movement during the P.M. peak hour
  - Northbound approach during the A.M. and P.M. peak hours
  - Northbound left-turn queue anticipated to exceed storage during the A.M. and P.M. peak hours
  - Northbound right-turn queue anticipated to exceed storage during the P.M. peak hour
  - Southbound left-turn during the P.M. peak hour

- Southbound through movement during the A.M. and P.M. peak hours
- Southbound approach during the P.M. peak hour
- Southbound left-turn queue anticipated to exceed storage during the A.M. peak hour
- Southbound through queue anticipated to exceed left-turn lane storage during the A.M. and P.M. peak hours

Figure 17 illustrates the projected 2040 deficiencies by approach for the I-95 at Northlake Boulevard interchange AOI.

**Figure 17: Northlake Boulevard – Projected 2040 Deficiencies by Intersection Approaches**



## 11 Conceptual Design Alternative Evaluation

### 11.1 Conceptual Design Alternatives

Conceptual design alternatives (CDAs) were developed and evaluated to determine the most viable alternative that considers practical design and the optimum Benefit to Cost (B/C) ratio without compromising overall traffic operations and safety for the interchange. CDAs were evaluated for horizontal geometry; typical section; constructability; impacts on structures, drainage, signing, utilities, adjoining side street connections and signalized intersections; opportunities for the integration of multimodal systems; utilization of ITS applications; and consideration for SIS connectors. The CDA along with its typical sections are included in Appendix I.

The following table shows considerations from the roadway design perspective for recommended improvements.

**Table 17: 2040 Recommended Improvements**

<b>Recommended Improvements Based on Traffic Operations Analysis</b>	<b>Roadway Design Considerations</b>
<p>Widen I-95 northbound off-ramp left-turn movement to provide triple (3) left-turn lanes (Previously recommended for 2020)</p>	<ul style="list-style-type: none"> <li>• Widen ramp to inside to accommodate triple (3) left-turn lanes</li> <li>• Additional lane design length: 750'</li> <li>• Adequate receiving throat is provided on Northlake Boulevard (added a fourth westbound through lane) under I-95 bridge to receive triple (3) left-turn lanes. I-95 bridge structure is to remain</li> </ul>
<p>Widen I-95 northbound on-ramp to accommodate free-flow westbound to northbound right-turn (Previously recommended for 2020)</p>	<ul style="list-style-type: none"> <li>• Widen ramp to inside and outside to accommodate an additional outside lane</li> <li>• Provide two-lane ramp entering I-95 mainline</li> <li>• Widen northbound I-95 to receive an additional auxiliary lane</li> </ul>
<p>Widen I-95 southbound off-ramp to provide quadruple (4) left-turn lanes (Triple left turn lanes previously recommended for 2020)</p>	<ul style="list-style-type: none"> <li>• Widening of ramp to the inside to accommodate quadruple (4) left-turn lanes</li> <li>• Additional lane design length: 800' total for two (2) lanes</li> <li>• Provide 60-foot receiving throat width on eastbound Northlake Boulevard under I-95 bridge to receive quadruple (4) left-turn lanes. At the receiving throat, widen Northlake Boulevard to four 14-foot through lanes; reduce the width of eastbound dual (2) left-turn lanes to 10 feet per lane. The 60-foot receiving throat includes the 4-foot undesignated bike lane. I-95 bridge structure is to remain</li> </ul>

<p>Add a second westbound left-turn lane at the Northlake Boulevard and Keating Drive intersection (Previously recommended for 2020)</p>	<ul style="list-style-type: none"> <li>• Shift the median to the south to accommodate dual (2) left-turn lanes</li> <li>• Additional lane design length: 440'</li> <li>• Widen Gardens Towne Square driveway to west to accommodate receiving throat for dual (2) left-turn lanes from Northlake Boulevard</li> <li>• Modify signal heads to accommodate the proposed lane geometry</li> </ul>
<p>Widen Northlake Boulevard to provide additional through lane in each direction from Military Trail to MacArthur Boulevard</p>	<ul style="list-style-type: none"> <li>• Maintain existing I-95 bridge structure</li> <li>• Roadway widening will require right-of-way acquisition adjacent to Northlake Blvd. on both sides</li> <li>• Additional westbound through lane becomes a drop right-turn lane at N Military Trail</li> <li>• Existing dedicated right-turn lanes were utilized to provide the fourth through lane at the eastbound and westbound approaches to the intersections within the widened segment. However, dedicated right-turn lanes will be maintained on the eastbound approach to the I-95 southbound ramps eastbound approach, I-95 northbound ramps westbound approach, and Sandtree Drive eastbound approach</li> <li>• Additional eastbound through lane becomes a drop right-turn lane at MacArthur Boulevard</li> <li>• Existing span wire signal at Military Trail will be replaced by mast arm</li> <li>• Existing mast arm signals at Keating Drive, I-95 southbound ramps, I-95 northbound ramps, and Sandtree/Sunrise Drive will be replaced</li> </ul>

<p>Build retention pond to account for additional impervious area (Previously recommended for 2020)</p>	<ul style="list-style-type: none"> <li>Retention pond site will require right-of-way acquisition adjacent to I-95 northbound on-ramp</li> </ul>
<p>Replace/modify all affected existing overhead sign structures (Previously recommended for 2020)</p>	<ul style="list-style-type: none"> <li>As required to provide positive guidance to motorists</li> </ul>
<p>Construct all affected sidewalk crossings per ADA standards (Previously recommended for 2020)</p>	<ul style="list-style-type: none"> <li>Maintain ADA compliance for all sidewalk crossings</li> </ul>
<p>Restripe northbound approach of Gardens Towne Square (Keating Drive) to provide one (1) left-turn lane, one (1) through lane, and one (1) right-turn lane</p>	<ul style="list-style-type: none"> <li>Modify the signal heads and phasing to accommodate the proposed lane geometry and a right-turn overlap</li> </ul>
<p>Add a second eastbound left-turn lane at the Northlake Boulevard and Sunrise Drive/Sandtree Drive intersection</p>	<ul style="list-style-type: none"> <li>Widen Sunrise Drive to west to accommodate receiving throat for dual (2) left-turn lanes from Northlake Boulevard and dedicated right onto Northlake Boulevard</li> <li>Additional lane design length: 350'</li> <li>Roadway widening will require right-of-way acquisition on Sunrise Drive</li> </ul>
<p>Provide southbound dedicated right-turn lane on Sunrise Drive at Northlake Boulevard intersection</p>	<ul style="list-style-type: none"> <li>Widen Sunrise Drive to west to accommodate receiving throat for dual (2) left-turn lanes from Northlake Boulevard and dedicated right onto Northlake Boulevard</li> <li>Additional lane design length: 150'</li> <li>Roadway widening will require right-of-way acquisition on Sunrise Drive</li> </ul>

## 11.2 Considered Alternatives

As part of the Design Year (2040) analysis, multiple design alternatives were considered prior to the recommendation of the preferred alternative. The non-preferred alternatives were eliminated from consideration due to traffic operation, safety, and/or geometric design deficiencies/concerns. A list of considered alternatives and noted deficiencies/concerns is provided in Table 18 below.

**Table 18: Considered Alternatives**

Considered Alternative	Deficiencies/Concerns
Single Point Urban Interchange (SPUI)	<ul style="list-style-type: none"> <li>The current I-95 bridge utilizes piers within the median along Northlake Boulevard. In order to construct a SPUI, a new single span bridge without piers would be required across Northlake Boulevard. The new bridge would require a thicker depth to accommodate the span without piers which would raise the elevation of I-95 at the bridge and subsequently require reconstruction of the northbound and southbound approaches along I-95 to match the new bridge elevation.</li> </ul>
Multi-level design with flyover ramps for either the I-95 northbound and southbound off-ramps or I-95 northbound and southbound on-ramps	<ul style="list-style-type: none"> <li>Due to the close proximity of Keating Drive to the west and Roan Lane to the east, flyover ramps cannot be lowered to grade with sufficient distance from the adjacent signals to allow merging/weaving with eastbound-westbound Northlake Boulevard traffic.</li> </ul>

## 11.3 Maintenance of Traffic

No construction work is proposed on the I-95 mainline bridge. Northbound I-95 mainline is proposed to be shifted to the west (by temporarily eliminating the gap between the HOV lane and the general purpose lanes) to accommodate the construction of additional northbound on-ramp acceleration lane. Existing vehicular and pedestrian traffic can be accommodated during the construction of proposed improvements along Northlake Boulevard including its intersecting

side streets. Advance coordination should be conducted with impacted utilities owners and agencies for any utility relocation, including Palm Beach County for signal infrastructure relocation and replacements. Coordination with these agencies will be critical for successful transportation management during construction.

## 12 Design Year (2040) Build Conditions Traffic Operational Analysis (With Improvements)

### 12.1 Build Conditions (With Improvements)

Traffic operational analyses were conducted to evaluate the 2040 future conditions (with improvements) for the I-95 at Northlake Boulevard interchange and adjacent signalized intersections. A.M. and P.M. peak hour operational analyses were performed for the five study intersections to determine the anticipated future delay and LOS. The Synchro worksheets for the intersections analyses are included in Appendix G. Tables 19 and 20 summarize the results of the operational analyses for the A.M. and P.M. peak hours at the five intersections. Tables 21 and 22 provide a summary of the reduction in delay anticipated in 2040 with the implementation of the recommended improvements.

**Table 19: A.M. Peak Hour Intersection LOS Summary – 2040 Build Conditions**

Northlake Boulevard Intersection	Approach LOS				Overall LOS	Overall Delay (seconds per vehicle)
	EB	WB	NB	SB		
Keating Drive	C	B	F	E	C	26.6
I-95 southbound ramps	D	A	-	E	D	38.0
I-95 northbound ramps	A	D	E	-	C	31.4
Roan Lane	A	A	-	-	A	3.5
Sunrise Drive/Sandtree Drive	C	C	E	E	C	33.9

**Table 20: P.M. Peak Hour Intersection LOS Summary – 2040 Build Conditions**

Northlake Boulevard Intersection	Approach LOS				Overall LOS	Overall Delay (seconds per vehicle)
	EB	WB	NB	SB		
Keating Drive	E	D	F	E	E	58.7
I-95 southbound ramps	D	A	-	E	C	31.9
I-95 northbound ramps	A	D	E	-	C	32.4
Roan Lane	A	A	-	-	A	1.7
Sunrise Drive/Sandtree Drive	D	D	E	E	D	45.6

**Table 21: 2040 A.M. Peak Hour Intersection Operational Benefit Summary**

Northlake Boulevard Intersection	Overall Delay (seconds per vehicle)		
	2040 No-Build	2040 Build	Change in Delay
Keating Drive	59.1	26.6	- 32.5
I-95 southbound ramps	80.0	38.0	- 42.0
I-95 northbound ramps	60.4	31.4	- 29.0
Roan Lane	2.8	3.5	+ 0.7
Sunrise Drive/Sandtree Drive	83.2	33.9	- 49.3

**Table 22: 2040 P.M. Peak Hour Intersection Operational Benefit Summary**

Northlake Boulevard Intersection	Overall Delay (seconds per vehicle)		
	2040 No-Build	2040 Build	Change in Delay
Keating Drive	102.2	58.7	- 43.5
I-95 southbound ramps	53.0	31.9	- 21.1
I-95 northbound ramps	78.5	32.4	- 46.1
Roan Lane	1.0	1.7	+ 0.7
Sunrise Drive/Sandtree Drive	103.8	45.6	- 58.2

The Keating Drive intersection is anticipated to operate at LOS C with an overall delay of 26.6 seconds per vehicle during the A.M. peak hour and at LOS E with an overall delay of 58.7 seconds per vehicle during the P.M. peak hour. During the A.M. peak hour, the eastbound left-turn, northbound left-turn, and northbound through movements, and northbound approach are anticipated to operate at LOS F. All other movements are anticipated to operate at LOS E or better. During the P.M. peak hour the eastbound left-turn and northbound left-turn movements and northbound approach are anticipated to operate at LOS F. However, all movements with the exception of the northbound left-turn movement during the A.M. and P.M. peak hours are anticipated to operate with a v/c ratio of less than 1.0. The recommended improvements are anticipated to reduce the overall average delay by 32.5 seconds per vehicle during the A.M. peak hour and 43.5 seconds per vehicle during the P.M. peak hour.

The I-95 southbound ramps intersection is anticipated to operate at LOS D with an overall delay of 38.0 seconds per vehicle during the A.M. peak hour and at LOS C with an overall delay 31.9 seconds per vehicle during the P.M. peak hour. All movements and approaches are anticipated to operate at LOS E or better during the A.M. and P.M. peak hours, except for the southbound left-turn movement. However, the southbound left-turn movement is anticipated to operate with a v/c ratio of less than 1.0. The recommended improvements are anticipated to reduce the overall average delay by 42.0 seconds per vehicle during the A.M. peak hour and 21.1 seconds per vehicle during the P.M. peak hour. In particular, the delay for the southbound off-ramp approach is anticipated to be reduced from 158.9 seconds per vehicle to 77.9 seconds per vehicle (81.0 seconds per vehicle reduction) during the A.M. peak hour.

The I-95 northbound ramps intersection is anticipated to operate at LOS C with an overall delay of 31.4 seconds per vehicle during the A.M. peak hour and at LOS C with an overall delay of 32.4 seconds per vehicle during the P.M. peak hour. All movements and approaches are anticipated to operate at LOS E or better during the A.M. and P.M. peak hours, except for the northbound left-turn movement during the P.M. peak hour. Although the northbound left-turn movement is anticipated to operate at LOS F, the v/c ratio is anticipated to be less than 1.0. The recommended improvements are anticipated to reduce the delay by 29.0 seconds per vehicle during the A.M. peak hour and 46.1 seconds per vehicle during the P.M. peak hour. In particular, the delay for the northbound off-ramp approach is anticipated to be reduced from 91.8 seconds per vehicle to 63.9 seconds per vehicle (27.9 seconds per vehicle reduction) during the A.M. peak hour.

The Roan Lane intersection is anticipated to operate at LOS A with an overall delay of 3.5 seconds per vehicle during the A.M. peak hour and at LOS A with an overall delay of 1.7 seconds per vehicle during the P.M. peak hour. All movements and approaches are anticipated to operate at LOS E or better during the A.M. and P.M. peak hours, except for the eastbound left-turn movement during the P.M. peak hour. Although the eastbound left-turn movement is anticipated to operate at LOS F, the v/c ratio is anticipated to be less than 1.0. The recommended improvements are not anticipated to significantly affect the delay at the intersection.

The Sunrise Drive/Sandtree Drive intersection is anticipated to operate at LOS C with an overall delay of 33.9 seconds per vehicle during the A.M. peak hour and at LOS D with an overall delay

of 45.6 seconds per vehicle during the P.M. peak hour. All movements and approaches are anticipated to operate at LOS E or better during the A.M. peak hour, except the eastbound left-turn, westbound left-turn, and northbound through movements which are anticipated to operate at LOS F. However, all movements are anticipated to operate with a v/c ratio less than 1.0 during the A.M. peak hour. All movements and approaches are anticipated to operate at LOS E or better during the P.M. peak hour, except the eastbound left-turn and southbound through movements. However, all movements are anticipated to operate with a v/c ratio less than 1.0 during the P.M. peak hour. The recommended improvements are anticipated to reduce the overall average delay by 49.3 seconds per vehicle during the A.M. peak hour and 58.2 seconds per vehicle during the P.M. peak hour.

A.M. and P.M. peak hour queuing analysis were performed for the five study intersections to estimate whether existing and/or recommended storage would accommodate anticipated vehicle queues. The Synchro worksheets for the queuing analyses are included in Appendix G. Table 23 summarizes the results of the queuing analyses for the A.M. and P.M. peak hour conditions for the five study intersections.

**Table 23: A.M. and P.M. Peak Hour 95<sup>th</sup> Percentile Queuing Analysis – 2040 Build Conditions**

Northlake Boulevard Cross Street	Approach	Movement	AM Peak Hour			PM Peak Hour		
			Existing/ Recommended Storage Per Lane (feet)	95th Percentile Queue Per Lane (feet)	Queue in Excess of Storage Per Lane (feet)	Existing/ Recommended Storage Per Lane (feet)	95th Percentile Queue Per Lane (feet)	Queue in Excess of Storage Per Lane (feet)
Keating Drive	EB	Left	170	72	0	170	161	0
		Through <sup>(1)</sup>	-	678	508	-	909	739
	WB	Left <sup>(3)</sup>	465	110	0	465	246	0
		Through <sup>(1)</sup>	-	328	0	-	853	388
	NB	Left <sup>(3)</sup>	250	273	23	250	634	384
		Through <sup>(1)</sup>	-	35	0	-	99	0
		Right <sup>(2)</sup>	-	156	0	-	475	0
	SB	Left	375	238	0	375	324	0
Through <sup>(1)</sup>		-	98	0	-	210	0	
I-95 southbound ramps	EB	Auxiliary	403	587	184	403	620	217
		Through <sup>(1)</sup>	-			-		
		Right <sup>(2)</sup>	-			-		
	WB	Left	280	0	-	280	0	-
		Through <sup>(1)</sup>	-	2	0	-	10	0
	SB	Left <sup>(3)</sup>	850	358	0	850	234	0
Right		433	254	0	433	555	122	
I-95 northbound ramps	EB	Left	280	637	357	280	0	0
		Through <sup>(1)</sup>	-	73	0	-	1	0
	WB	Auxiliary	688	262	0	688	650	0
		Through <sup>(1)</sup>	-			-		
		Right <sup>(2)</sup>	-			808		
	NB	Left <sup>(3)</sup>	1,193	338	0	1,193	354	0
Right		748	717	0	748	696	0	
Roan Lane	EB	Left	280	63	0	280	78	0
		Through <sup>(1)</sup>	-	0	0	-	0	0
	WB	Through <sup>(1)</sup>	-	282	-	-	203	-
		Right	-	0	-	-	0	-
Sunrise Drive / Sandtree Drive	EB	Left <sup>(3)</sup>	350	123	0	350	169	0
		Through <sup>(1)</sup>	-	900	550	-	720	370
		Right	730	153	0	730	237	0
	WB	Left	253	117	0	253	207	0
		Through <sup>(1)</sup>	-	438	185	-	968	715
	NB	Left	270	274	4	270	337	67
		Through <sup>(1)</sup>	-	35	0	-	33	0
		Right	150	66	0	150	366	216
	SB	Left	175	252	77	175	168	0
		Through <sup>(1)</sup>	-	77	0	-	77	0
Right <sup>(3)</sup>		150	245	95	150	278	128	

Notes: (1) – Through lane queue compared to left-turn, right-turn, and auxiliary lane lengths to determine if the through lane queue is anticipated to exceed the turn lane length potentially blocking access to the turn lane  
 (2) – Lane operates under free-flow conditions; therefore, no queue forms for this movement  
 (3) – Recommended design storage length

The Keating Drive intersection is anticipated to experience queues that exceed the existing turn lane storage length for the northbound left-turn lane during the A.M. and P.M. peak hours. The northbound left-turn lanes have been designed with the maximum allowable storage length

within the geometric restrictions of the shopping center parking area. Additionally, the eastbound through queue is anticipated to exceed the left-turn lane length, potentially blocking access to the turn lane during the both peak hours. The eastbound left-turn lane abuts a westbound left-turn lane at the adjacent intersection and cannot be extended. The westbound through queue is anticipated to exceed the left-turn length during the P.M. peak hour, potentially blocking access to the turn lane. The westbound left-turn lanes abut the I-95 southbound ramps median opening and cannot be extended.

The I-95 southbound ramps intersection is anticipated to have turn lane queues that exceed the existing storage length for the southbound right-turn lane during the P.M. peak hour, although sufficient storage length along the length of the outside off-ramp lane is anticipated to be available such that queuing should not affect the left-turning traffic. Additionally, the eastbound through/auxiliary queue is anticipated to exceed the auxiliary lane storage during the A.M. and P.M. peak hours, potentially resulting in either spillback from the auxiliary lanes or the queue from the through lanes blocking access to the auxiliary lanes. The eastbound auxiliary lanes have been designed to fully utilize the space available within the median and cannot be extended.

The I-95 northbound ramps intersection is anticipated to have turn lane queues that exceed the existing storage length for the eastbound left-turn lane during the A.M. peak hour. However, the signal timing is programmed to clear all queuing between the southbound and northbound ramps intersections; therefore, the eastbound left-turn queue will be accommodated within the eastbound auxiliary lanes at the I-95 southbound ramps. The left-turn queue is anticipated to exceed the auxiliary lane storage, potentially resulting in spillback from the auxiliary lanes. The eastbound auxiliary lanes have been designed to fully utilize the space available within the median and cannot be extended.

The Roan Lane intersection is not anticipated to experience any queues that exceed the existing turn lane storage lengths during the A.M. peak hour or P.M. peak hour.

The Sunrise Drive/Sandtree Drive intersection is anticipated to experience queues that exceed the existing turn lane length storage for the northbound left-turn, southbound left-turn, and southbound right-turn movements during the A.M. peak hour, and the northbound left-turn, northbound right-turn, and southbound right-turn movements during the P.M. peak hour. The northbound left-turn lane abuts a shift in the southbound through lanes and cannot be extended. The northbound right-turn lane abuts a driveway and cannot be extended. Additionally, the eastbound through queue is anticipated to exceed the left-turn and right-turn lane lengths during the A.M. peak hour and the left-turn lane length during the P.M. peak hour, potentially blocking access to the turn lanes. The eastbound left-turn lane has been designed to abut the auxiliary lanes at the I-95 northbound ramps and cannot be extended. The eastbound right-turn lane extends back through Roan Lane to the channelized right-turn lanes at the I-95 northbound off-ramp and cannot be extended without impacting the required spacing from the channelized right-turn lanes. The westbound through queue is anticipated to exceed the left-turn lane length during the A.M. and P.M. peak hours, potentially blocking access to the left-turn lane. The westbound left-turn lanes abut an eastbound left-turn lane for the adjacent intersection and cannot be extended.

## 13 Other Considerations/Improvements

### 13.1 Intelligent Transportation Systems (ITS) Applications

A DMS is provided along I-95 northbound, north of the Northlake Boulevard interchange; however, a DMS is not provided along I-95 southbound within the vicinity of Northlake Boulevard. Additionally, ADMS are not currently provided along Northlake Boulevard in the vicinity of the I-95 interchange. Installation of DMS along I-95 southbound and ADMS along Northlake Boulevard should be considered to inform drivers of traffic conditions in the area.

The programmed adaptive signal control system implementation could benefit the Northlake Boulevard corridor, particularly during off-peak hours when the signalized intersections are not approaching their capacity.

### 13.2 Transit and Other Mode Improvements

Sidewalk and crosswalks are provided along both sides of Northlake Boulevard within the vicinity of the interchange. All affected sub-standard curb ramps and sidewalk crossings should be constructed per ADA standards, including transit accessible landing pads for transit stops. Final design coordination is required with transit authority/agency (e.g. Palm Tran) on the disposition of impacted bus stops and bus bays.

Bicycle lanes are provided along Northlake Boulevard within the interchange AOI; however, the bicycle lanes do not extend west of Keating Drive or east of Sunrise Drive/Sandtree Drive. The recommended design for the widening of Northlake Boulevard includes designated bicycle lanes. The recommended bicycle lanes west of Keating Drive to Military Trail will connect to existing bicycle lanes west of Military Trail. Designated bicycle lanes along Northlake Boulevard should be considered east of the MacArthur Boulevard intersection, the eastern limit of the recommended widening, to provide consistent bicycle facilities.

Bus service is currently provided along Northlake Boulevard between Prosperity Farms Road and Military Trail, including the AOI, via Palm Tran Route 20. Because bus service is currently provided, no further bus service improvements are recommended.

## 13.3 Potential Environmental Impacts

### 13.3.1 Socio-Cultural Features

Based on a review of available information and site reconnaissance conducted on January 9, 2014, there is one State Historic Preservation Officer (SHPO) Resource Group (Military Trail (PB13795)) within 300 feet of the proposed Northlake Blvd improvements. Military Trail has not been evaluated by SHPO. There are also two (2) parks (Lake Catherine Park and Lake Catherine Sports Complex) within 2,000 feet of the proposed Northlake Blvd improvements and a place of worship (Covenant Centre International) adjacent to the northbound on-ramp to I-95. The recommended CDA proposes to construct a stormwater pond on an undeveloped parcel partially owned by the Covenant Centre International.

The area falls within three U.S. Census tracts (9.02, 9.03 and 10.04) that are predominantly ( $\geq 60\%$ ) comprised of white households, with the remaining households being Hispanic (11-17%), Black or African American (6-18%), or some other ethnicity (2-5%). Also, the households in Census tracts 9.02, 9.03, and 10.04 have median household incomes of \$72,379, \$42,457 and \$42,304, respectively (U.S. Census Bureau Table P9 and S1901). Thus, the areas are not considered minority or low income communities.

### 13.3.2 Potential Relocation Impact Areas

The proposed I-95 at Northlake Boulevard improvements will require additional right-of-way along the northern and southern portions of Northlake Blvd, both east and west of the existing I-95 interchange. Based on the CDA, Northlake Boulevard will be widened to accommodate both eastbound and westbound through lanes, turning lanes, bicycle lanes, sidewalks, and curb and gutter. Additionally, the southbound Sunrise Drive approach to Northlake Boulevard is proposed to be widened to the west to accommodate a dedicated right-turn lane as well as an additional northbound receiving lane. These improvements will result in acquisition of new right-of-way that has the potential to impact approximately 19 commercial businesses located west of the interchange between Military Trail and I-95, and approximately ten (10) commercial businesses east of the interchange between MacArthur Boulevard and I-95. Of these businesses, a gas station located at the northeast corner of the Military Trail at Northlake Boulevard intersection and a McDonald's located at the northwest corner of the Sunrise Drive/Sandtree Drive at Northlake Boulevard intersection are the only businesses likely to require relocation.

### 13.3.3 Hazardous Material and Contamination Impacts

Based on a review of the Florida Department of Environmental Protection (FDEP) GIS data, the FDEP contamination locator map, FDEP OCULUS database, and limited site reconnaissance conducted on January 9, 2014, several potential hazardous material sites were identified within the vicinity of the I-95 and Northlake Blvd Interchange.

There are 29 potential storage tank contamination monitoring (STCM) sites, three dry cleaning solvents cleanup sites, one open waste cleanup (responsible party) site, and four small quantity generators, documented by the FDEP Division of Waste Management, and 170 State Underground Environmental Response Act (SUPER Act) monitoring and risk sites documented by the Florida Department of Health within 0.25 miles of the proposed I-95/Northlake Blvd interchange improvements. The recommended CDA proposes impacts to 29 commercial businesses, of which four (4) are gas stations. These gas stations are located at the northeast corner of the Military Trail/Northlake Blvd intersection, the northwest corner of the Keating Drive/Northlake Blvd intersection, immediately west of the I-95 southbound off-ramp, and immediately east of the I-95 northbound on-ramp respectively. Based on the FDEP contamination locator map and associated OCULUS database files, the four gas stations have documented discharges within the STCM program that have ongoing cleanup activities. Additional file review or field reconnaissance would be required to determine the potential and severity of hazardous material and contamination impacts.

### 13.3.4 Natural Resources Features

Based on a review of available information and site reconnaissance conducted on January 9, 2014, several natural resource features were identified within the vicinity of the I-95 and Northlake Blvd Interchange.

#### (1.) Wetlands/Surface Waters

There are surface waters within the vicinity of the proposed I-95/Northlake Blvd interchange improvements. The project area crosses an unnamed drainage canal located approximately 3,000 feet north of Northlake Blvd that runs perpendicular to I-95 and connects to Lake Catherine and eventually the South Florida Water Management District (SFWMD) C-17 Canal to the east of the interchange. Also, there are two stormwater retention ponds and one dry detention pond adjacent to the project corridor. One retention pond lies north of Northlake Blvd within a commercial development that is approximately 0.25 miles east of Military Trail and the other retention pond is adjacent (east) to the I-95 northbound off-ramp. The dry detention pond is along the eastbound lane of Northlake Blvd approximately 300 feet east of Military Trail. The C-17 Canal and stormwater ponds near the proposed improvements will not be impacted. However, the unnamed canal connecting to the SFWMD C-17 Canal has the potential to be impacted by the proposed improvements, which include widening of the I-95 northbound on-ramp as well as construction of an adjacent retaining wall. Both of these improvements cross the canal.

#### (2.) Threatened and Endangered Species

The interchange is within USFWS Consultation Areas for the Florida scrub-jay (*Aphelocoma coerulescens*) and within the USFWS core foraging area (CFA) of one wood stork (*Mycteria americana*) colony: 619220 PBC SWA. Also, one least tern (*Sternula antillarum*) and one black skimmer (*Rynchops niger*) were documented in the southeast quadrant of the interchange in 2000. There is no habitat for either species, however, in the project area. Least terns are known to nest on tar and gravel roofs and on spoil piles left exposed during construction. Either of which may be the case for this species. Impacts to these species from the improvements are not anticipated. Portions of the SFWMD C-17 Canal and Lake Catherine have been designated by the USFWS as critical habitat for the West Indian manatee. However, the proposed improvements do not impact the C-17 Canal or Lake Catherine and, according to the Comprehensive Everglades Restoration Plan (CERP) Manatee Canal Access Map for West Palm Beach and the CERP West Palm Beach Structure Accessibility list, these water bodies are not accessible to manatees due to SFWMD weir structure S44 to the east. No impacts to listed species or their habitats are anticipated.

### (3.) Soils

According to the Natural Resources Conservation Service (NRCS), soil types located within the proposed interchange improvements include:

- (4) Arents-Urban Land Complex, 0 to 5 Percent Slopes
- (18) Immokalee Fine Sand
- (22) Myakka-Urban Land Complex

Note: None of the soils documented are considered hydric soils in Palm Beach County.

### (4.) Floodplains and Drainage (as required under FHPM 6-7-3-2)

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) panels 1202210002B (01/03/1979), 1202210004B (01/03/1979), 1201920130B (10/15/1982), and 1202210003C (01/06/1988), the interchange is located within flood zone B. Flood zone B represents areas between the limits of the 100-year and 500-year flood. Proposed improvements will not encroach into any special flood zone hazard (100-year flood plain) areas, thus potential impacts to the 100-year floodplain will not occur.

## 13.3.5 Noise Sensitive Receptors

Based on review of available information and site reconnaissance conducted on January 9, 2014, there are currently noise sensitive receptors within 500 feet of the interchange improvements, which consist of the Covenant Centre International Church (adjacent to interchange improvements), single family homes 300-500 feet north of Northlake Blvd (east of I-95 between Sunrise Drive and Roan Lane and between Military Trail and I-95 to the west), and multifamily homes 300-500 feet south of Northlake Blvd (along Dania Drive and Sunset Drive west of I-95 and Lyndall Lane east of I-95). Currently, there are sound barriers in the vicinity of the Northlake Blvd interchange along the north- and southbound on-ramps and southbound off-ramp. However, the northbound on-ramp barrier begins immediately north of the Covenant Centre International Church.

Additional noise analysis may be required to determine the effects of the improvements, if any, on these receptors.

## 13.4 Potential Design Exceptions and Variations

The proposed improvements will require the following design variations:

- A border width variation for Northlake Boulevard eastbound under I-95, as the required 12-foot border to the bridge abutment is not met.
- A horizontal clearance variation for Northlake Boulevard eastbound under I-95, as the required 16-foot clearance from the edge of travel lane to the bridge abutment is not met.
- A border width variation for the interchange ramps as the required 94-foot border is not met.

No exceptions are anticipated for the existing and proposed facilities impacted by these improvements.

### 13.5 Potential Right-of-Way Impacts

Right-of-way acquisition is required for the implementation of the CDA for the following improvements and areas at the study intersections.

- Northlake Boulevard
  - Eastbound through lane
    - South side of Northlake Boulevard from Military Trail to east of Dania Drive
  - Westbound through lane
    - North side of Northlake Boulevard from Military Trail to southbound off-ramp limited access right-of-way
    - North side of Northlake Boulevard from Sunrise Drive to MacArthur Boulevard
- I-95 northbound ramp
  - Westbound Right-Turn Lane
    - North side of Northlake Boulevard from I-95 northbound on-ramp to Roan Lane
- I-95 southbound ramp
  - Eastbound Right-Turn Lane
    - Southside of Northlake Boulevard from Keating Drive to I-95 southbound on-ramp
- Sandtree Drive/Sunrise Drive
  - Southbound right-turn lane and northbound through lane
    - West side of Sunrise Drive from Northlake Boulevard to intersection behind the existing McDonalds.

### 13.6 Potential Drainage Impacts

The additional impervious area required for the proposed improvements is approximately 7.5 acres. Additional stormwater treatment areas are available by expanding the existing dry retention areas within the interchange, in addition to a potential new retention pond adjacent to the I-95 northbound on-ramp. To minimize impact to these stormwater treatment areas and to allow them to be expanded, guardrail with 1:2 slope or retaining walls are proposed along the edge of widening. Some of the modifications can be accommodated on a global basis when connected to a shared outfall. Local stormwater management may be required to attenuate additional runoff and to mitigate floodplain encroachment. Local attenuation and water quality requirements can be provided through exfiltration trenches in the median as needed. No drainage analysis was performed for this conceptual study

## 14 Cost Estimate and Benefit Cost Analysis

### 14.1 Cost Estimate

Cost estimates were made based on an engineer's probable opinion of cost using current FDOT Long Range Estimate (LRE) (2012) base costs. The cost for the improvements is estimated to be approximately \$10.3 million including maintenance of traffic, mobilization, and contingency. The cost does not include design-build or right-of-way acquisition costs. The LRE is included in Appendix J.

### 14.2 Benefit-to-Cost Analysis and Net Present Value

To estimate potential safety benefits of the proposed improvements, the following approach was established.

- The signing and pavement markings improvements were analyzed to identify short-term safety improvements that could be implemented through maintenance or pavement markings and signing (PMS) task work orders. Short-term PMS task work order improvements would be implemented before the capital intensive core recommendations in the IMP are programmed and implemented, and should not be considered in the safety B/C and net present value (NPV) analyses. It was determined that no improvements would be implemented through PMS task work orders; therefore, all recommended improvements and costs have been considered in the safety B/C and NPV analyses.
- Improvements were considered in the safety B/C and NPV analyses if those improvements were deemed to have safety implications based on historical crash data. If there was no direct correlation between proposed improvements and historical crash data or appropriate crash reduction factors were not available, B/C analysis were not performed. Further, the Predictive Method, as outlined in the Highway Safety Manual, was not utilized to estimate future crashes for the No Build and Build scenarios since the input data within the Freeway Ramp Terminal worksheet was not sensitive to the recommended improvements. Additionally, the maximum number of lanes allowable for Urban Conditions is six; however, the recommended laneage along Northlake Boulevard is eight. Therefore, the reduction in crashes utilized in the safety B/C analysis was based on Crash Reduction Factors (CRF) from FDOT's Crash Reduction Factors and FHWA's Crash Modification Factors Clearinghouse.

The improvements considered in the safety B/C and NPV analyses are listed below.

- Add one eastbound lane to Northlake Boulevard between Military Trail and MacArthur Boulevard
- Add one westbound lane to Northlake Boulevard between MacArthur Boulevard and Military Trail
- Add a third northbound left-turn lane on the I-95 northbound off-ramp
- Add two southbound left-turn lanes on the I-95 southbound off-ramp
- Add receiving lane on the I-95 northbound on-ramp
- Add signal heads along Northlake Boulevard to provide one (1) signal head per lane and add backplates with yellow retro reflective tape on each signal head

A summary of B/C and NPV analyses are included in Appendix K. The estimated B/C ratio is 9.8 and NPV is approximately \$55.1 million. The B/C and NPV calculations utilized a total cost for improvements of approximately \$10.3 million, which includes construction, maintenance of traffic, mobilization, contingency, and design-build costs; however, the cost estimate does not include right-of-way acquisition costs. The breakdown of costs is included in the B/C worksheet in Appendix K.

## 15 Prioritization and Implementation

The recommended improvements should be implemented in one group. The majority of improvements at the I-95 interchange can be implemented without the widening of Northlake Boulevard to eight lanes; however, the additional of two southbound left-turn lanes at the I-95 southbound off-ramp will require four lanes along eastbound Northlake Boulevard.

## 16 Conclusions and Recommendations

The purpose of this study is to identify short-term and long-term needs through 2040 and develop design concepts to address traffic spillback onto I-95, improve interchange operations, reduce congestion, and increase safety at the I-95 and Northlake Boulevard interchange. The proposed improvements are anticipated to address the identified operational deficiencies to prevent traffic spillback onto I-95, improve interchange operations, and address identified safety issues. The proposed improvements are anticipated to provide a B/C ratio of 9.8 with a NPV of approximately \$55.1 million. Based on the benefits provided by the proposed improvements, it is recommended that FDOT implement this package of proposed improvements to address operational and safety issues/deficiencies through 2040.

# APPENDIX