Final Traffic Impact Analysis

Simon Group Outlet Mall Retail Development
Norfolk, Virginia

March 2015

Prepared for:
Simon Property Group

© Kimley-Horn and Associates, Inc. 2015

This document, together with the concepts and designs presented herein, as an instrument of service, is intended only for the specific purpose and client for which it was prepared. Reuse of and improper reliance on this document without written authorization and adaptation by Kimley-Horn and Associates, Inc. shall be without liability to Kimley-Horn and Associates, Inc.

Final Traffic Impact Analysis
for
Simon Group Outlet Mall Retail Development
Norfolk, Virginia

Prepared for:
Simon Group, Inc.

Prepared by:
Kimley-Horn and Associates, Inc.
Suite 500
4500 Main Street
Virginia Beach, VA 23462
P: 757.213.8600 F: 757.213.8601

116498000
March 2015

COMMONWEALTH OF VIRGINIA
CARLIN J. HEBERT
Lic. No. 049269
3/5/15
PROFESSIONAL ENGINEER

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY 1

2.0 INTRODUCTION 4

3.0 PROJECT BACKGROUND 7

3.1 STUDY AREA 7
3.2 EXISTING LAND USE 7
3.3 EXISTING CONDITIONS 10
3.4 EXISTING TRAFFIC 14

4.0 TRAFFIC GENERATION 16

4.1 PASS-BY 16
4.2 PROPOSED DEVELOPMENT TRIP GENERATION 16
4.3 ADJACENT APPROVED DEVELOPMENT PROPOSED TRIP GENERATION 17

5.0 TRAFFIC DISTRIBUTION AND TRIP ASSIGNMENT. 19

6.0 SITE ACCESS 21

7.0 PROJECTED TRAFFIC VOLUMES 21

7.1 BACKGROUND TRAFFIC GROWTH 21
7.2 TOTAL TRAFFIC 22

8.0 INTERSECTION OPERATIONAL ANALYSIS 27

8.1 INTERSECTION OPERATIONAL ANALYSIS RESULTS 28
8.1.1 Northampton Boulevard/Lake Wright East 30
8.1.2 Northampton Boulevard/Interstate 64 Westbound Off-Ramp 32
8.1.3 Northampton Boulevard/Wesleyan Drive 34
8.1.4 Northampton Boulevard/Norwich Avenue 36
8.1.5 Northampton Boulevard/Burton Station Road 38
8.1.6 Northampton Boulevard/Baker Road 40
8.1.7 Northampton Boulevard/Diamond Springs Road 42
8.1.8 Robin Hood Road/Interstate 64 Eastbound Off-Ramp/Almeda Avenue 44
8.1.9 Military Highway/Robin Hood Road 46
8.1.10 Robin Hood Road/Interstate 64 Westbound Ramps 48
8.1.11 Robin Hood Road/Miller Store Road 50
8.1.12 Miller Store Road/Simon Access Driveway Extension 52
8.1.13 Additional Arterial Analysis 53

9.0 INTERSTATE FACILITY OPERATIONAL ANALYSES 64

9.1 HCS ANALYSIS 64
9.2 CORSIM FREEWAY ANALYSIS 72

10.0 CONCLUSIONS AND RECOMMENDATIONS 84

LIST OF TABLES

Table 1—Proposed Development Trip Generation for Simon Group Outlet Mall Development 16
Table 2—Traffic Generation of Additional Developments 17
Table 3 —LOS and Ranges of Delay 28
Table 4—Northampton Boulevard/Lake Wright East PM Peak Hour Signalized Intersection LOS 31
Table 5—Northampton Boulevard/Lake Wright East PM Peak Hour Queuing 31
Table 6—Northampton Boulevard/Interstate 64 Westbound Off-Ramp PM Peak Hour Signalized Intersection LOS 33
Table 7—Northampton Boulevard/Interstate 64 Westbound Off-Ramp PM Peak Hour Queuing 33
Table 8—Northampton Boulevard/Wesleyan Drive PM Peak Hour Signalized Intersection LOS 35
Table 9—Northampton Boulevard/Wesleyan Drive PM Peak Hour Queuing 36
Table 10—Northampton Boulevard/Norwich Avenue PM Peak Hour Unsignalized Intersection LOS 37
Table 11—Northampton Boulevard/Norwich Avenue PM Peak Hour Queuing 37
Table 12—Northampton Boulevard/Burton Station Road PM Peak Hour Signalized Intersection LOS 39
Table 13—Northampton Boulevard/Burton Station Road PM Peak Hour Queuing 39
Table 14—Northampton Boulevard/Baker Road PM Peak Hour Signalized Intersection LOS 41
Table 15—Northampton Boulevard/Baker Road PM Peak Hour Queuing 41
Table 16—Northampton Boulevard/Diamond Springs Road PM Peak Hour Signalized Intersection LOS 43
Table 17—Northampton Boulevard/Diamond Springs Road PM Peak Hour Queuing 43
Table 18—Robin Hood Road/Interstate 64 Eastbound Off-Ramp/Almeda Avenue PM Peak Hour Signalized Intersection LOS 45
Table 19—Robin Hood Road/Interstate 64 Eastbound Off-Ramp/Almeda Avenue PM Peak Hour Queuing 45
Table 20—Military Highway/Robin Hood Road PM Peak Hour Signalized Intersection LOS 47
Table 21—Military Highway/Robin Hood Road PM Peak Hour Queuing 47
Table 22—Robin Hood Road/Interstate 64 Westbound Ramps PM Peak Hour Signalized Intersection LOS 49
Table 23—Robin Hood Road/Interstate 64 Westbound Ramp PM Peak Hour Queuing 49
Table 24—Robin Hood Road/Miller Store Road PM Peak Hour Unsignalized Intersection LOS 51
Table 25—Robin Hood Road/Miller Store Road PM Peak Hour Queuing 51
Table 26—Miller Store Road/Simon Access Driveway PM Peak Hour Unsignalized Intersection LOS 52
Table 27—Miller Store Road/Simon Access Driveway PM Peak Hour Queuing 53
Table 28—LOS Criteria for Merge/Diverge Segments 64
Table 29—LOS Criteria for Freeway Segments 64
Table 30—HCS Ramp/Weave Movement PM Peak Hour LOS and Density (pc/ln/mi) 65
Table 31—HCS Freeway Segment PM Peak Hour LOS and Density (pc/ln/mi) 66

LIST OF FIGURES

Figure 1—Study Area....6
Figure 2—Existing Zoning....9
Figure 3A—Existing Laneage....12
Figure 3B—Programmed Improvements....13
Figure 4—Turning Movement Count Data - 2012 Existing PM Peak Hour....15
Figure 5—Additional Development Site Trips - Lake Wright East....18
Figure 6—Traffic Distribution and Assignment - PM Peak Hour....20
Figure 7—Turning Count Data – Northampton Boulevard – Future (2015) PM Peak Hour....23
Figure 8—Turning Count Data – Robin Hood Road – Future (2015) PM Peak Hour....24
Figure 9—Turning Count Data – Northampton Boulevard – Future (2021) PM Peak Hour....25
Figure 10—Turning Count Data – Robin Hood Road – Future (2021) PM Peak Hour....26
Figure 11—Level of Service and Delay – Northampton Boulevard – Existing (2012) PM Peak Hour....54
Figure 12— Level of Service and Delay – Robin Hood Road – Existing (2012) PM Peak Hour....55
Figure 13—Level of Service and Delay – Northampton Boulevard – Future (2015) PM Peak Hour – No Build Conditions....56
Figure 14— Level of Service and Delay – Robin Hood Road – Future (2015) PM Peak Hour – No Build Conditions....57
Figure 15— Level of Service and Delay – Northampton Boulevard – Future (2015) PM Peak Hour – Build Conditions....58
Figure 16—Level of Service and Delay – Robin Hood Road – Future (2015) PM Peak Hour –Build Conditions....59
Figure 17— Level of Service and Delay – Northampton Boulevard – Future (2021) PM Peak Hour – No Build Conditions....60
Figure 18— Level of Service and Delay – Robin Hood Road – Future (2021) PM Peak Hour – No Build Conditions....61
Figure 19— Level of Service and Delay – Northampton Boulevard – Future (2021) PM Peak Hour – Build Conditions....62
Figure 20—Level of Service and Delay – Robin Hood Road – Future (2021) PM Peak Hour – Build Conditions....63
Figure 21—Existing Conditions Analysis Results - HCS....67
Figure 22—2015 No Build Conditions Analysis Results - HCS....68
Figure 23—2015 Build Conditions Analysis Results - HCS....69
Figure 24—2021 No Build Conditions Analysis Results - HCS....70
Figure 25—2021 Build Conditions Analysis Results - HCS....71
Figure 26—Interchange Analysis – Eastbound PM Peak Hour MOE's – Existing PM Peak Hour....74
Figure 27—Interchange Analysis – Westbound PM Peak Hour MOE's – Existing PM Peak Hour....75
Figure 28—Interchange Analysis – Eastbound PM Peak Hour MOE's – No Build (2015) PM Peak Hour....76
Figure 29— Interchange Analysis – Westbound PM Peak Hour MOE's – No Build (2015) PM Peak Hour....77

Figure 30— Interchange Analysis – Eastbound PM Peak Hour MOE's – Build (2015) PM Peak Hour 78
Figure 31— Interchange Analysis – Westbound PM Peak Hour MOE's – Build (2015) PM Peak Hour 79
Figure 32— Interchange Analysis – Eastbound PM Peak Hour MOE's – No Build (2021) PM Peak Hour 80
Figure 33—Interchange Analysis – Westbound PM Peak Hour MOE's – No Build (2021) PM Peak Hour 81
Figure 34—Interchange Analysis – Eastbound PM Peak Hour MOE's – Build (2021) PM Peak Hour 82
Figure 35— Interchange Analysis – Westbound PM Peak Hour MOE's – Build (2021) PM Peak Hour 83
Figure 36—Proposed Laneage and Roadway Improvements 86

1.0 Executive Summary

Kimley-Horn and Associates, Inc. (Kimley-Horn) was retained to perform a traffic impact analysis (TIA) for the proposed outlet mall development to be located on a portion of the existing Lake Wright Golf Course in Norfolk, Virginia. The proposed development will be located in the northeast quadrant of the Interstate 64 (I-64) interchange with Northampton Boulevard (U.S. Route 13/State Route 166) and will include approximately 450,000 square feet of total gross leasable area for factory outlet retail space. This TIA examines the traffic impacts associated with the outlet mall development. The development site consists of approximately +/-55 acres and is primarily zoned as open space preservation (OSP), with limited light industrial (I-1, I-2) and residential duplex district (R-5D). The property will be rezoned to facilitate the land use envisioned with the proposed development. Two access points are proposed: one (1) primary access point along Northampton Boulevard and a secondary access point on Miller Store Road. The traffic study area includes roadways and intersections in the immediate vicinity of the proposed development as agreed to by VDOT, the City of Norfolk, and Kimley-Horn during a scope of work meeting on October 21, 2013 for the previous TIA. It is anticipated that build-out (opening day) of the proposed development will occur during the summer of 2016. It should be noted that this revised TIA is being prepared for comparison with the previous TIA that was submitted to Simon Group in January of 2014. The original TIA assumed that the development would be complete in late 2015; however, due to recent understanding of the construction schedule, the development will likely not be open to the public until summer of 2016. In order to remain consistent with the previous TIA the same analysis years (i.e., 2015 and 2021) and study area have been maintained for this revised TIA analysis. It is the intent of this revised TIA to assess the impacts of relocating site access along Northampton Boulevard to the existing Wesleyan Drive intersection.

This study identifies the transportation improvements necessary to support the proposed development generated traffic while maintaining and/or improving existing traffic operations along the study area corridors and/or mitigating impacts to the adjacent interstate interchanges. It is recommended that these improvements be implemented prior to opening day with continued monitoring of corridor and interstate interchange operations as traffic patterns stabilize. As expected, the proposed outlet mall development will increase traffic through the interchange (particularly the I-64/Northampton Boulevard interchange), along adjacent roadways, and at intersections located in the vicinity of the site. This TIA has been prepared in coordination with representatives from City of Norfolk staff, Virginia Department of Transportation (VDOT) staff, and in accordance with VDOT Chapter 527 regulations. To mitigate any potential operational issues and deteriorations in future LOS as a result of this development, the following improvements are recommended for implementation prior to opening day:

- Network-Wide - Optimize signal timing and lead/lag phasing to improve the coordinated signal operations along the Northampton Boulevard and Robin Hood Road/Military Highway corridors, particularly with the introduction of a revised signal timings at the Northampton Boulevard and Wesleyan Drive intersection.

- Northampton Boulevard/Wesleyan Drive/Wesleyan Drive Extension (primary access point) – modify the signalized intersection allowing for full movement with the following laneage:
    - Northbound Northampton Boulevard– four (4) exclusive through lanes, one (1) exclusive left-turn lane (operating as a protected only movement), and one exclusive channelized right-turn lane with yield control
        - Left-turn lane should be extended to provide approximately 950 feet of storage and a 100-foot taper.
        - Install/construct a physical barrier to channelize the exclusive left-turn lane to prevent driver maneuvers between the westbound I-64 off ramp and the left-turn lane.
            - The physical barrier channelizing the left-turn lane should extend back from the stop bar a distance of 850 feet.
        - Signage should be provided on the westbound I-64 off-ramp to notify drivers destined for the Simon Outlet Mall they must use the right-turn lane at the westbound I-64 Off-Ramp/Northampton Boulevard signalized intersection to access the exclusive left-turn lane serving the site.
    - Southbound Northampton Boulevard – four (4) exclusive through lanes, one (1) exclusive left-turn lane, and one (1) exclusive right-turn lane (operating with a right-turn overlap)
        - Right-turn lane should be constructed to provide 250 feet of storage and a 100-foot taper.
    - Eastbound Wesleyan Drive Extension – two (2) exclusive left-turn lanes and one (1) exclusive through lane (operating as split phase), and one (1) exclusive right-turn lane (operating with a right-turn overlap)
        - Inside exclusive left-turn lane should be constructed to provide 200-feet of storage and a 100-foot taper.
        - The outside exclusive left-turn lane will be a “trap” lane for the eastbound inside through lanes (no storage required).
        - Construct an exclusive right-turn lane with 200-feet of storage and a 100-foot taper.
            - Since the Wesleyan Drive approaches to the intersection will operate as split phase, continue to monitor traffic volumes and periods of congestion/delay for the eastbound approach.
            - Additionally, consider restriping the exclusive through lane to function as a shared through and right-turn lane or potentially a shared left, through, and right-turn lane when or if it is deemed appropriate.

  - Westbound Wesleyan Drive – three (3) exclusive left-turn lanes (operating as split phase), one (1) exclusive through lane, and one (1) exclusive channelized right-turn lane with yield control. (no change from improvements by others).

- Miller Store Road/Simon Access Driveway (secondary access point) – modify the existing unsignalized intersection to provide the following laneage:
  - Eastbound Miller Store Road – one (1) exclusive through lane and one (1) exclusive right-turn lane (uncontrolled approach).
    - Right-turn lane should be constructed to provide 225-feet of storage and a 100-foot taper.
  - Westbound Miller Store Road – one (1) exclusive through lane and one (1) exclusive left-turn lane (uncontrolled approach).
    - Left-turn lane should be constructed to provide 225-feet of storage and a 100-foot taper.
  - Simon Access Driveway – one (1) exclusive left-turn lane and one (1) exclusive right-turn lane (stop controlled approach).
    - The exclusive left and right-turn lanes will each be a “trap” lane for the northbound through lanes (no storage required).

2.0 Introduction

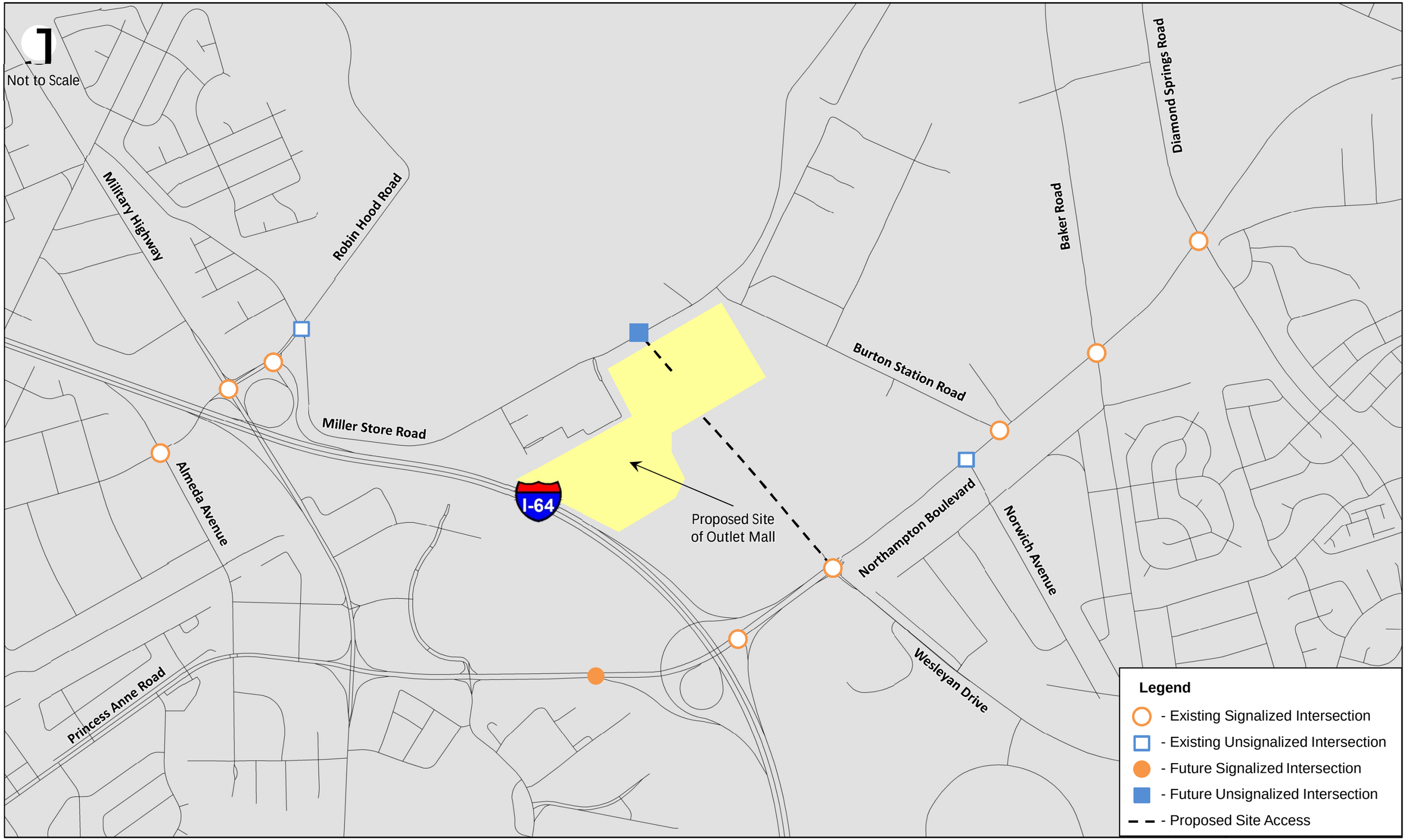
Kimley-Horn was retained to perform a TIA for the proposed outlet mall development to be located on a portion of the existing Lake Wright Golf Course in Norfolk, Virginia. The proposed development will include approximately 450,000 square feet of total gross leasable area for factory outlet retail space and will be located in the northeast quadrant of the Interstate 64 (I-64) interchange with Northampton Boulevard (U.S. Route 13/State Route 166). This TIA will examine the traffic impacts associated with the outlet mall development. The +/-55 acre site is currently zoned as open space preservation (OSP), with limited light industrial (I-1, I-2) and residential duplex district (R-5D), and will be rezoned to facilitate the proposed development. Two access points are proposed: one (1) primary access point along Northampton Boulevard (herein referred to as Wesleyan Drive Extension) and a secondary access point (Simon Access Driveway) on Miller Store Road.

The roadway network adjoining the study area includes Interstate 64, Northampton Boulevard (U.S. Route 13/State Route 166), Military Highway (State Route 165), Miller Store Road, and Wesleyan Drive. **Figure 1** illustrates the location of the outlet mall development as well as the approximate limits of the study area. As shown in **Figure 1**, Northampton Boulevard is oriented in a general east-west direction in the vicinity of the proposed development, but operates primarily as a north-south arterial. As such, the corridor is identified in the report with northbound and southbound designations, with intersecting roadways identified as eastbound and westbound. The corridor serves as a major transportation arterial between I-64 and the Chesapeake Bay Bridge Tunnel, which provides direct access to the Eastern Shore of Virginia and points further north. It is also a key corridor for access to/from Little Creek Joint Expeditionary Base and I-64.

This study has been prepared for submittal to the City of Norfolk and VDOT to evaluate existing conditions as well as future traffic conditions and associated improvements for the proposed outlet mall development. The TIA is consistent and in accordance with the regulations of the VDOT Chapter 527 process for preparing traffic impact studies.

A previous TIA was prepared and submitted to Simon Group in January 2014 which included a scope of work meeting with the City of Norfolk, VDOT, and Kimley-Horn held on Monday, October 21, 2013 to discuss and agree upon the study area parameters. A copy of the Pre-Scope of Work form and the executed 527 TIA checklist from the previous TIA can be found in the **Appendix** of this report. As part of the previous TIA, the construction, occupancy, and build-out (opening day) timeline for the proposed development was anticipated to occur by the last quarter of 2015. Due to recent understanding of the construction schedule, the development will likely not be open to the public until summer 2016. In order to remain consistent with the January 2014 TIA the same analysis years (i.e., 2015 and 2021) and study area have been maintained for this revised TIA analysis. It is the intent of this revised TIA to assess the impacts of relocating site access along Northampton Boulevard to the existing Wesleyan Drive intersection. In order to gain concurrence on the assumptions for this analysis, a revised Pre-Scope of Work form and 527 TIA Checklist were prepared and submitted to VDOT approval. Copies of the revised forms are also provided in the **Appendix** for reference. The study provides trip generation, trip distribution, traffic analyses, and recommendations for transportation improvements (such as roadway geometrics and turn-lane

requirements) to support anticipated traffic demands. In addition to the existing traffic conditions analysis, the study analyzes the traffic impacts associated with the proposed development on the adjacent roadway network for 2015 and 2021.



Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Study Area

FIGURE
1

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

3.0 Project Background

3.1 Study Area

The study area for this analysis includes the following roadways and intersections:

Roadways

- Interstate 64 (I-64)
- Northampton Boulevard (U.S. Route 13, State Route 166)
- Military Highway (U.S. Route 165)
- Robin Hood Road
- Miller Store Road
- Wesleyan Drive

Intersections

- I-64 WB Off-Ramp and Northampton Boulevard (signalized)
- Northampton Boulevard and Wesleyan Drive (signalized)
- Northampton Boulevard and Norwich Avenue (unsignalized)
- Northampton Boulevard and Burton Station Road (signalized)
- Northampton Boulevard and Baker Road (signalized)
- Northampton Boulevard and Diamond Springs Road (signalized)
- Robin Hood Road and Almeda Avenue/I-64 EB Off-Ramp (signalized)
- Robin Hood Road and Military Highway (signalized)
- I-64 WB Off-Ramp/On-Ramp and Robin Hood Road (signalized)
- Robin Hood Road and Miller Store Road (unsignalized)

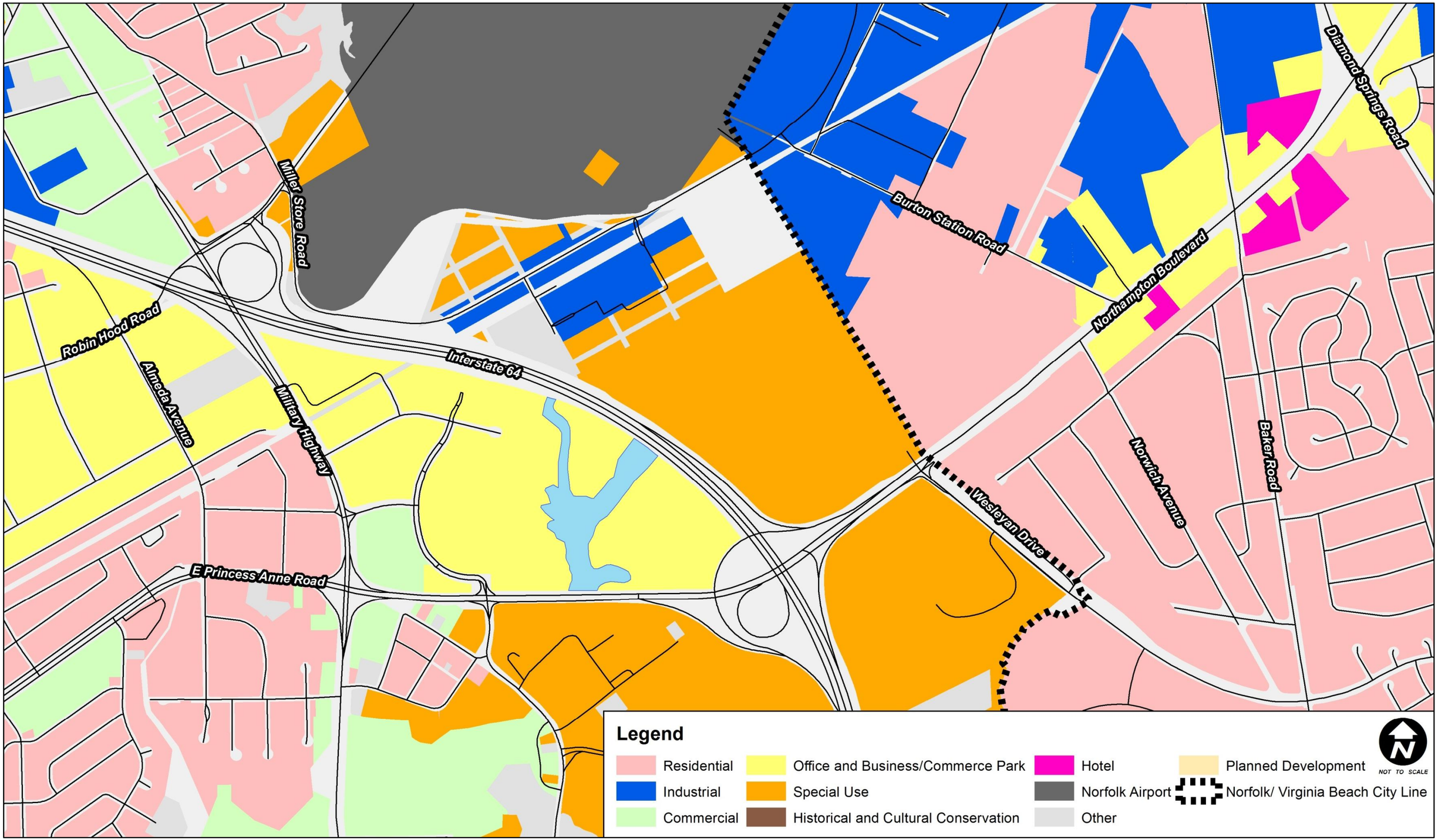
These intersections were identified during conversations with VDOT and the City of Norfolk staff at the October 21, 2013 scope of work meeting. The study area as defined above reflects the key areas of influence that will be impacted by the outlet mall development. The study area also defines the limits of the primary traffic patterns associated with this development and those roadways and intersections that will most be affected, as noted above. Intersections and roadways beyond the study limits are difficult to accurately assess as traffic becomes dispersed resulting in the overall impacts to those further reaching roadways and intersections being minimal.

3.2 Existing Land Use

The site is currently occupied by the Lake Wright Golf Course, which is maintained and operated by the City of Norfolk, and consists of approximately +/-55 acres of primarily open space for the golf course itself, with limited portions of wooded areas. The remainder of the approximately +/-180 acre Lake Wright Golf Course property, including the approximately +/-26 acre Lake Wright, will not be redeveloped as part of the currently proposed outlet mall development. Land uses in the vicinity of the study area consist of residential neighborhoods, commercial properties, business parks, as well as other traffic generators, including the Norfolk International Airport, Norfolk Academy, and Virginia Wesleyan College. Current zoning for the property is open space preservation (OSP), with limited light industrial (I-1, I-2) and residential duplex district (R-5D). Zoning within the project study area is shown in **Figure 2**.

The City of Norfolk's comprehensive plan, "plaNorfolk2030", currently designates this site as Open Space/Recreation. The Enhancing Economic Vitality chapter of the document identifies Lake Wright/Lake Wright East as a Strategic Economic Development Area where the City should support the intensification of land uses due to existing infrastructure capacity and access.

While not consistent with the current land uses and zoning, the Virginia Beach Strategic Growth Area Implementation Plan (which includes the project site) identifies a plan to convert the existing site to a commercial office and retail district. The proposed development will be in line with the proposed growth plan for the area.



Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Existing Zoning

FIGURE
2

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

3.3 Existing Conditions

Interstate 64 in the vicinity of the project study area is a six-lane controlled access facility, with interchanges at Robin Hood Road and Northampton Boulevard that will provide access to the project site. The latter will be considered the primary means of access for future trips to the site (through interstate signage directing/encouraging traffic to the site via Northampton Boulevard), with limited volume expected to travel to the site via the interchange at Robin Hood Road. The two-lane reversible roadway for high occupancy vehicles (HOV) is not considered part of the project study area given that it does not allow for access to or from the site. 2012 mainline Interstate 64 average daily traffic (ADT) counts obtained from VDOT indicate a range of volume in the eastbound direction from 54,700 vehicles per day (vpd) to 68,500 vpd. Similarly, in the westbound direction, 2012 ADT counts reflect a range from 67,900 vpd to 80,000 vpd. Each interstate segment between the two project study area interchanges were evaluated based on their respective ADT data.

Northampton Boulevard (U.S. Route 13, State Route 166) is the primary north/south roadway in the study area, linking I-64 to the Chesapeake Bay Bridge Tunnel. Northampton Boulevard is a principal arterial with a posted speed limit of 45 miles per hour (mph) within the project study area. South of I-64, the roadway is a six-lane divided facility and north of I-64, it is an eight-lane divided facility. According to 2012 average daily traffic (ADT) counts obtained from VDOT, Northampton Boulevard carried approximately 34,000 vpd south of the interstate and 81,000 vpd at the northern limits of the project study area. Traffic volumes along Northampton Boulevard are significantly influenced by the Little Creek Joint Expeditionary Base located to the north along Little Creek Road as it serves as a key transportation link between the installation and I-64.

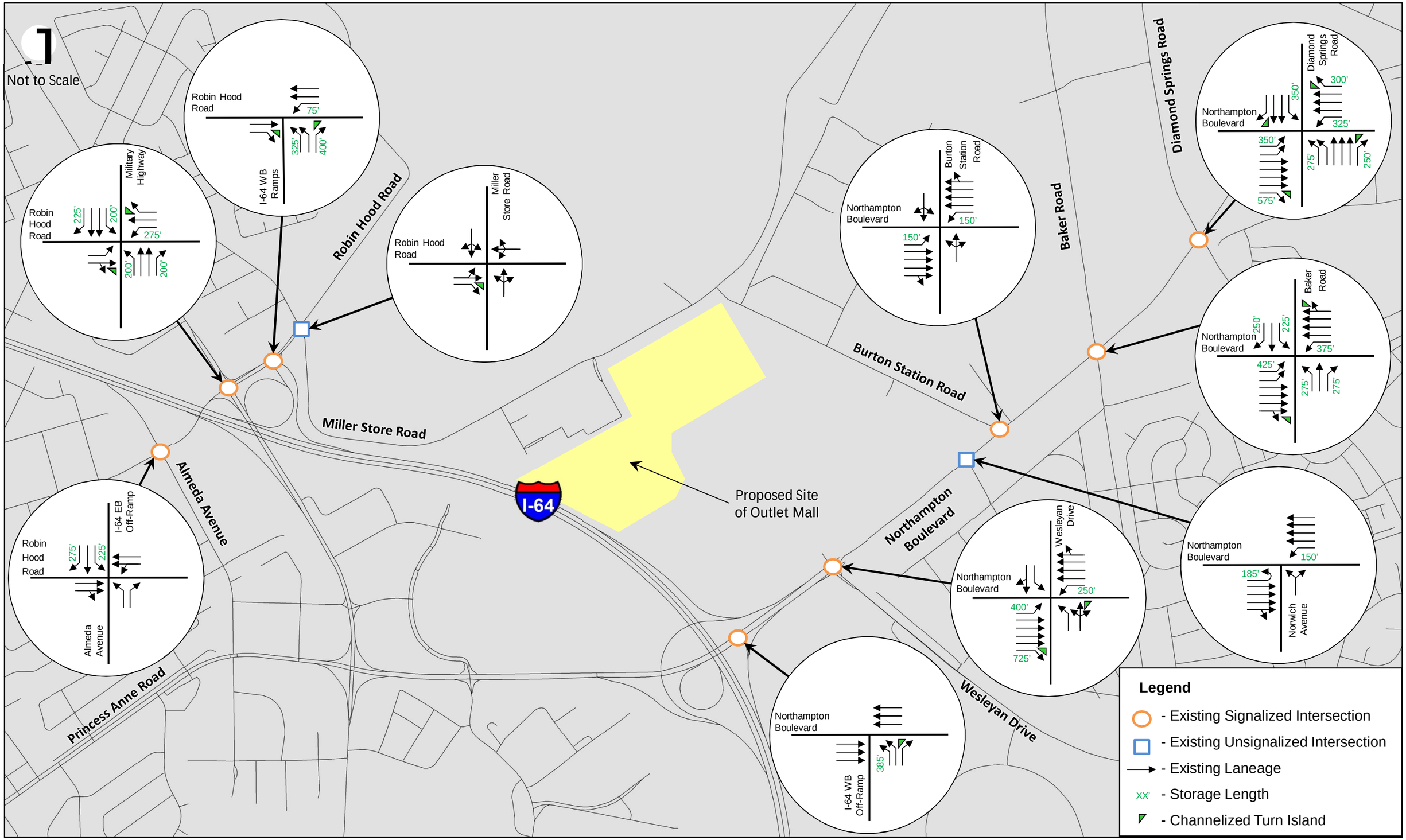
Military Highway (State Route 165) is a major north/south roadway that runs through much of the City of Norfolk, providing access to residential communities, commercial business, and I-64. The four-lane, divided principal arterial has a posted speed limit within the study area of 45 mph. According to 2012 ADT counts obtained from the City of Norfolk, Military Highway carries approximately 43,000 vpd south of Interstate 64 and 12,000 vpd north of the Interstate 64. For the purposes of this report, the roadway is referred to as an east/west facility to retain the east/west cardinal designation of Interstate 64 and its intersections with Robin Hood Road, which is subsequently referred to as a north/south facility.

Robin Hood Road is a four-lane, undivided Minor Arterial (with the exception of a short segment that is a three-lane section) that runs east/west underneath I-64 and provides access to Military Highway and Miller Store Road. The posted speed limit along the roadway is 30 mph. Year 2012 ADT counts obtained from VDOT indicate that Robin Hood Road carried approximately 9,300 vpd in the study area. For the purposes of this report, the roadway is referred to as a north/south facility to retain the east/west cardinal designation of I-64 and its intersections with Robin Hood Road.

Wesleyan Drive was previously a four-lane, undivided Minor Arterial, running east/west into the City of Virginia Beach with a posted speed limit of 35 mph. The 2012 ADT counts obtained from VDOT indicate that Wesleyan Drive carries approximately 18,000 vpd. As of November 2013, the roadway is now a four-lane, divided facility with increased capacity provided at the intersection

with Northampton Boulevard. The future year analyses considered the new geometry of the corridor.

Figure 3A depicts existing (2012) laneage for study area roadways and intersections. **Figure 3B** depicts programmed roadway improvements including the Northampton Boulevard/Wesleyan Drive intersection as well as improvements associated with the Lake Wright East development which is discussed in further detail in **Section 4.3**.



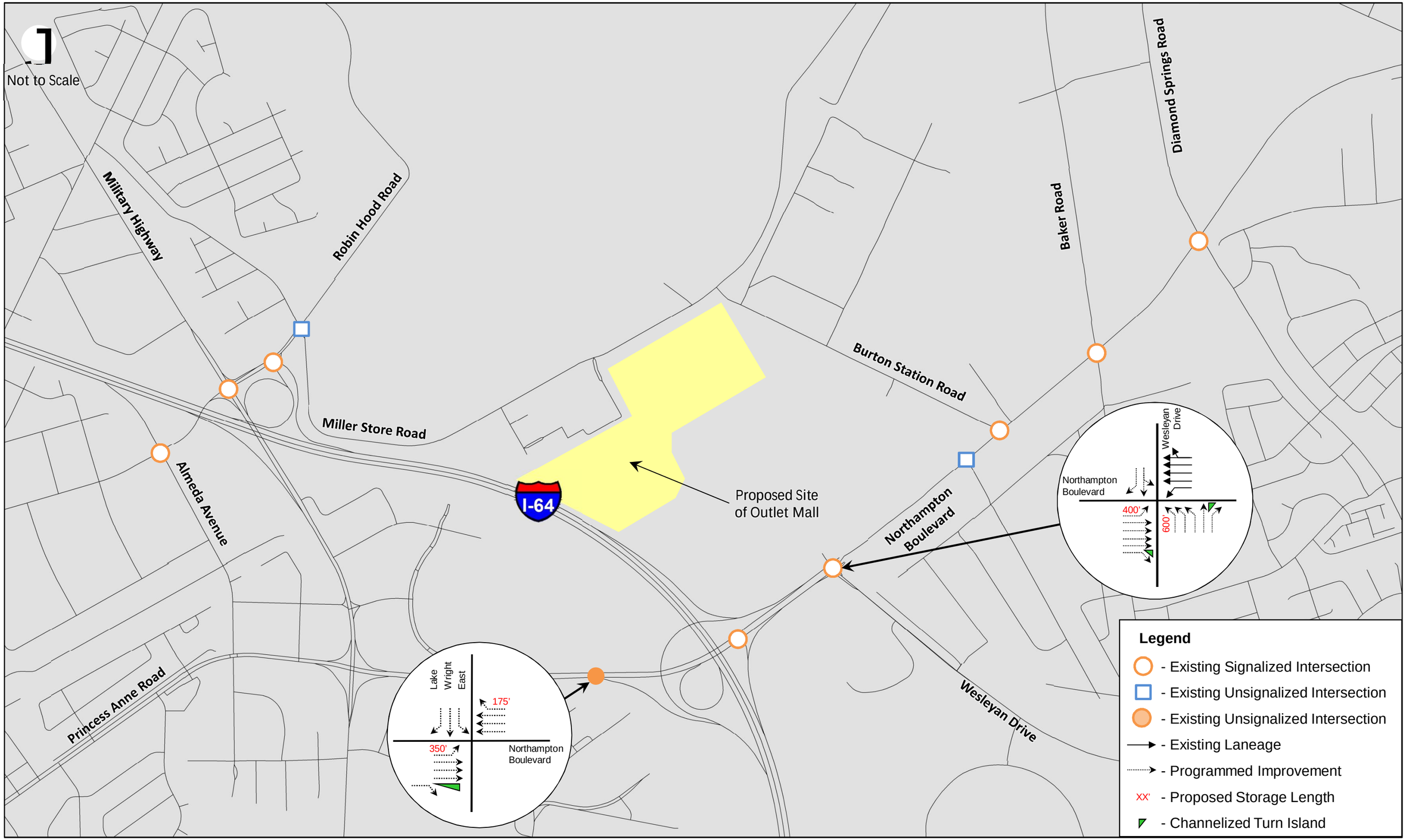
Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Existing Laneage

FIGURE
3A

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Programmed Improvements

FIGURE
3B

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

3.4 Existing Traffic

As agreed to at the scope of work meeting on October 21, 2013, the analysis of the project study area only considered the PM peak hour as it was perceived to be the timeframe during which the combination of background and site generated trips would have the greatest impact on the study area roadway network. The City of Norfolk provided 2012 PM peak hour weekday (Tuesday, Wednesday, or Thursday) turning movement counts (TMC) for those study area intersections identified below and 2012 average daily traffic (ADT) counts. Supplemental TMC were collected by Peggy Malone and Associates, Inc. at the four study area intersections located along Northampton Boulevard in the City of Virginia Beach. Year 2012 data was agreed to be used to avoid collecting new data during the construction of the Northampton Boulevard/Wesleyan Drive improvements which influenced traffic volumes in the study area.

Turning Movement Counts (TMC) locations provided by the City of Norfolk:

- I-64 WB Off-Ramp and Northampton Boulevard – March 22, 2012
- Northampton Boulevard and Wesleyan Drive – March 22, 2012
- Robin Hood Road and Almeda Avenue/I-64 EB Off-Ramp – March 22, 2012
- Robin Hood Road and Military Highway – March 20, 2012
- I-64 WB Off-Ramp/On-Ramp and Robin Hood Road – March 22, 2012
- Robin Hood Road and Miller Store Road – March 29, 2012

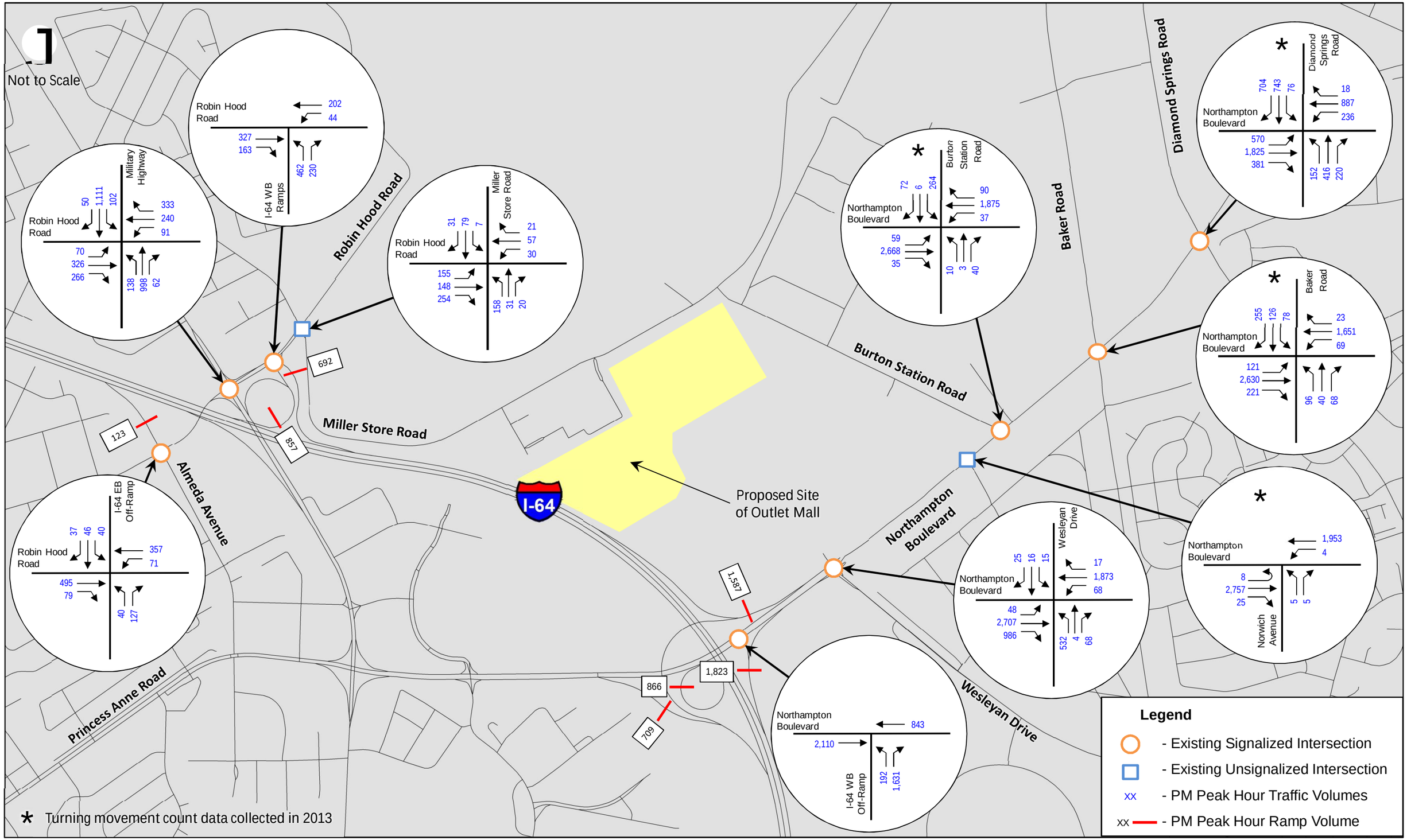
Average Daily Traffic (ADT) count locations provided by the City of Norfolk:

- I-64 WB Off-Ramp to Northampton Boulevard – March 21, 2012 to March 22, 2012 (48-hour ADT)
- I-64 EB Off-Ramp to Northampton Boulevard – March 21, 2012 to March 22, 2012 (48-hour ADT)
- Northampton Boulevard WB to I-64 On-Ramps – March 21, 2012 to March 22, 2012 (48-hour ADT)
- Northampton Boulevard EB to I-64 EB On-Ramp – March 21, 2012 to March 22, 2012 (48-hour ADT)
- I-64 EB Off-Ramp to Robin Hood Road – March 21, 2012 to March 22, 2012 (48-hour ADT)
- I-64 WB Off-Ramp to Robin Hood Road – March 21, 2012 to March 22, 2012 (48-hour ADT)
- Robin Hood Road to I-64 WB On-Ramp – March 20, 2012 to March 21, 2012 (48-hour ADT)

Counts performed by Peggy Malone and Associates, Inc.:

- Northampton Boulevard and Norwich Avenue – (TMC) – Tuesday, October 29, 2013
- Northampton Boulevard and Burton Station Road – (TMC) – Tuesday, October 29, 2013
- Northampton Boulevard and Baker Road – (TMC) – Wednesday, October 30, 2013
- Northampton Boulevard and Diamond Springs Road – (TMC) – Wednesday, October 30, 2013

Figure 4 shows existing (2012) turning movement volumes during the PM peak hour.



Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Turning Movement Count Data
2012 Existing PM Peak Hour

FIGURE
4

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

4.0 Traffic Generation

The trip generation potential of the proposed development was determined using traffic generation rates published by the Institute of Traffic Engineers (ITE) in the *ITE Trip Generation* (9th Edition, 2012). Currently, the site functions as a public golf course and generates a lower volume of trips throughout the day than the proposed outlet mall development. The addition of the outlet mall retail development will result in new traffic being generated by the site and assigned to the adjacent street network.

4.1 Pass-By

It was agreed to at the scope of work meeting on October 21, 2013 (as well as through the revised Pre-Scope of Work form and 527 TIA checklist that were agreed to in January of 2015) that the land use to be used in the traffic analysis was Factory Outlet Center (ITE Code 823). During the meeting, the topic of pass-by trips was discussed; however, since ITE does not allow for a reduction in the number of "new trips" generated by the site, pass-by reduction was not considered for this project.

4.2 Proposed Development Trip Generation

The *ITE Trip Generation* (9th Edition, 2012) provides trip generation data for the type of development being considered for the property, a Factory Outlet Center (ITE Code 823). At the time of the scope of work meeting, no other land uses or developments were proposed for the project site. **Table 1** summarizes the estimated daily, AM, and PM peak hour trip generation for the proposed development at full build-out. While daily and AM peak hour trip generation rates are provided, as previously mentioned, the analysis only considered the PM peak hour.

Table 1—Proposed Development Trip Generation for Simon Group Outlet Mall Development

ITE Code	Description	Size	Daily	AM Peak			PM Peak		
				In	Out	Total	In	Out	Total
823	Factory Outlet Center	450,000 Square Feet	11,966	220	82	302	485	546	1,031
Total			**11,966**	**220**	**82**	**302**	**485**	**546**	**1,031**

As shown in **Table 1**, the proposed development has the potential to generate approximately 11,966 driveway trips per day including a total of 302 during the AM peak hour and 1,031 during the PM peak hour. Since pass-by reduction was not considered for this project, these trip generation projections represent the number of **new** trips that are anticipated to be added to the surrounding roadway network.

4.3 Adjacent Approved Development Proposed Trip Generation

Through discussion with the City and VDOT, it was determined that the Lake Wright East Corporate Center, located in the vicinity of the proposed outlet mall development, would be the sole adjacent approved development considered in the analysis. Any additional redevelopment or smaller development that might take place before the build-out of the outlet mall development will be accounted for in the annual growth rate(s) applied to generate the background traffic volumes.

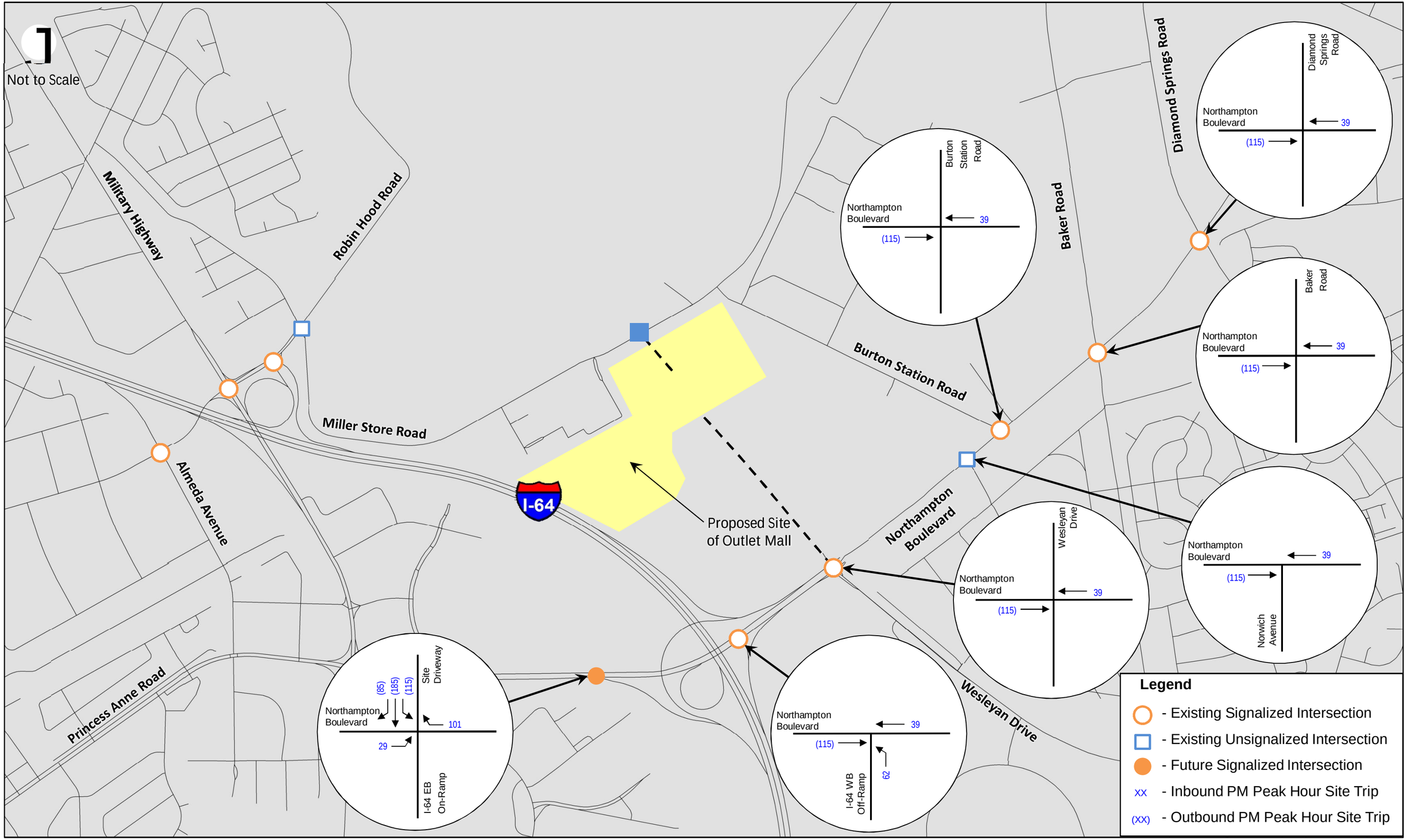
Lake Wright East is a proposed mixed-use development that will represent an expansion of the existing Lake Wright Corporate Center, which is bound by Military Highway, Northampton Boulevard, and I-64. Based on the traffic impact analysis prepared by URS Corporation dated January 11, 2007, the proposed development will consist of two office buildings and a combined office and hotel. The office buildings will consist of 200,000 square feet of new office space, additional office space to accommodate 72 employees, and a 250-room hotel. Access to Lake Wright East is proposed from a new signalized intersection on Northampton Boulevard across from the existing I-64 eastbound on-ramp.

Table 2 summarizes the proposed new trips that will be generated by the Lake Wright East developments as documented in the previous study.

Table 2—Traffic Generation of Additional Developments

Development	Daily	AM Peak Hour			PM Peak Hour		
		In	Out	Total	In	Out	Total
Lake Wright East	4,439	429	94	523	130	385	515
Total Additional Development Trip Generation	**4,439**	**429**	**94**	**523**	**130**	**385**	**515**

Trips associated with the Lake Wright East development described above were assigned to study area intersections as detailed in the corresponding traffic impact analysis report. The additional outlet mall development site trips were carried through the project study area based on the agreed upon trip distributions discussed at the scope of work meeting on October 21, 2013. The total trip assignment for the Lake Wright East Development for the PM peak hour only is illustrated in **Figure 5**.



Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Additional Development Site Trips
Lake Wright East

FIGURE
5

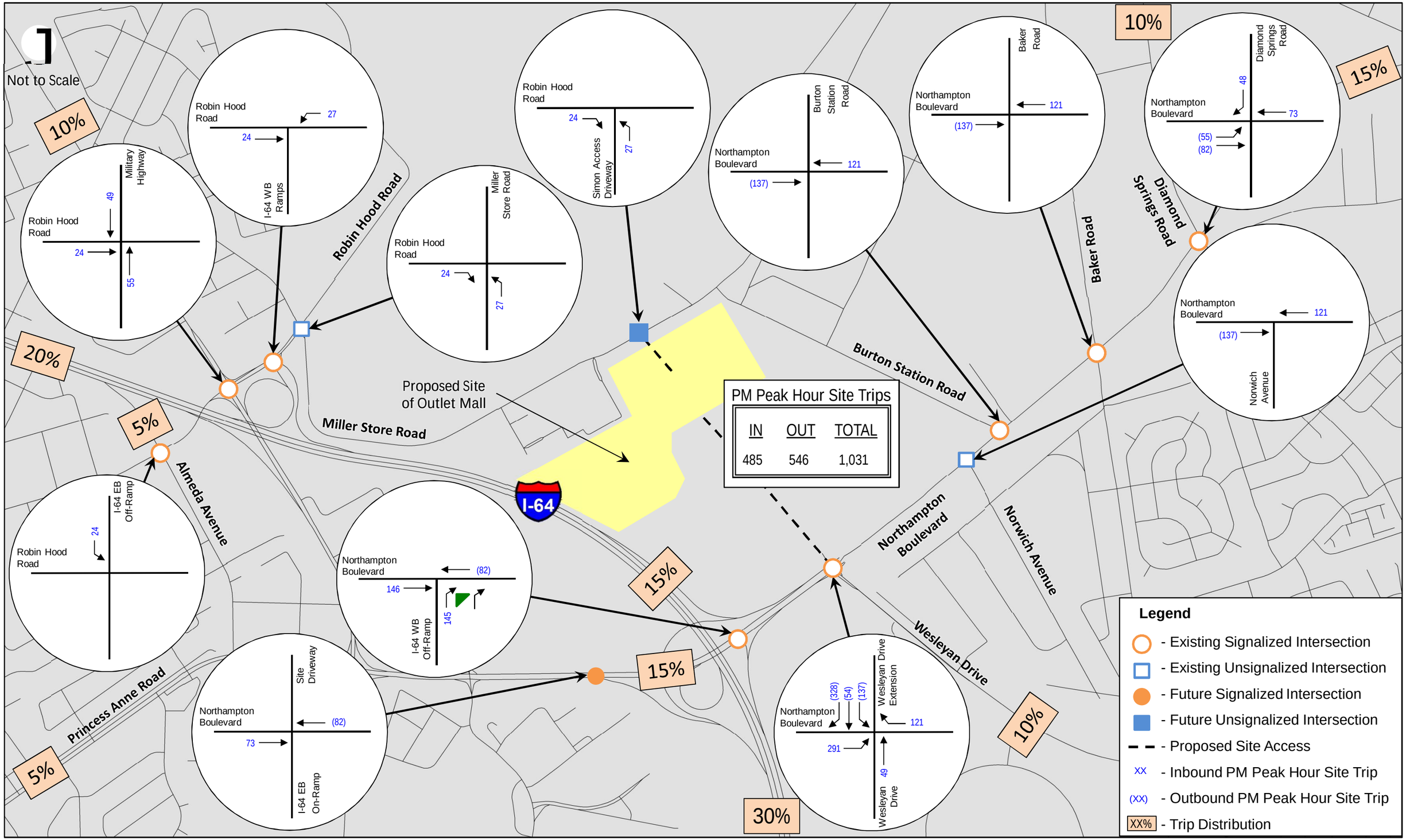
THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

5.0 Traffic Distribution and Trip Assignment

The directional distribution and assignment of trips generated by the proposed development is based on a review of existing roadway volumes, an understanding of travel patterns within the study area, and an assessment of residential areas within the vicinity of the project site. Based on the review of the above mentioned sources as well as conversations with the City of Norfolk and VDOT staff, distributions were developed and agreed upon during the scope of work meeting on October 21, 2013. The following trip distribution patterns apply to the build-out development conditions:

- 5% to/from the west on I-64 via Miller Store Road
- 15% to/from the south on Northampton Boulevard
    - 10% to/from the north via Military Highway
    - 5% to/from the west via Princess Anne Road
- 15% to/from the west on I-64 via Northampton Boulevard
- 30% to/from the east on I-64 via Northampton Boulevard
- 10% to/from the east on Wesleyan Drive
- 25% to/from the north on Northampton Boulevard
    - 10% to/from the northwest via Diamond Springs Road
    - 15% to/from the northeast via Northampton Boulevard

The anticipated outlet mall development traffic distribution and trip assignment is illustrated in **Figure 6**.



Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Traffic Distribution and Assignment
PM Peak Hour

FIGURE
6

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

6.0 Site Access

Northampton Boulevard will be the primary corridor providing access to the proposed Simon Group Outlet Mall development. The proposed access point along Northampton Boulevard will be located at the west leg of the existing Northampton Boulevard/Wesleyan Drive signalized intersection. The west leg of the intersection currently only provides access to the existing hotel site; however, in order to accommodate site access for the proposed development, the west leg will be widened and reconfigured as the Wesleyan Drive Extension. The primary access point along Miller Store Road to the proposed Simon Group Outlet Mall development is an existing site access driveway located approximately 1,100 feet east of Pritchard Street and approximately 1,500 feet west of Burton Station Road. It is envisioned that this intersection will be unsignalized but consist of an exclusive westbound left-turn and an exclusive eastbound right-turn lane in addition to the through travel lanes. The site driveway will tie into the roadway network that will serve the parking areas anticipated to surround the retail development as well as provide a connection to the proposed Wesleyan Drive Extension.

Trips entering and exiting the site were assigned to the access points based on the traffic distribution values shown in **Figure 6**.

7.0 Projected Traffic Volumes

7.1 Background Traffic Growth

Background traffic growth is the increase in traffic volumes due to usage increases and non-specific growth throughout an area. Traditionally, growth rates are developed by evaluating past traffic counts for a roadway or intersection. However, this study is unique in that one of the roadways contributing to site trip generation, Wesleyan Drive, was recently improved from a two lane facility to a four lane facility. Since the existing analysis year (2012) considers traffic data collected prior to completion of these roadway improvements, the data does not reflect the traffic conditions anticipated with the new roadway. The *Traffic Analysis Study – Wesleyan Drive Improvements* completed by Clark Nexsen in April 2010 evaluated the Wesleyan Drive roadway up to its intersection with Northampton Boulevard. Based on the analysis performed as part of this study, an annualized growth rate of 0.85 percent was recommended. To be consistent with the recent analysis of this roadway and yield future year volumes comparable to those portrayed in this study, the same 0.85 percent annualized growth rate was used as part of the analysis for this study.

In addition to the 0.85 percent growth rate applied per year, traffic associated with adjacent, approved developments as discussed in **Section 4.3** was assigned to the roadway network. As mentioned in **Section 4.3**, assumptions regarding trip generation, trip distributions, and trip assignment remained consistent with the original traffic studies.

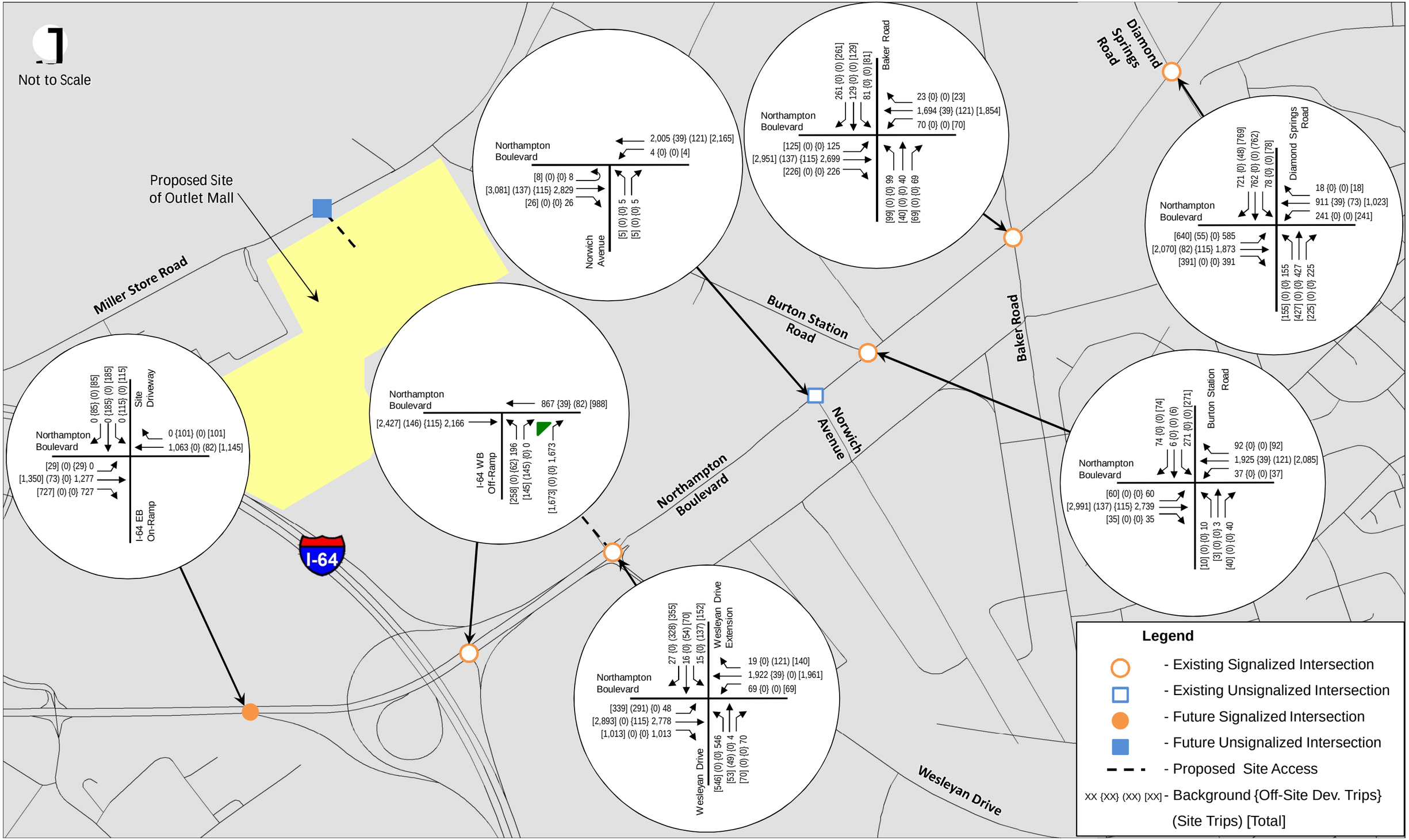
7.2 Total Traffic

To obtain total 2015 and 2021 No Build traffic volumes, existing traffic volumes along Northampton Boulevard and Robin Hood Road were incrementally grown using the aforementioned 0.85 percent annual growth rate.

In addition to the historic growth rate, the anticipated trip generation potential for the proposed development described in **Section 4.3** and illustrated in **Figure 6** was added to projected traffic volumes to calculate the total background traffic volumes.

Once the background traffic volumes were established, traffic associated with the proposed outlet mall development was added to develop total traffic volumes for the 2015 and 2021 build scenarios. The following figures illustrate future turning movement volumes to reflect background no build traffic, site generated traffic, and total build network traffic volumes:

- **Figure 7** – Turning Count Data – Northampton Boulevard – Future (2015) PM Peak Hour
- **Figure 8** – Turning Count Data – Robin Hood Road – Future (2015) PM Peak Hour
- **Figure 9** – Turning Count Data – Northampton Boulevard – Future (2021) PM Peak Hour
- **Figure 10** – Turning Count Data – Robin Hood Road – Future (2021) PM Peak Hour



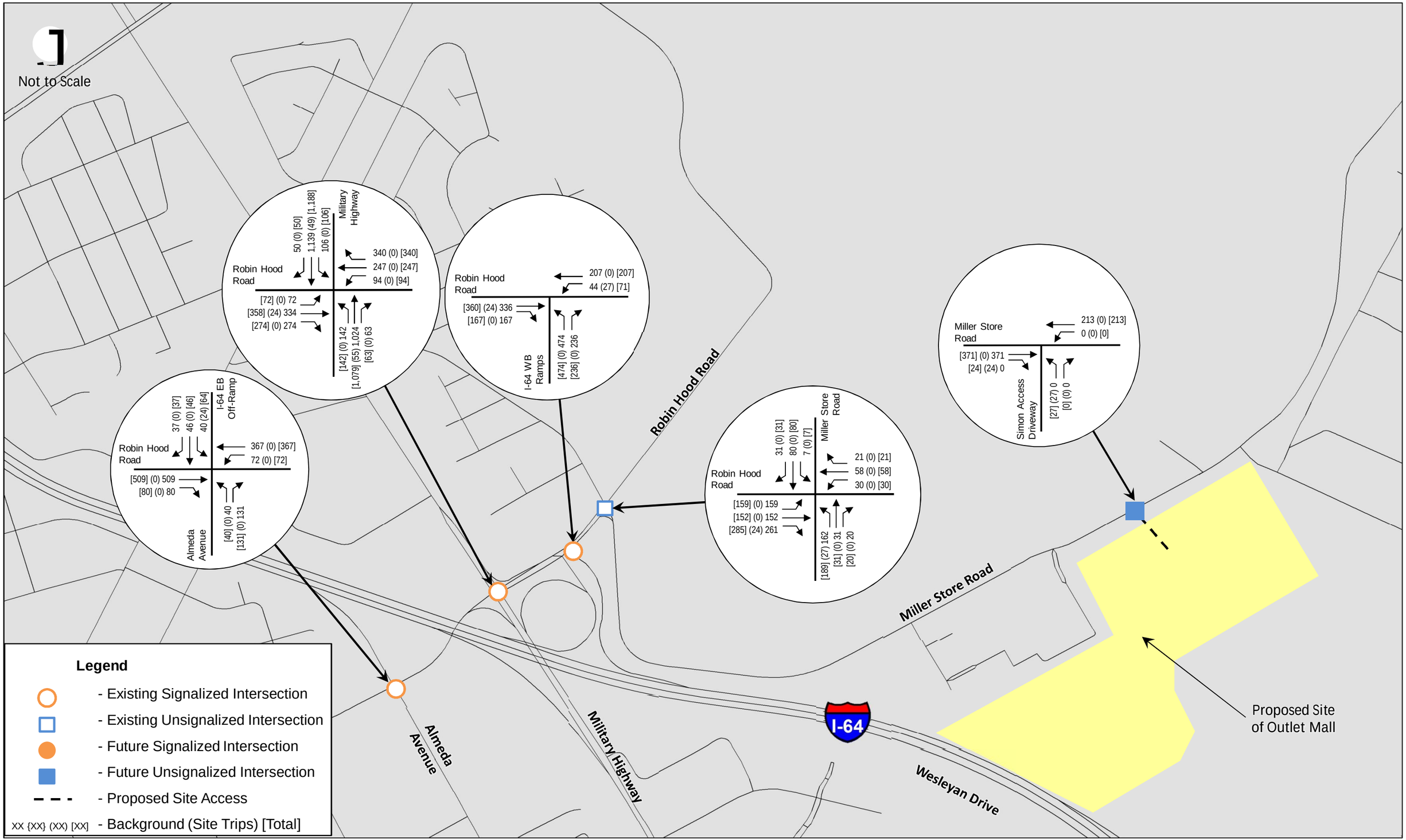
Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Turning Movement Count Data – Northampton Boulevard
Future (2015) PM Peak Hour

FIGURE
7

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



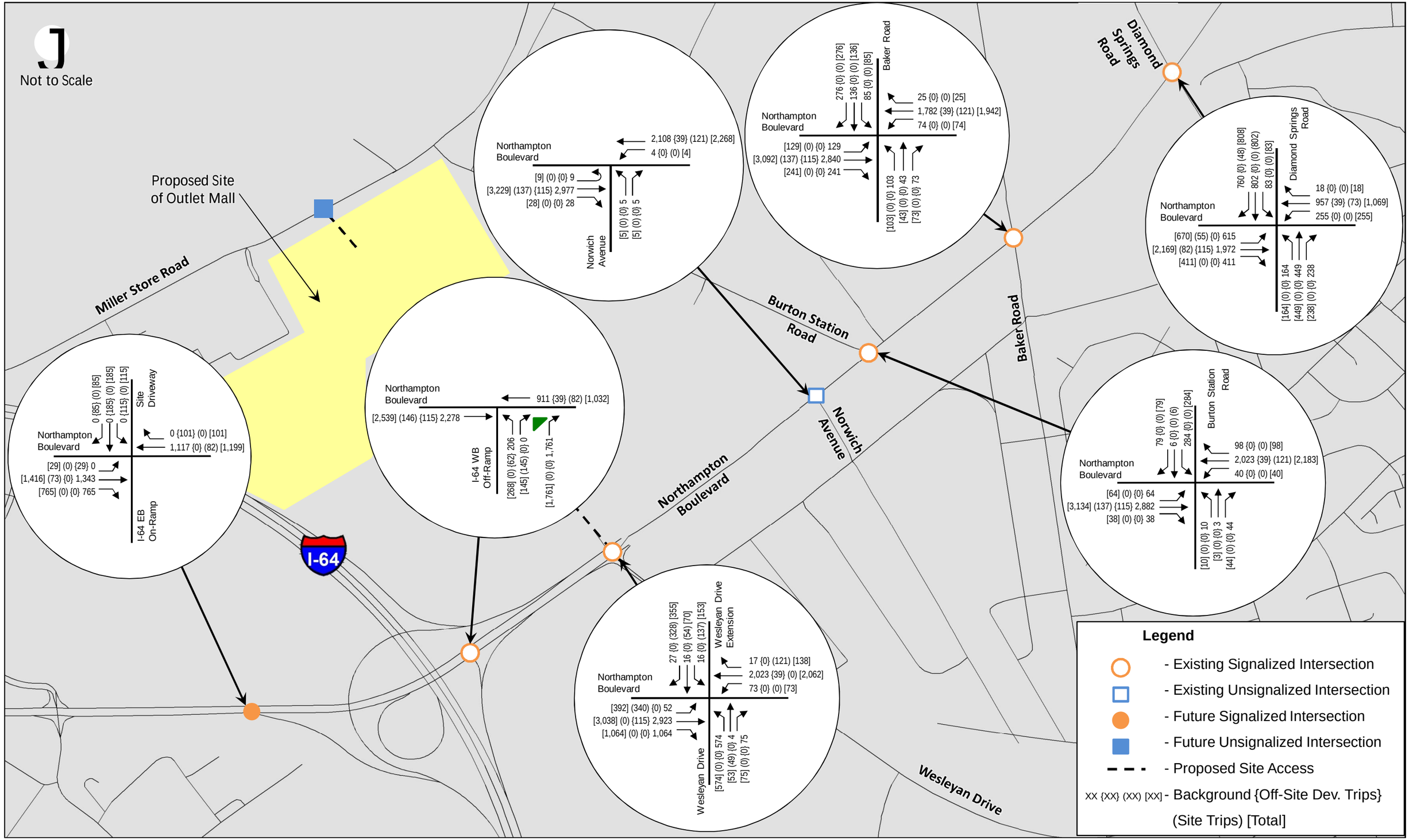
Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Turning Movement Count Data – Robin Hood Road
Future (2015) PM Peak Hour

FIGURE
8

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



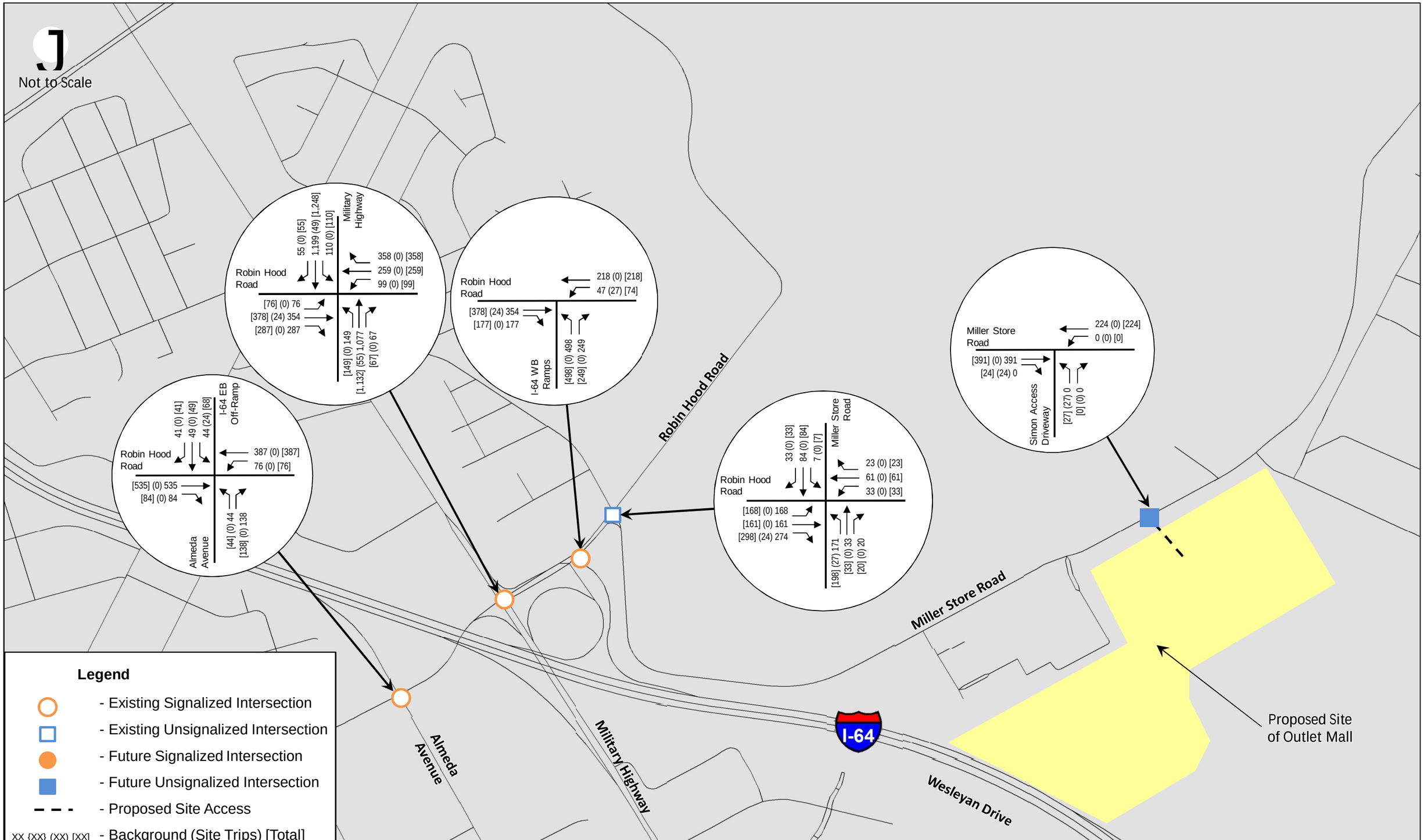
Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Turning Movement Count Data – Northampton Boulevard
Future (2021) PM Peak Hour

FIGURE
9

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Turning Movement Count Data – Robin Hood Road
Future (2021) PM Peak Hour

FIGURE
10

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

8.0 Intersection Operational Analysis

Capacity analysis for the signalized and unsignalized intersections in the PM peak hour was performed for the following scenarios:

- Existing (2012)
- 2015 No Build
- 2015 with the proposed development (Build)
- 2021 No Build
- 2021 with the proposed development (Build)

Signalized intersection operations were optimized as a coordinated system using *Synchro Professional 8.0*; however, since the analysis needed to evaluate the freeway/ramp/arterial interaction, VDOT requested that all formal analysis be performed with CORSIM *(TSIS Version 6.3)*. This approach is consistent with VDOT's *Traffic Operations Analysis Tool Guidebook* (TOATG). All intersections were analyzed in terms of average control delay and queuing. Additionally, level-of-service (LOS) was documented based on the average control delays reported. All elements of the intersection capacity analyses, including coding methodology, input parameters, calibration, and output reporting, were compliant with the guidance provided in the TOATG.

CORSIM (*COR*ridor microscopic *SIM*ulation) is a micro level traffic simulation and analytical tool which incorporates both urban traffic and freeway traffic simulation. Unlike standard Highway Capacity Manual (HCM) methodologies, which provide an analytical macroscopic snapshot, CORSIM can evaluate the integrity of geometry as volumes and speeds fluctuate. The traffic simulation output includes user-selected and defined Measures of Effectiveness (MOEs), which can be evaluated for variations in traffic operations under multiple scenarios.

8.1 Intersection Operational Analysis Results

The CORSIM analysis and simulation results were used to determine existing and future levels of service. Level of service (LOS) describes traffic conditions in the amount of traffic congestion at an intersection or on a roadway. LOS ranges from A to F, where LOS A indicates a condition of little or no congestion and LOS F indicates a condition with severe congestion, unstable traffic flow, and stop-and-go conditions. LOS A through LOS D are considered acceptable. LOS and delay determined using CORSIM were reported based on the LOS criteria for signalized and unsignalized intersections indicated in the 2010 *Highway Capacity Manual* (see **Table 3**).

Table 3 —LOS and Ranges of Delay

LOS	Delay per Vehicle (seconds per vehicle)	
	Signalized	Unsignalized
A	≤ 10	≤ 10
B	> 10 – 20	> 10 – 15
C	> 20 – 35	> 15 – 25
D	> 35 – 55	> 25 – 35
E	> 55 – 80	> 35 – 50
F	> 80	> 50

All analyses were conducted within the "TSIS Next" module of CORSIM. This built-in module provides the same outputs as the standard package, but is more appropriate in the analysis of signalized intersections involving detailed mainline signal coordination and lead-lag left-turn phasing.

Since CORSIM is a micro-simulation tool, results vary by each simulation run. Therefore, simulated volumes and average control delay are variables for each analysis scenario. This means that results across analysis scenarios could seem inconsistent. This is not the case – all simulated volumes are within (+/-) 10% of actual volumes and therefore, all results are valid. Throughout this chapter, average control delay and queuing are summarized in tabular formats. There are a few instances where intuitively, results do not correlate to increased volumes. A hypothetical example is that an intersection appears to be operating better with more volume under 2015 build conditions than 2015 no build.

For the most part, all variations in results were minor in nature (within a few seconds). Where variations are greater than a few seconds, additional reasoning is provided in the text to justify or explain these results. While there are numerous reasons why results may differ slightly, there are three primary explanations as to why this occurs for this simulation – all of which do not discount the validity of the results.

Reason 1 – CORSIM results are dynamic representations of traffic operations and are not based on a single equation, but dynamic algorithms. With the dynamic nature, simulated volumes may be greater than or less than the actual volumes in a simulation run. Based on how vehicles arrive at the signalized intersections, average control delay can fluctuate.

In other words, a scenario (i.e., 2015 build) with more traffic demand can show an average control delay less than or equal to that of a scenario with less traffic demand (i.e., 2015 no build), even if the signal timings are kept constant.

Reason 2 – CORSIM results are averaged. All micro-simulation analysis is an iterative process. This means that one simulation run is never taken to be representative of final results. In this report, 10 simulation runs were conducted for each scenario, before being averaged together. When averaged together, variance is introduced.

Reason 3 – Low volumes. Low volumes are another common reason as to why no build and build results could appear inconsistent at first glance. The best way of explaining this is with an example. Hypothetically, an approach has an actual volume of five (5) vehicles per hour (vph). If the average CORSIM simulation results show a simulated volume of six (6) vph, the average control delay of that extra vehicle will be incorporated into the results. This would be different from a simulation run which has exactly five (5) vph simulated. In the end, this is only one (1) vph that is causing the skew in interpretation amongst results. In general however, LOS results should be consistent in either scenario. If not, this will be addressed in the text that accompanies the tabular results throughout this chapter.

Each of the aforementioned scenarios was analyzed during the weekday PM peak hour. During the existing (2012) scenario, cycle lengths, splits, and offsets were maintained per City of Norfolk and City of Virginia Beach signal timing plans provided. In the future, no build, and build scenarios, cycle lengths were maintained, but splits and offsets were optimized.

In addition to the LOS analysis, a queuing analysis was performed using CORSIM. In the sections below, the queuing analysis tables show the available storage along the link by movement and the maximum queue length that was reported. Those movements that exceed the available storage are illustrated with bold text. The available storage reported represents the length of effective storage (full storage plus half of the taper), distance to the nearest full movement intersection, or distance to the start of the gore area. A maximum storage length of 1,500 feet was reported.

8.1.1 Northampton Boulevard/Lake Wright East

This intersection does not currently exist but will be constructed as part of the planned Lake Wright East development and is anticipated to be operating as a signalized intersection under the future year scenarios. This proposed intersection will provide the following laneage:

- Northampton Boulevard (northbound)—one exclusive left-turn lane, three exclusive through lanes, and one exclusive, yield-controlled right-turn lane
- Northampton Boulevard (southbound)—three exclusive through lanes and one exclusive right-turn lane
- Lake Wright East (eastbound)—one exclusive left-turn lane, one exclusive through lane, and one exclusive right-turn lane

Under 2015 and 2021 no build and build conditions, this signalized intersection is anticipated to operate acceptably at overall LOS B during the PM peak hour, with all movements operating at a LOS D or better with the exception of the northbound left-turn movement. This movement is anticipated to operate at LOS E for all future no build and build conditions. However, this movement is anticipated to experience a low peak hour volume and the poor LOS is a function of the high cycle length (160 seconds) and arrival of the platoon which cannot be overcome by increasing green time allocation. Nominal increases in delay are anticipated in future conditions with the addition of site traffic as the additional volume is associated with the mainline through movements.

Table 4 shows levels of service and delay for the intersection under 2015 and 2021 no build and 2015 and 2021 build conditions. LOS and delays are depicted graphically by lane group in **Figure 11** through **Figure 20**. Additionally, **Table 5** indicates the anticipated queuing for each movement at this intersection. As shown, all movements are expected to be accommodated by the available storage with the exception of minimal queue spillback for the eastbound left-turn movement which is anticipated to exceed capacity by 50 feet (two vehicles) for 2015 and 2021 no build and build conditions. Queuing is not anticipated to create any adverse impacts to Northampton Boulevard at this intersection. Detailed level of service and queuing calculations are provided in the **Appendix.**

Table 4—Northampton Boulevard/Lake Wright East
PM Peak Hour Signalized Intersection LOS

Scenario	Overall LOS	Level of Service per Movement by Approach (Delay in sec/veh)						
		Northbound		Southbound		Eastbound		
		LT	TH	TH	RT	LT	TH	RT
2015 No Build	B (18.6)	E (69.9)	B (13.8)	B (18.9)	A (2.5)	D (38.0)	D (40.4)	A (4.0)
		B (15.6)		B (17.4)		C (32.3)		
2015 Build	B (18.6)	E (68.2)	B (14.5)	B (18.9)	A (2.8)	D (38.3)	D (38.9)	A (5.4)
		B (16.0)		B (17.6)		C (31.4)		
2021 No Build	B (19.4)	E (66.5)	B (14.0)	C (20.6)	A (3.2)	D (40.6)	D (40.9)	A (5.1)
		B (15.5)		B (19.2)		C (33.5)		
2021 Build	B (18.7)	E (69.0)	B (13.7)	C (20.1)	A (4.0)	D (39.7)	D (38.8)	A (5.4)
		B (15.0)		B (18.9)		C (32.0)		

Source: Kimley-Horn and Associates, Inc.

Table 5—Northampton Boulevard/Lake Wright East
PM Peak Hour Queuing

Scenario	Queue Lengths (feet)						
	Northbound		Southbound		Eastbound		
	LT	TH	TH	RT	LT	TH	RT
Future Storage Length	*350**	*1,500*	*1,250*	*175**	*150**	*300**	*150**
2015 No Build	125	325	325	75	200	275	75
2015 Build	100	375	375	50	200	250	75
2021 No Build	100	350	400	50	200	275	75
2021 Build	125	400	475	50	200	275	75

Source: Kimley-Horn and Associates, Inc.

*Storage lengths are based on the site plan provided in the Lake Wright East Traffic Impact Analysis.

8.1.2 Northampton Boulevard/Interstate 64 Westbound Off-Ramp

This signalized intersection currently provides the following laneage:

- Northampton Boulevard (northbound)—three exclusive through lanes
- Northampton Boulevard (southbound)—three exclusive through lanes
- Interstate 64 Westbound Off-Ramp (westbound)—two exclusive left-turn lanes and one exclusive, free-flow right-turn lane

Under future scenario build conditions, the geometry reflects an improved intersection that provides for the following configuration:

- Northampton Boulevard (northbound)—three exclusive through lanes
- Northampton Boulevard (southbound)—three exclusive through lanes
- Interstate 64 Westbound Off-Ramp (westbound)—one exclusive left-turn lane, one shared left/right-turn lane, and one exclusive, free-flow right-turn lane

The Northampton Boulevard/Interstate 64 Westbound Off-Ramp intersection operates acceptably at overall LOS A under existing (2012) conditions with all movements operating at LOS D or better. Mainline through movements experience minimal delay, operating at LOS A in both directions. Under 2015 and 2021 no build and build conditions with optimized signal timings, the intersection is anticipated to operate at overall LOS B. The addition of anticipated background growth results in increased traffic volumes for the Interstate 64 Westbound Off-Ramp left-turn movement; however, some future delays were observed to decrease slightly which is attributable to those reasons defined in **Section 8.1**. Under the 2015 and 2021 build conditions, the westbound approach is reconfigured to provide both left-turn and right-turn movements at the signal along with the existing channelized right-turn movement. The purpose of providing the additional right-turn movement at the signal is to accommodate trips associated with the Simon Outlet Center. This second right-turn lane will make it easier for vehicles destined for the development to merge into the northbound left-turn lane at the proposed Wesleyan Drive Extension access to the site. It is anticipated that this movement will be accommodated by a protected phase at this signalized intersection; therefore northbound vehicles will be stopped at the I-64 off ramp intersection which will allow vehicles to more easily reach the northbound left-turn lane at Wesleyan Drive. These turns are expected to operate at LOS C under both build scenarios and are not expected to substantially impact the westbound left-turn operations.

Table 6 shows levels of service and delay for the intersection under existing (2012), 2015 and 2021 no build, and 2015 and 2021 build conditions. LOS and delays are depicted graphically by lane group in **Figure 11** through **Figure 20**. Additionally, **Table 7** indicates the anticipated queuing for each movement at this intersection. As shown, all movements are expected to be accommodated by the available storage with the exception of the westbound left-turn lane, which is exceeding available storage capacity today under existing conditions. Although the storage is exceeded slightly, queues are not anticipated to impact mainline I-64. As mentioned, the development does not have a significant impact on this movement and therefore this condition is the result of naturally

anticipated background growth in the study area. Detailed level of service and queuing calculations are provided in the **Appendix.**

Table 6—Northampton Boulevard/Interstate 64 Westbound Off-Ramp PM Peak Hour Signalized Intersection LOS

Scenario	Overall LOS	Level of Service per Movement by Approach (Delay in sec/veh)			
		Northbound	Southbound	Westbound	
		TH	TH	LT	LT/RT
2012 Existing	A (7.8)	A (5.3)	A (3.3)	D (54.7)	-
2015 No Build	B (11.8)	B (10.8)	A (6.7)	D (38.9)	-
2015 Build	B (17.7)	B (11.0)	C (26.2)	D (38.2)	C (33.6)
				D (36.5)	
2021 No Build	B (12.2)	B (10.7)	A (7.8)	D (40.1)	-
2021 Build	B (17.4)	B (10.5)	C (26.8)	D (39.0)	C (33.1)
				D (37.0)	

Source: Kimley-Horn and Associates, Inc.

Table 7—Northampton Boulevard/Interstate 64 Westbound Off-Ramp PM Peak Hour Queuing

Scenario	Queue Lengths (feet)			
	Northbound	Southbound	Westbound	
	TH	TH	LT	LT/RT
Existing Storage Length	*600*	*1,200*	*385*	-
2012 Existing	400	150	550	-
2015 No Build	275	225	625	-
2015 Build	475	500	600	250
2021 No Build	425	275	625	-
2021 Build	500	500	650	250

Source: Kimley-Horn and Associates, Inc.

8.1.3 Northampton Boulevard/Wesleyan Drive

This signalized intersection currently provides the following laneage:

- Northampton Boulevard (northbound)—one exclusive left-turn lane, four exclusive through lanes, and one exclusive, channelized yield-controlled right-turn lane
- Northampton Boulevard (southbound)—one exclusive left-turn lane, three exclusive through lanes, and one shared through and right-turn lane
- Wesleyan Drive (westbound)—one exclusive left-turn lane and one shared left/through/ channelized yield-controlled right-turn lane
- Wesleyan Drive (eastbound)—one exclusive left-turn lane and one shared through and right-turn lane

Under the no build future year scenarios, the geometry reflects an improved intersection that provides for the following laneage:

- Northampton Boulevard (northbound)—one exclusive left-turn lane, four exclusive through lanes, and one exclusive channelized yield-controlled right-turn lane
- Northampton Boulevard (southbound)—one exclusive left-turn lane, three exclusive through lanes, and one shared through and right-turn lane
- Wesleyan Drive (westbound)—three exclusive left-turn lanes, one exclusive through lane, and one exclusive channelized yield-controlled right-turn lane
- Wesleyan Drive (eastbound)—one shared through and left-turn lane and one exclusive right-turn lane

Under the build future year scenarios, the proposed geometry reflects a further improved intersection that provides for the following laneage:

- Northampton Boulevard (northbound)—one exclusive left-turn lane, four exclusive through lanes, and one exclusive channelized yield-controlled right-turn lane
- Northampton Boulevard (southbound)—one exclusive left-turn lane, four exclusive through lanes, and one exclusive right-turn lane
- Wesleyan Drive (westbound)—three exclusive left-turn lanes, one exclusive through lane, and one exclusive channelized yield-controlled right-turn lane
- Wesleyan Drive Extension (eastbound)—two exclusive left-turn lanes, one exclusive through lane, and one exclusive right-turn lane

Under existing conditions and geometry at the time turning movement counts were collected, the intersection operated at an overall LOS C, with select movements and approaches operating at LOS E or LOS F. During the PM peak hour, the through movements carry significant volume, with competing demand on the westbound approach to the intersection.

With the increment of background traffic volume growth and accounting for intersection improvements, the overall intersection is anticipated to continue to operate at LOS C under the 2015 and 2021 no build conditions. While the intersection improvements provide for additional capacity for the westbound approach, the added capacity allows for the allocation of additional green time to the mainline which improves operations. Mainline left-turn movements will continue

to operate at LOS F and is a function of the platoon arrival and cycle length. For 2021 no build conditions, delays were calculated to slightly improve although volumes increased and signal timings were maintained. This is a function of those reasons defined in **Section 8.1**.

Under 2015 and 2021 build conditions, the intersection is anticipated to operate at overall LOS D and will provide the primary access point for the site along Northampton Boulevard. With the proposed site development traffic using this intersection an overall increase in delay is anticipated when compared to the no build scenarios. Delay for most movements is anticipated to increase compared to no build conditions with the exception of the northbound left-turns and the westbound through movement in 2015. The reduction in operational delay for these movements can be attributed to the optimized signal timings at this intersection to accommodate the proposed site driveway.

Table 8 shows levels of service and delay for the intersection under existing (2012), 2015 and 2021 no build, and 2015 and 2021 build conditions. LOS and delays are depicted graphically by lane group in **Figure 11** through **Figure 20**. Additionally, **Table 9** indicates the anticipated queuing for each movement at this intersection. As shown, all movements are expected to be accommodated by the available storage under existing and no build scenarios. Under the build scenarios the northbound left-turns and throughs, southbound left-turns, and eastbound right-turns are expected to exceed their storage length by 50 feet (2 vehicles) or more. Detailed level of service and queuing calculations are provided in the **Appendix.**

Table 8—Northampton Boulevard/Wesleyan Drive
PM Peak Hour Signalized Intersection LOS

Scenario	Overall LOS	Level of Service per Movement by Approach (Delay in sec/veh)											
		Northbound			Southbound			Westbound			Eastbound		
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
2012 Existing	C (29.1)	F (81.7)	C (20.3)	A (4.5)	E (79.0)	D (41.3)		E (57.7)	D (46.2)		E (70.8)	D (39.9)	
		B (17.4)			D (42.4)			E (56.4)			D (49.4)		
2015 No Build	C (21.6)	F (90.4)	A (8.0)	A (1.7)	F (89.5)	C (34.5)		E (63.3)	E (73.0)	A (3.1)	E (70.0)		A (8.1)
		A (7.8)			D (36.3)			E (57.1)			D (42.8)		
2015 Build	D (42.1)	E (77.1)	C (34.1)	A (7.5)	F (105.7)	E (57.6)	C (23.5)	E (63.3)	E (57.1)	A (8.8)	E (75.2)	F (84.8)	B (18.5)
		C (31.5)			E (57.4)			E (57.9)			D (42.6)		
2021 No Build	C (20.7)	F (93.8)	A (8.3)	A (1.9)	F (89.3)	C (31.1)		E (60.9)	D (51.6)	A (3.0)	E (74.0)		A (7.3)
		A (8.2)			C (33.0)			D (54.3)			D (44.9)		
2021 Build	D (45.0)	F (82.2)	C (30.5)	A (8.6)	F (135.0)	E (64.6)	C (28.0)	E (78.1)	E (65.0)	A (9.0)	F (96.2)	F (106.2)	C (20.1)
		C (29.7)			E (65.1)			E (70.0)			D (51.6)		

Source: Kimley-Horn and Associates, Inc.

Table 9—Northampton Boulevard/Wesleyan Drive
PM Peak Hour Queuing

Scenario	Queue Lengths (feet)											
	Northbound			Southbound			Westbound			Eastbound		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Existing Storage Length	*400*	*725*	*725*	*200*	*1,150*		*775*	*800*		*100*	*100*	
2012 Existing	175	700	425	200	750		475	375		75	100	
Future Storage Length	*800*	*725*	*725*	*250*	*975*	*200*	*600*	*775*	*775*	*200*	*1,000+*	*200*
2015 No Build	150	425	250	200	750		325	50	50	100		50
2015 Build	525	800	575	250	775	100	350	150	75	175	225	250
2021 No Build	200	450	275	250	725		325	50	50	125		50
2021 Build	600	800	625	225	925	100	375	125	100	175	250	250
	Source: Kimley-Horn and Associates, Inc.											

8.1.4 Northampton Boulevard/Norwich Avenue

This unsignalized intersection currently provides the following laneage:

- Northampton Boulevard (northbound)—one exclusive left-turn lane (U-turn), three exclusive through lanes, and one shared through and right-turn lane
- Northampton Boulevard (southbound)—one exclusive left-turn lane and four exclusive through lanes
- Norwich (westbound)—one stop-controlled shared left and right-turn lane

The Northampton Boulevard/Norwich Avenue intersection operates acceptably at overall LOS A during all scenarios. The southbound left-turn and westbound approach experience delays but operate acceptably as they are required to yield to the uncontrolled through movements along Northampton Boulevard. Under build conditions, delays for the westbound approach and southbound left-turn increase significantly mainly due to blocking at the intersection caused by northbound queues from the adjacent Burton Station/Northampton Boulevard intersection to the north. Lengthy queues at the adjacent signal spill back beyond the Norwich intersection which blocks westbound movements and increases delay.

Table 10 shows levels of service and delay for the intersection under existing (2012), 2015 and 2021 no build, and 2015 and 2021 build conditions. LOS and delays are depicted graphically by lane group in **Figure 11** through **Figure 20**. Additionally, **Table 11** indicates the anticipated queuing for each movement at this intersection. As shown, all movements are expected to be accommodated by the available storage. Detailed level of service and queuing calculations are provided in the **Appendix.**

Table 10—Northampton Boulevard/Norwich Avenue PM Peak Hour Unsignalized Intersection LOS

Scenario	Overall LOS	Level of Service per Movement by Approach (Delay in sec/veh)					
		Northbound		Southbound		Westbound	
		TH	RT	LT	TH	LT	RT
2012 Existing	A (0.2)	A (0.0)		E (43.8)	A (0.0)	E (36.0)	
				A (0.3)			
2015 No Build	A (0.1)	A (0.0)		C (22.7)	A (0.0)	B (15.0)	
				A (0.2)			
2015 Build	A (0.1)	A (0.0)		A (0.0)	A (0.0)	F (66.7)	
				A (0.0)			
2021 No Build	A (0.1)	A (0.0)		D (29.2)	A (0.0)	C (16.2)	
				A (0.2)			
2021 Build	A (0.1)	A (0.0)		A (0.0)	A (0.0)	F (54.2)	
				A (0.0)			

Source: Kimley-Horn and Associates, Inc.

Table 11—Northampton Boulevard/Norwich Avenue PM Peak Hour Queuing

Scenario	Queue Lengths (feet)					
	Northbound		Southbound		Westbound	
	TH	RT	LT	TH	LT	RT
Existing Storage Length	*575*		*150*	*475*	*400*	
2012 Existing	175		75	25	75	
2015 No Build	25		75	25	50	
2015 Build	0		25	0	75	
2021 No Build	25		75	25	50	
2021 Build	0		25	0	50	

Source: Kimley-Horn and Associates, Inc.

8.1.5 Northampton Boulevard/Burton Station Road

This signalized intersection currently provides the following laneage:

- Northampton Boulevard (northbound)—one exclusive left-turn lane, three exclusive through lanes, and one shared through and right-turn lane
- Northampton Boulevard (southbound)—one exclusive left-turn lane, three exclusive through lanes, and one shared through and right-turn lane
- Burton Station Road/McDonald's Restaurant Site Driveway (westbound)—one shared left/through/right-turn lane
- Burton Station Road (eastbound)—one shared left/through/right-turn lane

Under existing (2012) conditions, the signalized intersection of Northampton Boulevard/Burton Station Road operates at an overall LOS B, with some movements experiencing LOS E or LOS F. Mainline through movements along Northampton Boulevard operate acceptably at LOS B or better. Mainline left-turn movements, which are protected-only maneuvers, experience significant delay. However, the turning movement volumes are low when compared to the adjacent through movement volumes. Side-street delay is significant for the eastbound approach, which can be attributed to the cycle length, permissive signal operations, and the single lane approach to the intersection.

With the increment of background traffic volume growth, the intersection will continue to operate at an overall LOS B during the 2015 and 2021 scenarios. Similar LOS is expected as compared to existing conditions, with minimal changes in delay in most movements and approaches. Under the 2015 and 2021 build scenarios, the additional traffic volume at the intersection generated by the project site affects the mainline through movements only. As such, the northbound through movements under these scenarios is expected to experience an increase in delay from a LOS A in no build conditions to LOS D in both build conditions. This is a reflection of the signal optimization for the site driveway south of the intersection at Wesleyan Drive. Little change is expected for the mainline left-turn and side-street movements. However, during the build scenarios, some delays were decreased when compared to the respective no-build scenarios. This is attributed to the low volumes for this movement and the reasons defined in **Section 8.1**, but all scenarios still result in the same LOS for those movements between respective no build and build scenarios with the exception of the northbound through.

Table 12 shows levels of service and delay for the intersection under existing (2012), 2015 and 2021 no build, and 2015 and 2021 build conditions. LOS and delays are depicted graphically by lane group in **Figure 11** through **Figure 20**. Additionally, **Table 13** indicates the anticipated queuing for each movement at this intersection. As shown, all movements are expected to be accommodated by the available storage with the exception of the northbound approach, which is anticipated to be exceed available storage and spill back beyond the Norwich Avenue intersection. Detailed level of service and queuing calculations are provided in the **Appendix.**

Table 12—Northampton Boulevard/Burton Station Road
PM Peak Hour Signalized Intersection LOS

Scenario	Overall LOS	Level of Service per Movement by Approach (Delay in sec/veh)											
		Northbound			Southbound			Westbound			Eastbound		
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
2012 Existing	B (13.8)	F (98.3)	A (4.3)		E (61.6)	B (14.4)		C (26.0)			E (60.2)		
		A (6.7)			B (15.6)								
2015 No Build	B (10.9)	F (117.8)	A (1.9)		E (64.7)	B (11.9)		C (21.2)			D (47.1)		
		A (4.9)			B (13.0)								
2015 Build	C (30.6)	F (143.3)	D (37.8)		E (62.6)	B (13.9)		C (20.2)			D (47.4)		
		D (40.4)			B (14.9)								
2021 No Build	B (11.4)	F (112.0)	A (2.8)		E (66.4)	B (12.0)		B (18.6)			D (48.4)		
		A (5.6)			B (13.2)								
2021 Build	C (30.2)	F (132.3)	D (36.3)		E (62.9)	B (15.1)		C (23.5)			D (47.3)		
		D (38.6)			B (16.1)								

Source: Kimley-Horn and Associates, Inc.

Table 13—Northampton Boulevard/Burton Station Road
PM Peak Hour Queuing

Scenario	Queue Lengths (feet)											
	Northbound			Southbound			Westbound			Eastbound		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Existing Storage Length	*150*	*475*		*150*	*1,300*		*150*			*3,500*		
2012 Existing	175	325		125	425		125			500		
2015 No Build	175	250		125	625		100			425		
2015 Build	175	900		125	525		100			425		
2021 No Build	175	175		150	625		100			450		
2021 Build	175	950		125	550		100			450		

Source: Kimley-Horn and Associates, Inc.

8.1.6 Northampton Boulevard/Baker Road

This signalized intersection currently provides the following laneage:

- Northampton Boulevard (northbound)—one exclusive left-turn lane, three exclusive through lanes, and one shared through and channelized yield-controlled right-turn lane
- Northampton Boulevard (southbound)—one exclusive left-turn lane, three exclusive through lanes, and one shared through and channelized yield-controlled right-turn lane
- Baker Road (westbound)—one exclusive left-turn lane, one exclusive through lane, and one exclusive right-turn lane
- Baker Road (eastbound)—one exclusive left-turn lane, one exclusive through lane, and one exclusive right-turn lane

This intersection operates acceptably at overall LOS B under existing (2012) conditions. Similar to Burton Station Road, mainline through movements for the northbound approach experience little delay, operating at a LOS A under all scenarios. The mainline through movements for the southbound approach operate at LOS C or better under all scenarios. Mainline left-turn movements as well as side-street through and left-turn movements operate at a LOS D or worse. Mainline left-turn volumes are somewhat more significant than those at Burton Station Road, but side-street movements are much more balanced between the two approaches to the intersection. Delay for the westbound and eastbound approaches is relatively similar, with both operating at LOS D and LOS E, respectively.

Considering 2015 and 2021 no build conditions, the intersection is anticipated to operate at overall LOS C for both scenarios. The eastbound approach is expected to increase in delay and operate at LOS E. However, due to signal optimization, the northbound left turn movement is expected to experience a significant reduction in delay improving from a high LOS E to a LOS D for the no build scenarios. The additional volume at the intersection associated with the proposed development will result in an increased number of mainline through movements. However, the impact to overall intersection operations will be minimal, with incremental increases in delay expected for most movements when compared to no build conditions. The intersection will continue to operate at a LOS C under the 2015 and 2021 build conditions.

Table 14 shows levels of service and delay for the intersection under existing (2012), 2015 and 2021 no build, and 2015 and 2021 build conditions. LOS and delays are depicted graphically by lane group in **Figure 11** through **Figure 20**. Additionally, **Table 15** indicates the anticipated queuing for each movement at this intersection. All queues are expected to be contained within the provided storage with the exception of the eastbound right-turn lane, which is expected to spill beyond available storage by at least 75 feet (3 vehicles). Detailed level of service and queuing calculations are provided in the **Appendix.**

Table 14—Northampton Boulevard/Baker Road
PM Peak Hour Signalized Intersection LOS

Scenario	Overall LOS	Level of Service per Movement by Approach (Delay in sec/veh)											
		Northbound			Southbound			Westbound			Eastbound		
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
2012 Existing	B (15.1)	E (73.4)	A (6.4)		E (62.6)	B (11.7)		E (72.5)	E (65.0)	A (4.7)	E (70.0)	F (85.4)	B (16.0)
		A (9.3)			B (13.7)			D (49.0)			D (44.2)		
2015 No Build	C (20.9)	D (40.7)	A (3.8)		E (71.5)	C (33.2)		E (74.3)	E (66.3)	A (4.7)	F (82.3)	F (105.2)	C (23.6)
		A (5.5)			C (34.8)			D (51.0)			E (57.3)		
2015 Build	C (24.9)	D (48.1)	A (10.0)		E (74.0)	C (33.9)		E (73.9)	E (68.8)	A (5.5)	F (85.5)	F (106.4)	C (28.9)
		B (11.7)			D (35.5)			D (49.7)			E (60.4)		
2021 No Build	C (22.1)	D (40.8)	A (4.8)		E (77.0)	C (33.3)		E (78.1)	E (66.7)	A (4.8)	F (84.2)	F (109.4)	C (30.4)
		A (6.5)			D (35.3)			D (52.8)			E (62.0)		
2021 Build	C (24.7)	D (46.6)	A (9.0)		E (75.5)	C (33.5)		E (72.6)	E (66.6)	A (4.8)	F (85.0)	F (110.2)	D (38.6)
		B (10.5)			D (35.3)			D (47.4)			E (67.1)		

Source: Kimley-Horn and Associates, Inc.

Table 15—Northampton Boulevard/Baker Road
PM Peak Hour Queuing

Scenario	Queue Lengths (feet)											
	Northbound			Southbound			Westbound			Eastbound		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Existing Storage Length	*425*	*1,300*		*375*	*800*		*275*	*525*	*275*	*225*	*1,500*	*250*
2012 Existing	175	375		200	350		225	125	75	175	375	275
2015 No Build	175	225		200	600		225	125	75	225	475	300
2015 Build	150	350		200	625		200	125	75	200	625	300
2021 No Build	175	275		225	625		225	125	75	175	650	325
2021 Build	175	350		225	625		225	125	75	200	675	325

Source: Kimley-Horn and Associates, Inc.

8.1.7 Northampton Boulevard/Diamond Springs Road

This signalized intersection currently provides the following laneage:

- Northampton Boulevard (northbound)—two exclusive left-turn lanes, four exclusive through lanes, and one exclusive channelized yield-controlled right-turn lane
- Northampton Boulevard (southbound)—one exclusive left-turn lane, three exclusive through lanes, and one exclusive channelized yield-controlled right-turn lane
- Diamond Springs Road (westbound)—two exclusive left-turn lanes, three exclusive through lanes, and one exclusive channelized yield-controlled right-turn lane
- Diamond Springs Road (eastbound)—one exclusive left-turn lane and two exclusive through lanes (the channelized right-turn lane is outside the realm of influence of the signalized intersection)

The Northampton Boulevard/Diamond Springs Road intersection is a congested intersection today, with Diamond Springs Road providing access to the Little Creek Joint Expeditionary Base to the north and Interstate 264 (I-264) to the south, hence the heavy northbound left-turn movement along Northampton Boulevard to Diamond Springs Road. During the PM peak hour, several conflicting movements carry heavy volumes, which results in the overall intersection operating at LOS D. To accommodate the significant volume of northbound left-turn movements, the southbound through movement is allocated less green time than at the nearby Baker Road intersection. As such, the movement operates at LOS D. The eastbound approach operates at LOS E while the westbound approach operates at LOS D.

Under future no build conditions, the incremental increase in traffic volumes has a minimal impact on intersection operations. Green time was reallocated to balance the demand between conflicting through and left-turn movements. Overall intersection LOS D is maintained under no build conditions. Due to the reallocation of green time, the mainline left-turns are expected to experience less delay than that experienced in the existing conditions. Accounting for new site trips generated by the proposed development, an increase in volume is expected for the mainline through movements as well as the northbound left-turn movement for 2021 build conditions. The additional volume for these movements increases delay slightly, while maintaining LOS for all movements as compared to the 2015 no build condition. Generally, changes in LOS from no build to build conditions are minimal and occur for movements which were already experiencing delays near the threshold of a worse LOS.

Table 16 shows levels of service and delay for the intersection under existing (2012), 2015 and 2021 no build, and 2015 and 2021 build conditions. LOS and delays are depicted graphically by lane group in **Figure 11** through **Figure 20**. Additionally, **Table 17** indicates the anticipated queuing for each movement at this intersection. As shown, all movements are expected to be accommodated by the available storage with the exception of the northbound and southbound left-turn movements. This queue spillback is an existing condition and is not made worse by development traffic. Detailed level of service and queuing calculations are provided in the **Appendix.**

Table 16—Northampton Boulevard/Diamond Springs Road
PM Peak Hour Signalized Intersection LOS

Scenario	Overall LOS	Level of Service per Movement by Approach (Delay in sec/veh)										
		Northbound			Southbound			Westbound			Eastbound	
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH
2012 Existing	D (35.5)	D (43.9)	B (18.5)	A (3.1)	E (77.1)	D (37.6)	A (1.7)	E (67.8)	D (45.8)	B (10.5)	E (77.8)	E (61.2)
		C (21.8)			D (45.8)			D (40.5)			E (62.9)	
2015 No Build	D (37.4)	C (33.5)	C (26.0)	A (2.4)	E (73.0)	D (45.1)	A (2.6)	E (71.5)	D (52.0)	B (11.0)	E (72.1)	E (55.7)
		C (24.6)			D (50.4)			D (44.7)			E (57.3)	
2015 Build	D (40.0)	D (40.2)	C (25.8)	A (2.8)	E (76.7)	D (46.3)	A (2.8)	E (76.3)	D (52.1)	B (10.6)	F (83.1)	E (65.1)
		C (26.0)			D (51.7)			D (45.8)			E (66.9)	
2021 No Build	D (37.9)	C (31.5)	C (23.6)	A (2.3)	E (72.9)	D (45.0)	A (2.1)	E (75.1)	D (52.1)	B (11.0)	E (77.1)	E (67.0)
		C (22.6)			D (50.1)			D (45.6)			E (68.0)	
2021 Build	D (41.8)	D (37.4)	C (24.7)	A (2.8)	F (87.3)	D (46.5)	A (3.8)	E (77.7)	D (51.3)	B (12.8)	F (92.5)	E (78.7)
		C (24.8)			D (54.1)			D (46.2)			F (80.1)	

Source: Kimley-Horn and Associates, Inc.

Table 17—Northampton Boulevard/Diamond Springs Road
PM Peak Hour Queuing

Scenario	Queue Lengths (feet)										
	Northbound			Southbound			Westbound			Eastbound	
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH
Existing Storage Length	*350*	*1,500*	*575*	*325*	*1,500*	*300*	*275*	*575*	*250*	*350*	*1,500*
2012 Existing	400	550	200	375	350	25	200	200	200	200	550
2015 No Build	400	600	175	375	425	25	200	225	175	175	525
2015 Build	400	575	200	375	425	25	200	225	175	200	650
2021 No Build	400	575	150	375	450	25	225	225	175	200	750
2021 Build	400	575	175	375	450	25	200	250	175	200	725

Source: Kimley-Horn and Associates, Inc.

8.1.8 Robin Hood Road/Interstate 64 Eastbound Off-Ramp/Almeda Avenue

This signalized intersection currently provides the following laneage:

- Robin Hood Road (northbound)—one exclusive through lane and one shared through and right-turn lane
- Robin Hood Road (southbound)— one shared left and through lane and one exclusive through lane
- Almeda Avenue (westbound)—one exclusive left-turn lane and one exclusive right-turn lane
- Interstate 64 Eastbound Off-Ramp (eastbound)—one exclusive left-turn lane, one exclusive through lane, and one exclusive right-turn lane

This intersection operates at overall LOS A under existing (2012) operations during the PM peak hour, with all movements operating at LOS C or better. Compared to the adjacent intersection at Military Highway, intersection volumes are lower and fewer signal phases exist. As such, the intersection is able to operate more efficiently by running a half cycle (80 seconds). The half cycle length operations allow the signal to be more responsive to side-street demand, thereby reducing approach and intersection delay.

With the increment of background traffic volume growth, the intersection is expected to operate acceptably at overall LOS B, with all movements operating at a LOS C or better under 2015 and 2021 no build conditions. The addition of site generated trips to the intersection is minimal based on the trip distribution and assignment. Therefore, overall intersection operations are maintained under the build conditions, with insignificant changes in approach and intersection delay.

Table 18 shows levels of service and delay for the intersection under existing (2012), 2015 and 2021 no build, and 2015 and 2021 build conditions. LOS and delays are depicted graphically by lane group in **Figure 11** through **Figure 20**. Additionally, **Table 19** indicates the anticipated queuing for each movement at this intersection. As shown, all movements are expected to be accommodated by the available storage. Detailed level of service and queuing calculations are provided in the **Appendix.**

Table 18—Robin Hood Road/Interstate 64 Eastbound Off-Ramp/Almeda Avenue PM Peak Hour Signalized Intersection LOS

Scenario	Overall LOS	Level of Service per Movement by Approach (Delay in sec/veh)								
		Northbound		Southbound		Westbound		Eastbound		
		TH	RT	LT	TH	LT	RT	LT	TH	RT
2012 Existing	A (9.3)	A (5.3)		A (9.4)		C (34.0)	A (4.9)	C (31.5)	C (30.1)	A (3.5)
						B (12.1)		C (23.1)		
2015 No Build	B (12.3)	B (11.6)		B (11.8)		C (29.2)	A (4.7)	C (27.6)	C (25.6)	A (3.6)
						B (10.7)		B (19.9)		
2015 Build	B (12.6)	B (12.3)		B (11.0)		C (27.5)	A (4.6)	C (28.2)	C (26.3)	A (3.4)
						A (9.8)		C (21.5)		
2021 No Build	B (12.6)	B (12.3)		B (11.8)		C (29.0)	A (4.6)	C (27.4)	C (25.3)	A (3.5)
						B (10.6)		B (19.5)		
2021 Build	B (12.8)	B (11.8)		B (11.9)		C (28.5)	A (6.4)	C (28.1)	C (24.1)	A (3.7)
						B (11.9)		C (20.8)		

Source: Kimley-Horn and Associates, Inc.

Table 19—Robin Hood Road/Interstate 64 Eastbound Off-Ramp/Almeda Avenue PM Peak Hour Queuing

Scenario	Queue Lengths (feet)								
	Northbound		Southbound		Westbound		Eastbound		
	TH	RT	LT	TH	LT	RT	LT	TH	RT
Existing Storage Length	*675*		*900*		*1,000*	*1,000*	*225*	*900*	*275*
2012 Existing	175		200		100	100	100	100	50
2015 No Build	250		200		100	100	100	100	50
2015 Build	225		175		75	100	100	100	50
2021 No Build	250		200		100	100	100	100	50
2021 Build	250		225		100	125	100	75	50

Source: Kimley-Horn and Associates, Inc.

8.1.9 Military Highway/Robin Hood Road

This signalized intersection currently provides the following laneage:

- Robin Hood Road (northbound)—one exclusive left-turn lane and one shared through and channelized right-turn lane
- Robin Hood Road (southbound)—one exclusive left-turn lane, one exclusive through lane, and one exclusive channelized yield-controlled right-turn lane
- Military Highway (westbound)—one exclusive left-turn lane, two exclusive through lanes, and one exclusive right-turn lane
- Military Highway (eastbound)—one exclusive left-turn lane, two exclusive through lanes, and one exclusive right-turn lane

Existing signal operations at the intersection of Military Highway/Robin Hood Road operate at an overall LOS D. However, failing levels of service are exhibited by all left-turn movements and through movements along Robin Hood Road. The delay can be attributed to the cycle length as well as the platoon arrival associated with the half cycle signal operations at the adjacent intersections. The incremental increase in volume associated with background traffic volume growth results is associated with increases in delay under 2015 and 2021 no build conditions. The intersection maintains overall LOS D for the 2015 no build condition, but the 2021 LOS is expected to deteriorate to LOS E. When compared to the existing conditions, the Robin Hood Road approaches experience a decrease in delay for both scenarios from LOS E to LOS D or better. However, the eastbound approach experiences a significant increase in delay from scenario to scenario producing a LOS E for 2015 no build and LOS F for 2021 no build.

The distribution of site trips at the intersection is small compared to the total volume of traffic destined for the site. As compared with no build conditions, slight changes in delay are expected, under 2015 build conditions with LOS changes for the overall intersection, the eastbound through movement and the eastbound right-turn movement. Under the 2021 build scenario, significant increases in delay are expected with intersection operations at an overall LOS F. As compared to the 2021 no build scenario, most movements only experience slight increases in delay. However, the eastbound approach experiences a significant increase in delay with the right-turn movement going from LOS D to LOS F and the left-turn movement remaining at LOS F, but almost doubling in delay from 111.9 second per vehicle to 196.0 seconds per vehicle. Queues observed in the simulation along this approach were greater than 1,000 feet, resulting in vehicles being denied entry into the network. The reason for the significant increase in delay for the left- and right-turn movements between the 2021 no build and 2021 build scenario is due to the left- and right-turn storage lanes being blocked by the queue created from the through lanes. Although there are very minor improvements in delay shown some movements when comparing no build and build scenarios, these difference can be attributed to those reasons described in **Section 8.1**.

Table 20 shows levels of service and delay for the intersection under existing (2012), 2015 and 2021 no build, and 2015 and 2021 build conditions. LOS and delays are depicted graphically by lane group in **Figure 11** through **Figure 20**. Additionally, **Table 21** indicates the anticipated queuing for each movement at this intersection. As shown, all movements are expected to be

accommodated by the available storage with the exception of the eastbound and westbound left-turn movements for all scenarios and the eastbound through movement for both build scenarios. Detailed level of service and queuing calculations are provided in the **Appendix.**

Table 20—Military Highway/Robin Hood Road
PM Peak Hour Signalized Intersection LOS

Scenario	Overall LOS	Level of Service per Movement by Approach (Delay in sec/veh)										
		Northbound		Southbound			Westbound			Eastbound		
		LT	TH	LT	TH	RT	LT	TH	RT	LT	TH	RT
2012 Existing	D (38.0)	E (58.6)	E (61.7)	E (74.8)	E (59.1)	B (14.2)	F (90.1)	C (27.1)	A (8.6)	E (70.2)	C (31.0)	A (7.9)
		E (61.0)		D (39.3)			C (34.0)			C (33.5)		
2015 No Build	D (52.0)	E (71.3)	D (39.0)	F (83.4)	C (33.8)	B (11.8)	F (121.7)	D (37.9)	B (12.5)	F (99.2)	E (70.2)	C (33.4)
		D (45.2)		C (30.2)			D (46.2)			E (71.5)		
2015 Build	E (58.0)	E (71.2)	D (38.1)	F (101.8)	C (32.2)	B (12.5)	F (126.5)	D (38.5)	B (13.4)	F (119.5)	F (84.4)	D (51.7)
		D (44.3)		C (32.1)			D (47.1)			F (86.3)		
2021 No Build	E (59.4)	E (79.0)	D (40.2)	F (90.0)	C (33.6)	B (14.6)	F (129.0)	D (39.0)	B (15.1)	F (111.9)	F (87.9)	D (51.3)
		D (47.5)		C (32.5)			D (48.2)			F (88.7)		
2021 Build	F (88.0)	E (73.4)	D (39.5)	F (103.7)	D (35.7)	B (14.4)	F (109.4)	D (36.8)	B (15.5)	F (196.0)	F (176.4)	F (149.4)
		D (45.8)		D (35.4)			D (43.5)			F (177.0)		

Source: Kimley-Horn and Associates, Inc.

Table 21—Military Highway/Robin Hood Road
PM Peak Hour Queuing

Scenario	Queue Lengths (feet)										
	Northbound		Southbound			Westbound			Eastbound		
	LT	TH	LT	TH	RT	LT	TH	RT	LT	TH	RT
Existing Storage Length	*900*	*900*	*275*	*450*	*450*	*200*	*1,500*	*200*	*200*	*800*	*225*
2012 Existing	375	275	225	425	250	250	575	50	225	600	50
2015 No Build	250	275	250	250	275	250	500	75	225	925	50
2015 Build	300	250	250	350	325	225	775	50	225	900	50
2021 No Build	300	275	275	350	325	250	800	75	225	1,050	50
2021 Build	350	250	275	375	300	225	750	50	225	1800	75

Source: Kimley-Horn and Associates, Inc.

8.1.10 Robin Hood Road/Interstate 64 Westbound Ramps

This signalized intersection currently provides the following laneage:

- Robin Hood Road (northbound)—one exclusive through lane and one exclusive channelized yield-controlled right-turn lane
- Robin Hood Road (southbound)—one exclusive left-turn lane and two exclusive through lanes
- Interstate 64 Westbound Off-Ramp (westbound)—two exclusive left-turn lanes and one exclusive channelized yield-controlled right-turn lane

Similar to the intersection of Robin Hood Road/Interstate 64 Eastbound Off-Ramp/Almeda Avenue, the intersection of Robin Hood Road/Interstate 64 Westbound Ramps operates at a half cycle length (80 seconds) compared to the Military Highway intersection. The relatively lower volumes and half cycle signal operations allows for the intersection to operate at an overall LOS B under existing (2012) conditions, with all movements operating at a LOS C or better. Under future no build conditions, green time was reallocated to improve progression along Robin Hood Road. As a result, in conjunction with background traffic volume growth, delay for the northbound through movement is expected to be lower under 2015 and 2021 no build conditions, with an increase in delay expected for the westbound left-turn movement changing from LOS B to LOS C. Accounting for site trips under the build conditions, intersection operations will remain consistent with no build conditions, with all movements operating at a LOS C or better.

Table 22 shows levels of service and delay for the intersection under existing (2012), 2015 and 2021 no build, and 2015 and 2021 build conditions. LOS and delays are depicted graphically by lane group in **Figure 11** through **Figure 20**. Additionally, **Table 23** indicates the anticipated queuing for each movement at this intersection. As shown, all movements are expected to be accommodated by the available storage. Detailed level of service and queuing calculations are provided in the **Appendix.**

Table 22—Robin Hood Road/Interstate 64 Westbound Ramps PM Peak Hour Signalized Intersection LOS

Scenario	Overall LOS	Level of Service per Movement by Approach (Delay in sec/veh)					
		Northbound		Southbound		Westbound	
		TH	RT	LT	TH	LT	RT
2012 Existing	B (14.5)	C (31.5)	A (2.6)	B (18.7)	B (12.8)	B (11.8)	A (4.3)
		C (22.3)		B (14.0)		A (9.3)	
2015 No Build	B (15.1)	C (22.3)	A (1.9)	A (8.8)	A (4.7)	C (24.4)	A (4.7)
		B (15.5)		A (5.5)		B (18.1)	
2015 Build	B (15.00)	C (23.2)	A (2.1)	A (9.4)	A (4.9)	C (23.4)	A (4.9)
		B (16.6)		A (6.1)		B (17.3)	
2021 No Build	B (14.9)	C (24.4)	A (2.0)	A (8.8)	A (5.1)	C (22.4)	A (4.8)
		B (16.8)		A (5.7)		B (16.7)	
2021 Build	B (15.6)	C (28.7)	A (2.2)	B (11.5)	A (5.6)	C (20.1)	A (5.2)
		C (20.5)		A (7.2)		B (15.4)	

Source: Kimley-Horn and Associates, Inc.

Table 23—Robin Hood Road/Interstate 64 Westbound Ramp PM Peak Hour Queuing

Scenario	Level of Service per Movement by Approach (Delay in sec/veh)					
	Northbound		Southbound		Westbound	
	TH	RT	LT	TH	LT	RT
Existing Storage Length	*450*	*450*	*75*	*400*	*325*	*400*
2012 Existing	400	100	75	125	175	150
2015 No Build	400	100	75	75	225	150
2015 Build	425	100	75	75	200	150
2021 No Build	425	125	75	100	225	175
2021 Build	425	100	75	75	200	150

Source: Kimley-Horn and Associates, Inc.

8.1.11 Robin Hood Road/Miller Store Road

This unsignalized intersection currently provides the following laneage:

- Robin Hood Road (northbound)—one shared through and left-turn lane and one exclusive yield-controlled right-turn lane
- Robin Hood Road (southbound)—one shared left/through/right-turn lane
- Miller Store Road (westbound)—one stop-controlled shared left/through/right-turn lane
- Miller Store Road (eastbound)—one stop controlled shared left/through/right-turn lane

The Robin Hood Road/Miller Store Road intersection is the last diversion point along Robin Hood Road for vehicles prior to entering the Norfolk International Airport facility to the north and carries lower volumes than the adjacent Military Highway or Northampton Boulevard corridors. Existing (2012) conditions provide for acceptable unsignalized intersection operations, with all movements operating at a LOS C or better and an overall intersection LOS A. With the increment of background traffic volumes, slight increases in delay are expected under future no build conditions, but overall LOS A is expected to be maintained. Under 2015 build conditions, the addition of site trips results in increased delay for the westbound approach, which change from a LOS C to LOS E. This increased delay is a direct result of the increased westbound left-turn volume associated with the site trips and their impact on delay for the entire approach (due to the single, shared lane). The overall intersection delay changes from LOS A to LOS B under 2015 build conditions. Delay for the westbound approach is anticipated to decrease from LOS D to LOS E during 2021 build conditions. This approach may experience some delays during the PM peak hour; however, signalization is not warranted.

Table 24 shows levels of service and delay for the intersection under existing (2012), 2015 and 2021 no build, and 2015 and 2021 build conditions. LOS and delays are depicted graphically by lane group in **Figure 11** through **Figure 20**. Additionally, **Table 25** indicates the anticipated queuing for each movement at this intersection. As shown, all movements are expected to be accommodated by the available storage. Detailed level of service and queuing calculations are provided in the **Appendix.**

Table 24—Robin Hood Road/Miller Store Road
PM Peak Hour Unsignalized Intersection LOS

Scenario	Overall LOS	Level of Service per Movement by Approach (Delay in sec/veh)											
		Northbound			Southbound			Westbound			Eastbound		
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
2012 Existing	A (7.6)	A (1.7)		A (0.7)	A (2.6)			C (20.0)			C (19.9)		
		A (1.3)											
2015 No Build	A (8.0)	A (1.7)		A (0.7)	A (2.9)			C (21.8)			C (21.0)		
		A (1.3)											
2015 Build	B (12.8)	A (1.9)		A (0.7)	A (3.5)			E (40.1)			C (23.6)		
		A (1.3)											
2021 No Build	A (9.8)	A (1.9)		A (0.7)	A (3.4)			D (27.6)			C (24.8)		
		A (1.4)											
2021 Build	B (13.0)	A (2.0)		A (1.0)	A (3.6)			E (39.7)			D (25.8)		
		A (1.6)											

Source: Kimley-Horn and Associates, Inc.

Table 25—Robin Hood Road/Miller Store Road
PM Peak Hour Queuing

Scenario	Level of Service per Movement by Approach (Delay in sec/veh)											
	Northbound			Southbound			Westbound			Eastbound		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Existing Storage Length	*400*		*400*	*1,500*			*1,500*			*325*		
2012 Existing	125		100	75			150			200		
2015 No Build	150		100	100			200			175		
2015 Build	125		0	100			325			150		
2021 No Build	175		100	100			250			175		
2021 Build	150		0	100			300			175		

Source: Kimley-Horn and Associates, Inc.

8.1.12 Miller Store Road/Simon Access Driveway Extension

The secondary access point to the outlet mall development from Miller Store Road is proposed to be an unsignalized intersection with the following laneage:

- Simon Access Driveway (northbound)—one exclusive left-turn lane and one exclusive right-turn lane
- Miller Store Road (westbound)—one exclusive through lane and one exclusive left-turn lane
- Miller Store Road (eastbound)—one exclusive through lane and one exclusive right-turn lane

Under 2015 and 2021 build conditions, the proposed intersection is anticipated to operate at an overall LOS A, with all movements also operating at a LOS A. The analysis of the intersection considered only site generated trips utilizing the Simon Access Driveway. It is noted that the northbound left-turns in the 2021 build are experiencing zero delay while the 2015 northbound left-turns are expected to experience a delay of 6.1 seconds per vehicle. This is attributed to Reason 3 described in **Section 8.1**.

Table 26 shows levels of service and delay for the intersection under 2015 and 2021 build conditions. LOS and delays are depicted graphically by lane group in **Figure 11** through **Figure 20**. Additionally, **Table 27** indicates the anticipated queuing for each movement at this intersection. Based on the results of the queuing analysis, storage length recommendations are provided. Detailed level of service and queuing calculations are provided in the **Appendix.**

Table 26—Miller Store Road/Simon Access Driveway PM Peak Hour Unsignalized Intersection LOS

Scenario	Overall LOS	Level of Service per Movement by Approach (Delay in sec/veh)					
		Eastbound		Westbound		Northbound	
		TH	RT	LT	TH	LT	RT
2015 Build	A (0.3)	A (0.0)	A (0.0)	A* (0.0)	A (0.0)	A (6.1)	A* (0.0)
		A (0.0)		A (0.0)		A (6.1)	
2021 Build	A (0.0)	A (0.0)	A (0.0)	A* (0.0)	A (0.0)	A (0.0)	A* (0.0)
		A (0.0)		A (0.0)		A (0.0)	

Source: Kimley-Horn and Associates, Inc.

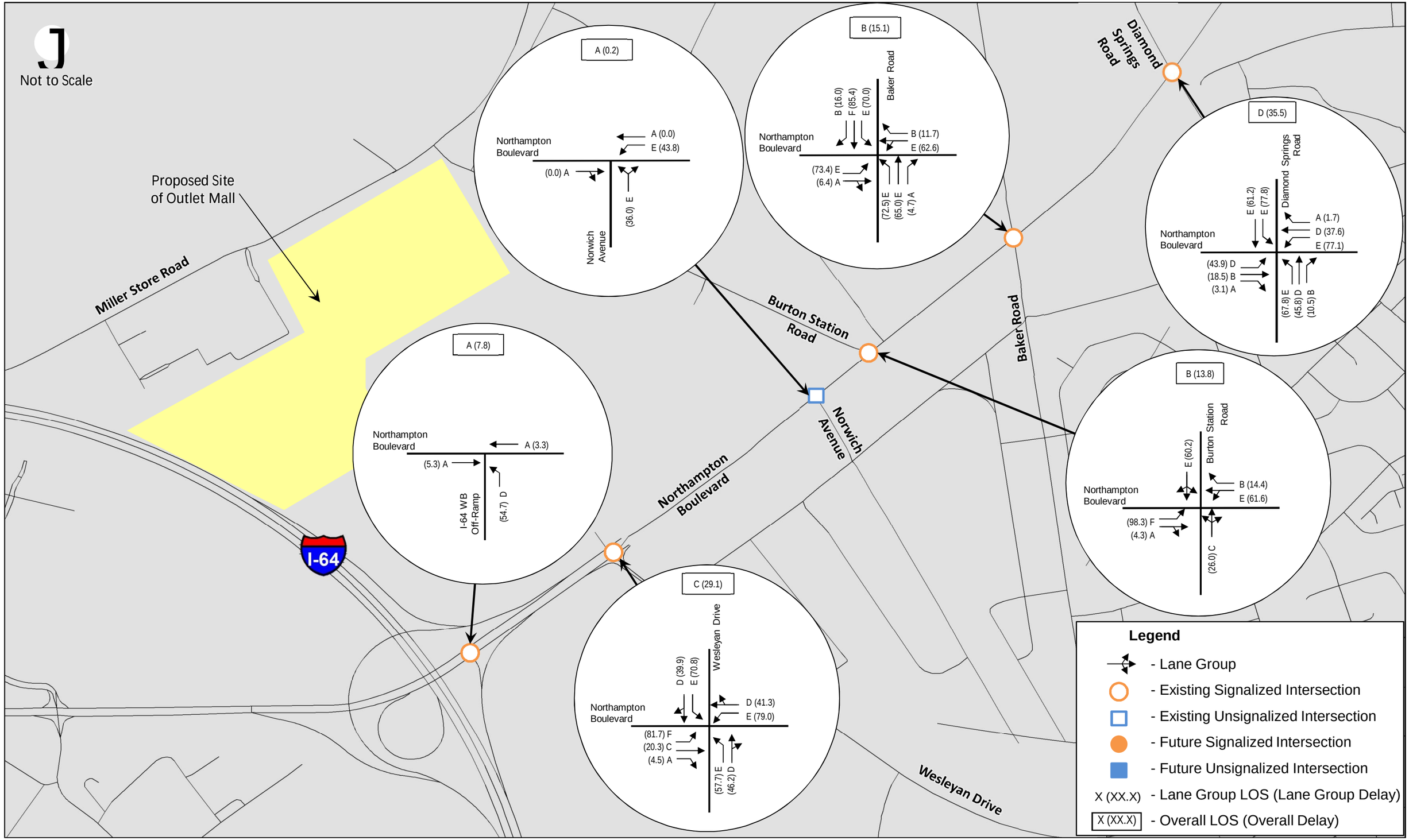
*Zero volume.

Table 27—Miller Store Road/Simon Access Driveway
PM Peak Hour Queuing

Scenario	Queue Lengths (feet)					
	Eastbound		Westbound		Northbound	
	TH	RT	LT	TH	LT	RT
Recommended Storage Length	*1,000*	*225*	*225*	*1,000*	*1,500*	*1,500*
2015 Build	0	0	0	0	50	0
2021 Build	0	0	0	0	25	0
Source: Kimley-Horn and Associates, Inc.						

8.1.13 Additional Arterial Analysis

An additional isolated arterial analysis was performed at the request of VDOT at the I-64 eastbound off-ramp merge with northbound Northampton Boulevard. The analysis' intent was to observe if traffic from the off-ramp was able to merge into northbound Northampton Boulevard traffic. Based on the analysis, 2021 build conditions indicate that northbound queuing at the I-64 westbound off-ramp intersection (immediately upstream) creates minimal impacts for off-ramp traffic to have to slow down or stop. The maximum queue of stopped/slowed vehicles observed from the analysis results was approximately two vehicles (50 feet) in the 2021 build scenario. The reported queue for the northbound approach of the I-64 Westbound Off-Ramp intersection is 500 feet (**Table 7**) which measures approximately 75 feet north of the gore of the ramp in question leaving space for merging maneuvers with minor slowing and/or stopping only during instances where the maximum queue from the upstream signal is present. With a total ramp length of approximately 1,200 feet, this queue is not anticipated to impact mainline operations along eastbound I-64.



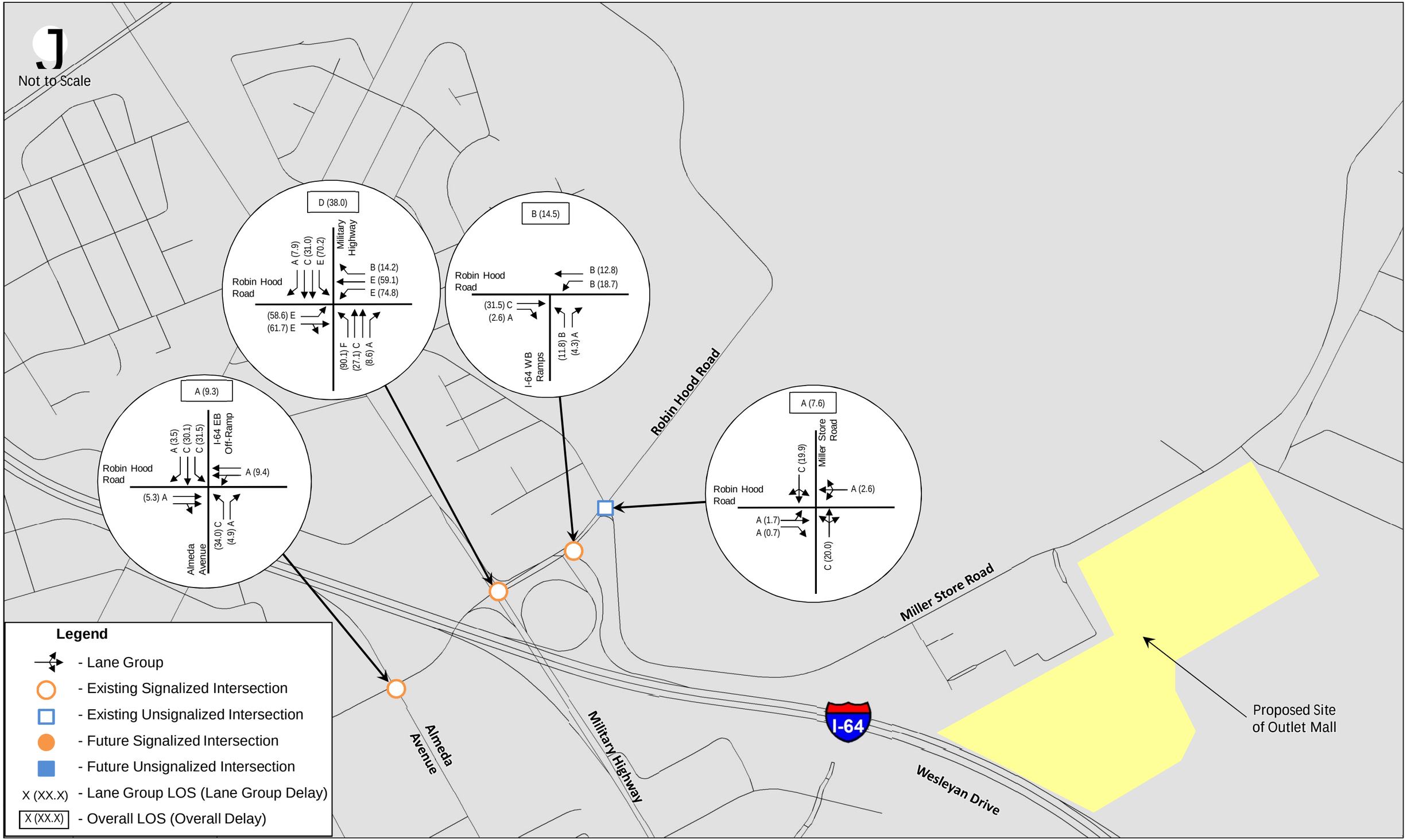
Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Level of Service and Delay – Northampton Boulevard
Existing (2012) PM Peak Hour

FIGURE
11

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



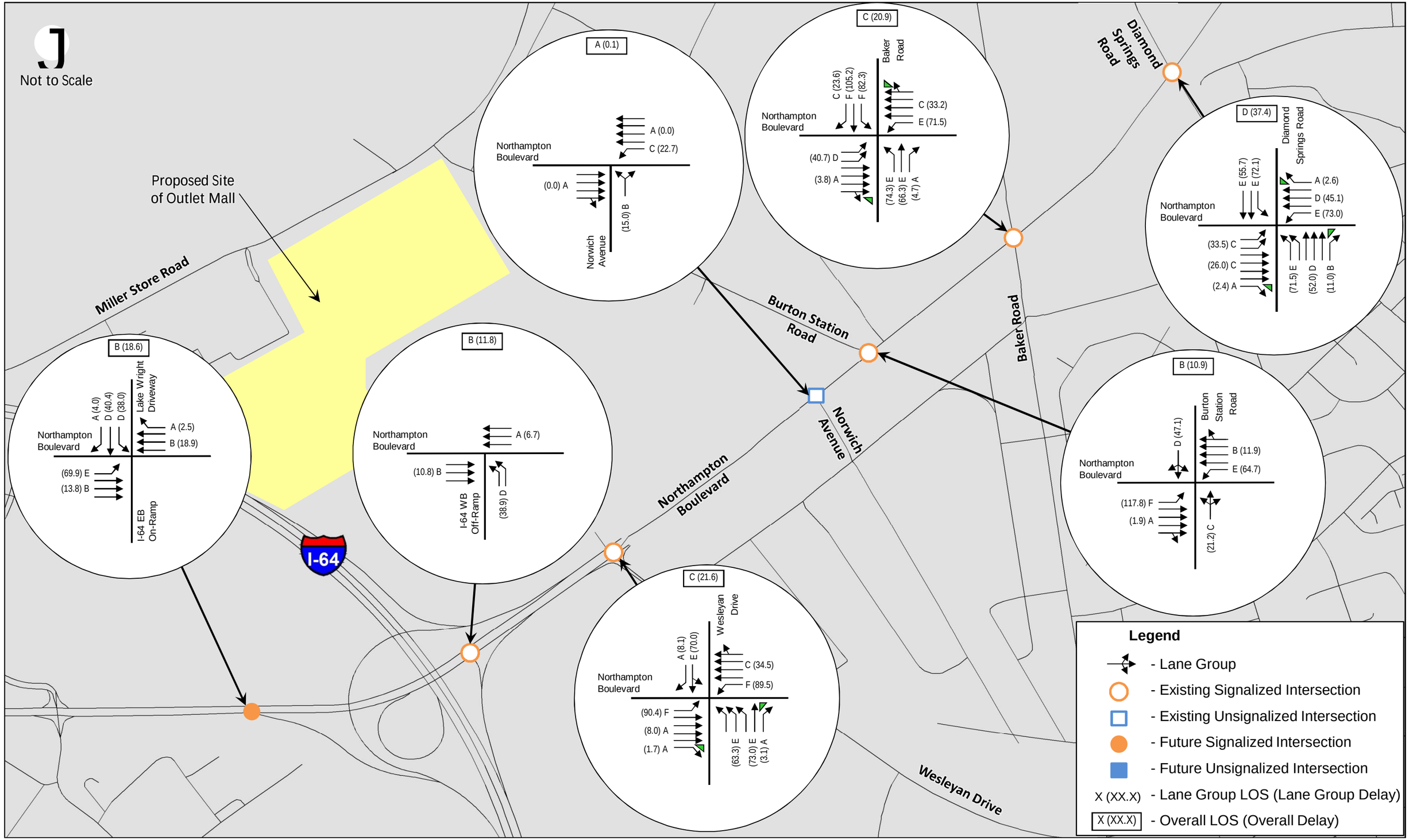
Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Level of Service and Delay – Robin Hood Road
Existing (2012) PM Peak Hour

FIGURE
12

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



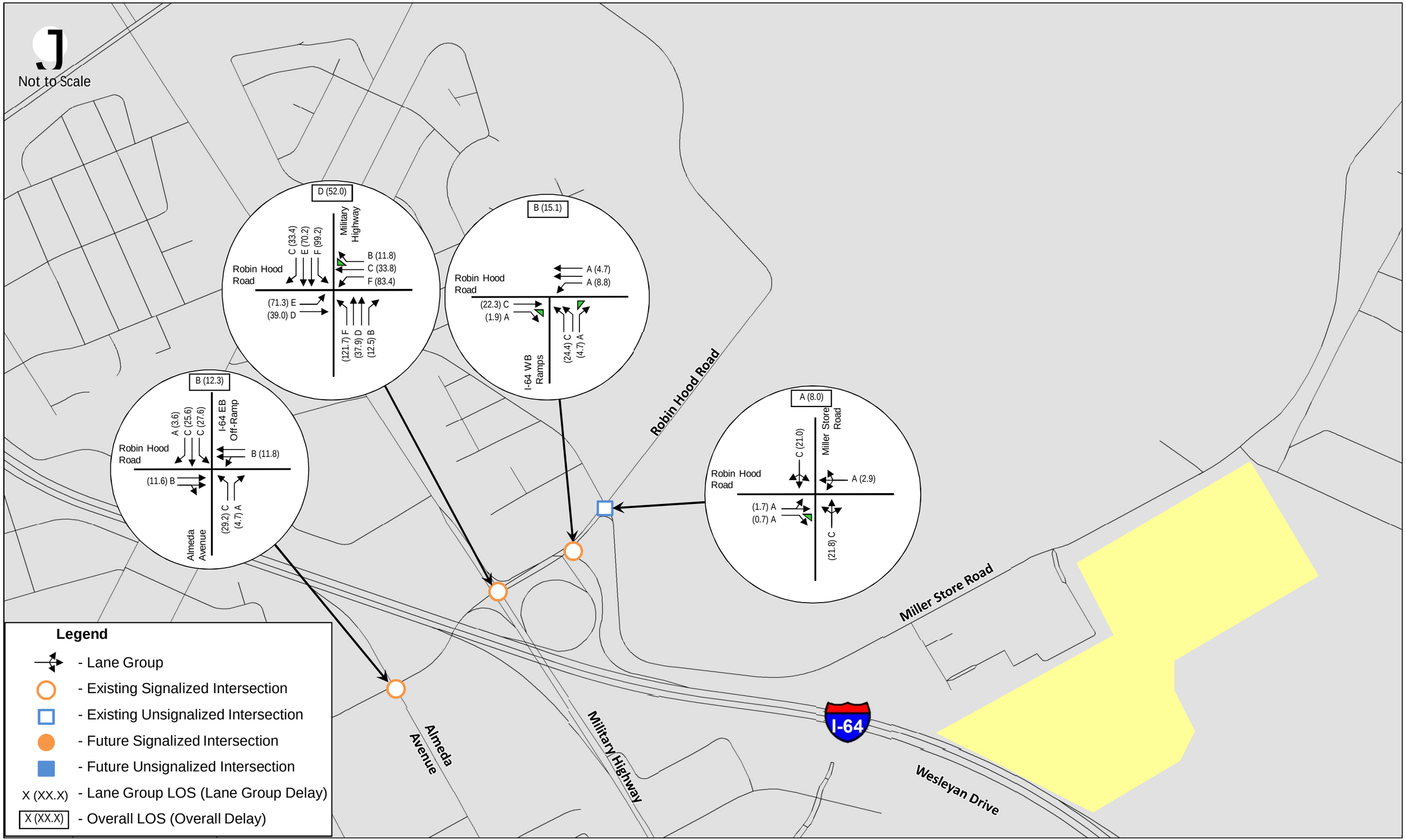
Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Level of Service and Delay – Northampton Boulevard
Future (2015) PM Peak Hour – No Build Conditions

FIGURE
13

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



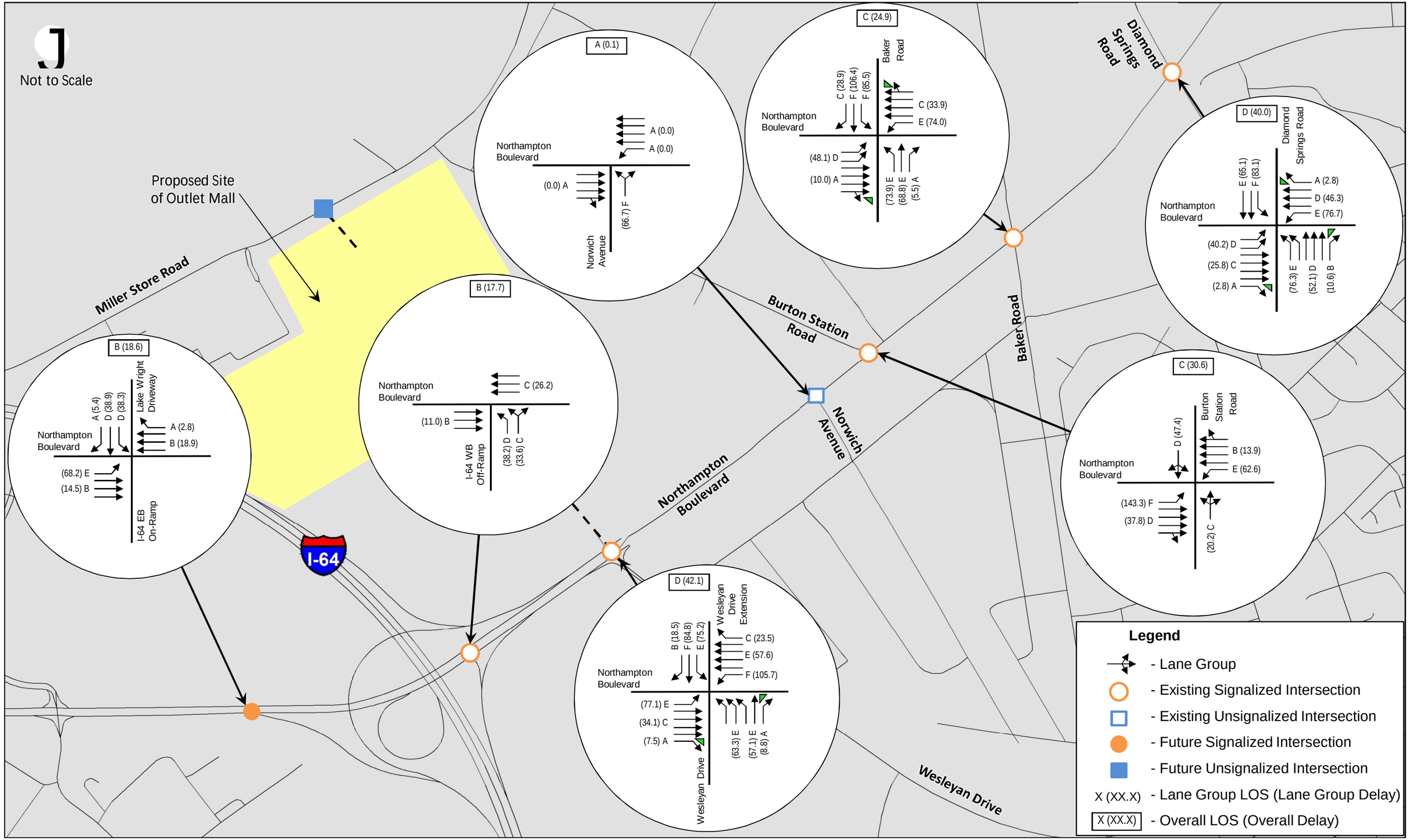
Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Level of Service and Delay – Robin Hood Road
Future (2015) PM Peak Hour – No Build Conditions

FIGURE
14

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



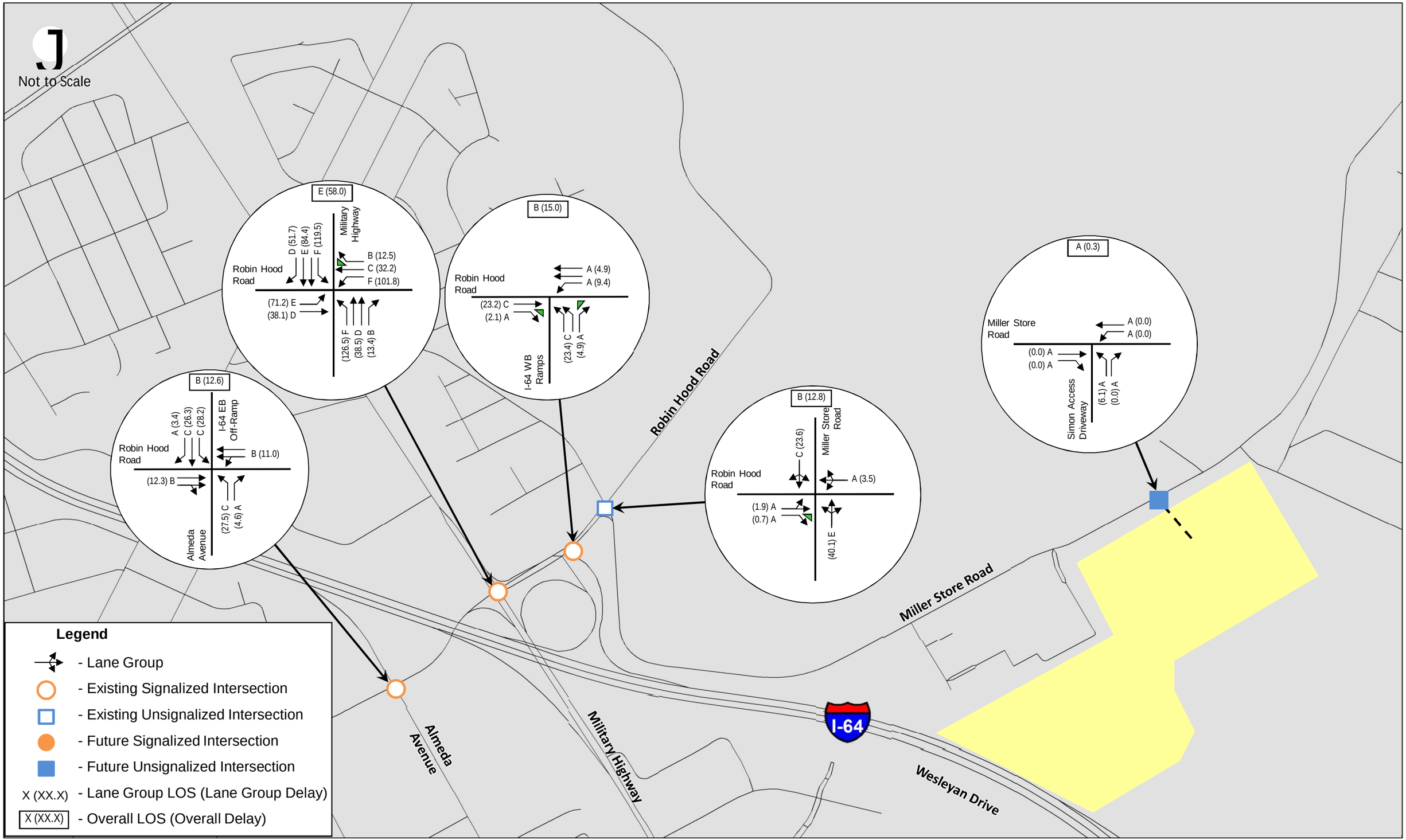
Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Level of Service and Delay – Northampton Boulevard
Future (2015) PM Peak Hour – Build Conditions

FIGURE
15

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



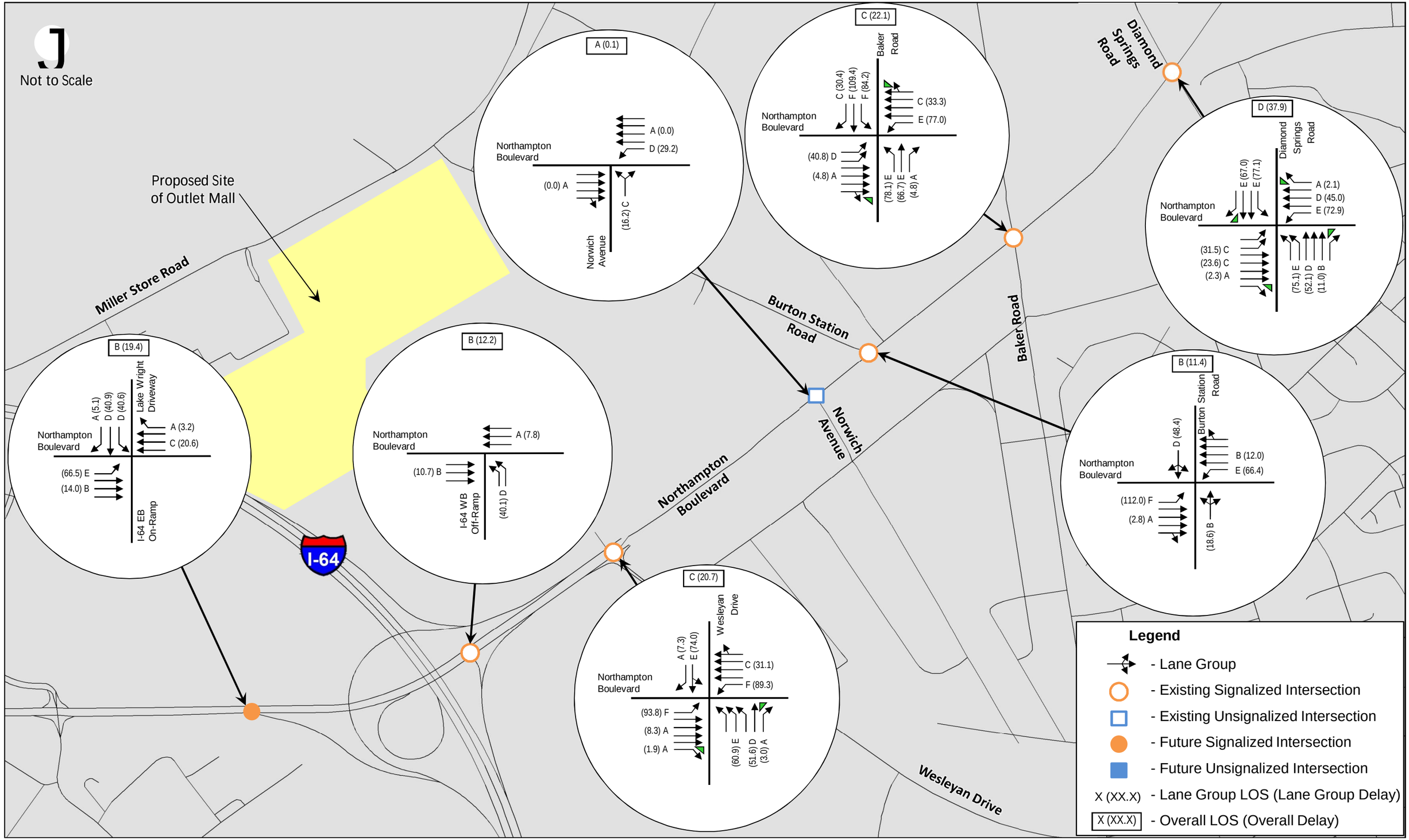
Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Level of Service and Delay – Robin Hood Road
Future (2015) PM Peak Hour – Build Conditions

FIGURE
16

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



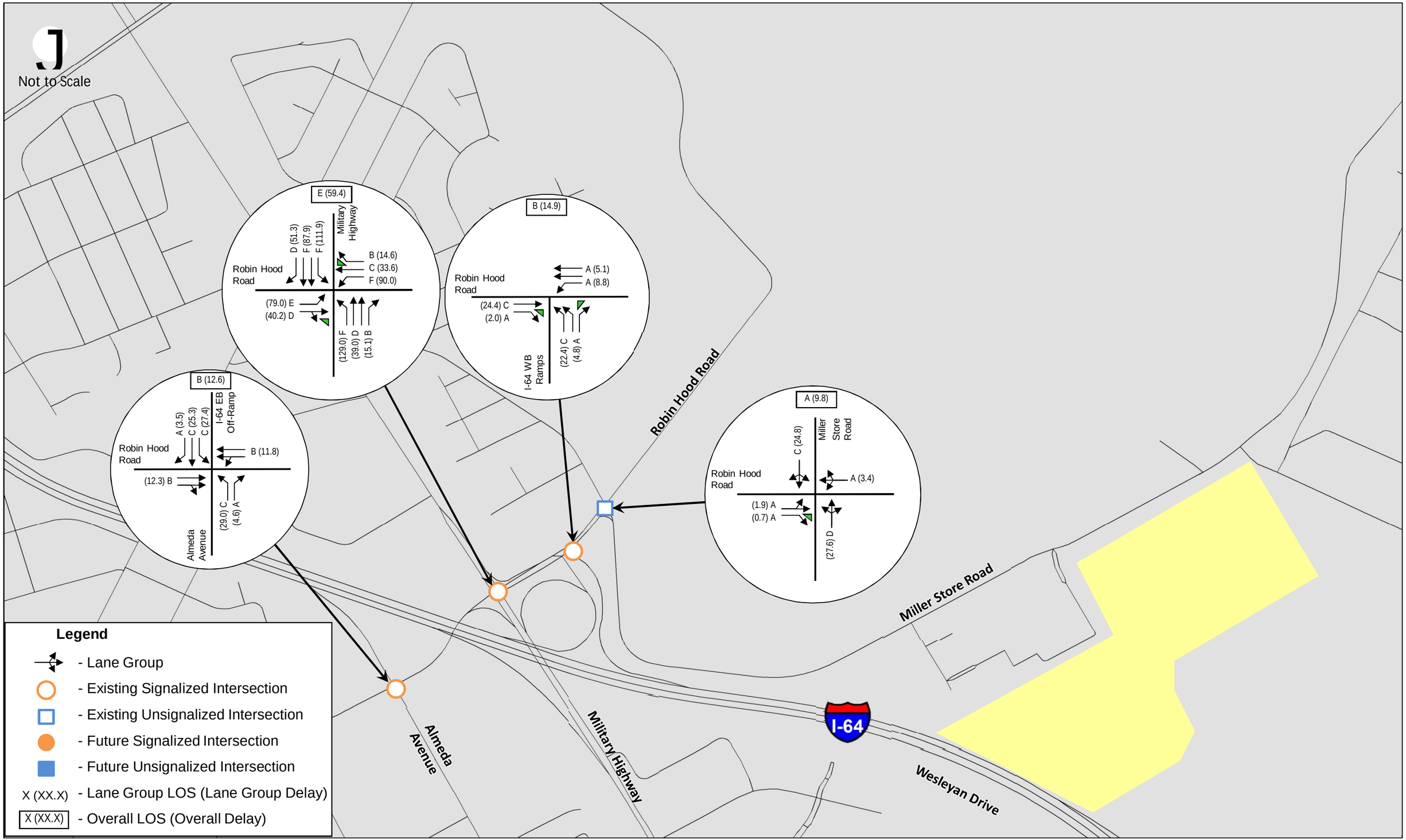
Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Level of Service and Delay – Northampton Boulevard
Future (2021) PM Peak Hour – No Build Conditions

FIGURE
17

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



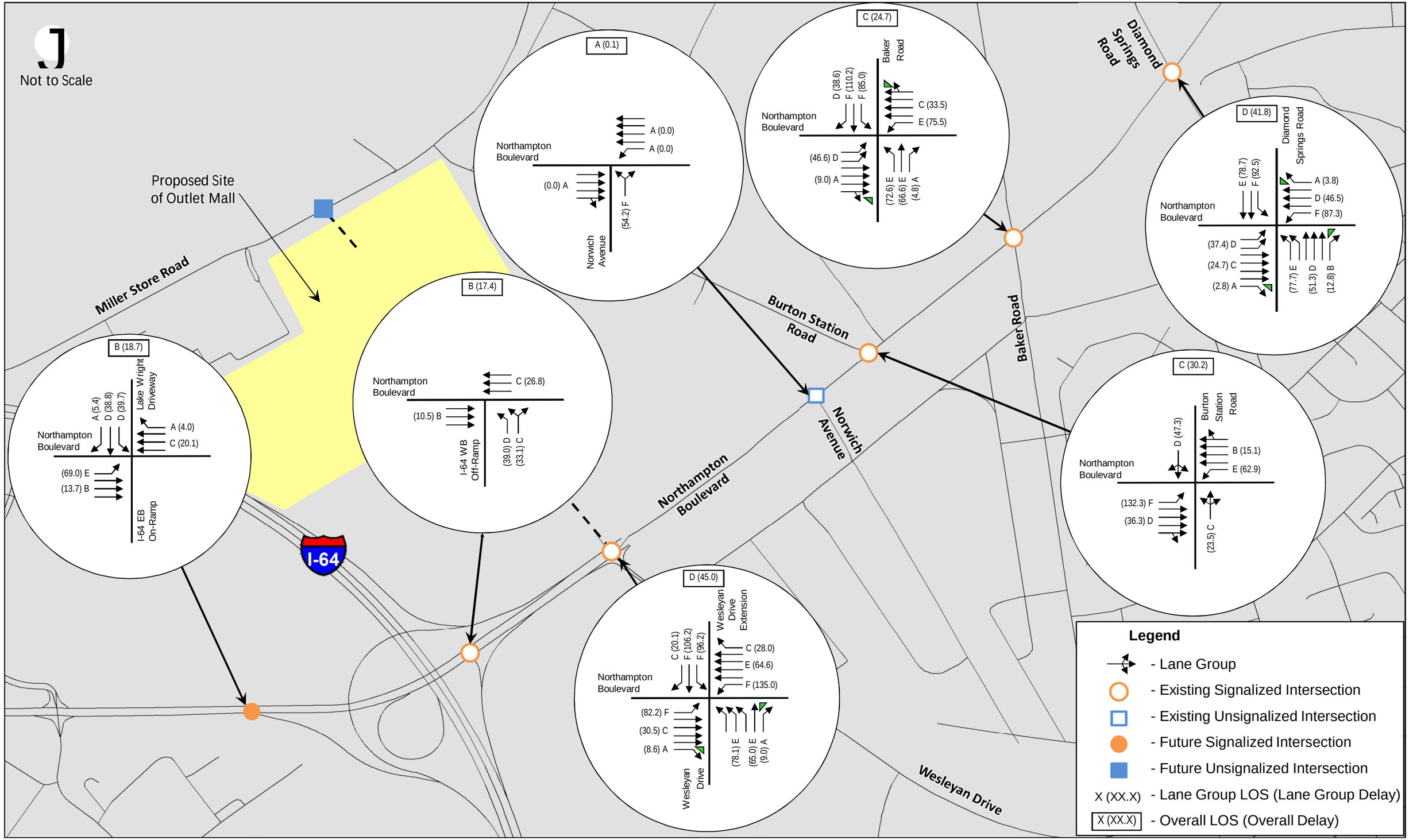
Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Level of Service and Delay – Robin Hood Road
Future (2021) PM Peak Hour – No Build Conditions

FIGURE
18

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



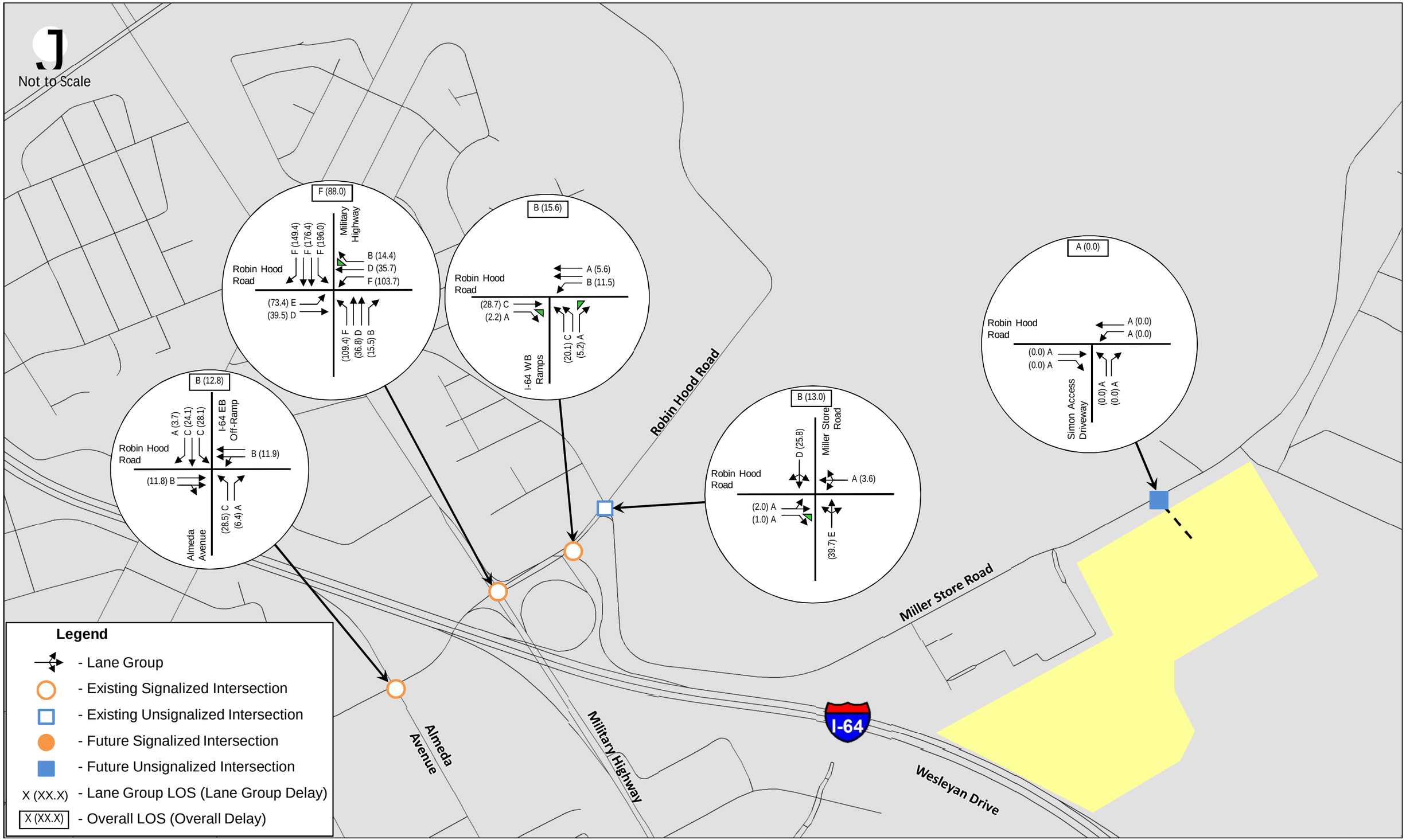
Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Level of Service and Delay – Northampton Boulevard
Future (2021) PM Peak Hour – Build Conditions

FIGURE
19

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Level of Service and Delay – Robin Hood Road
Future (2021) PM Peak Hour – Build Conditions

FIGURE
20

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

9.0 Interstate Facility Operational Analyses

9.1 HCS Analysis

Five separate traffic operational analyses were performed to evaluate the overall performance for existing and future no build and build scenarios. For the ramp merge, diverge, and freeway segment analyses, HCS 2010 (Version 6.40) was utilized. The HCS 2010 software utilizes methodologies in the 2010 *Highway Capacity Manual* (HCM). Inputs used in these analyses include ramp speed limits, laneage, acceleration/deceleration lane lengths, ramp spacing, and PM peak hour volumes.

Vehicle density, measured in passenger cars per lane per mile (pc/ln/mi) is the measure of effectiveness for merge, diverge, and freeway segments. For ramp/freeway analysis, the (LOS is used to describe traffic conditions in terms of density. Ramp merge and diverge segment LOS ranges from A to E, while freeway segment LOS ranges from A to F. LOS A indicates a condition of lower density, while LOS E/F reflect conditions of an over-saturated system. With the release of the 2010 HCM, LOS F is no longer considered a quantifiable metric for reporting operations for merge and diverge segments; rather, LOS F is defined as a condition in which demand exceeds capacity. While freeway segment analyses do consider LOS F as a quantifiable metric in terms of pc/ln/mi, the condition also considers the point at which demand exceeds capacity as LOS F, which could potentially occur below the thresholds listed below. LOS criteria for merge, diverge, and freeway segments are provided in **Table 28** and **Table 29** as defined by the 2010 HCM.

Table 28—LOS Criteria for Merge/Diverge Segments

LOS	Density (pc/ln/mi)
A	≤ 10
B	> 10 – 20
C	> 20 – 28
D	> 28 – 35
E	> 35

Table 29—LOS Criteria for Freeway Segments

LOS	Density (pc/ln/mi)
A	≤ 11
B	> 11 – 18
C	> 18 – 26
D	> 26 – 35
E	> 35 – 45
F*	> 45

*Note: Freeway segment is considered to be LOS F if the demand flow rate to capacity ratio is greater than 1 (v_d/c > 1.0)

Each ramp junction (merge and diverge) along I-64 was analyzed in addition to the freeway segments between project study area interchanges. The *HCS* results for each movement are summarized in **Table 30** for the existing, no build, and build scenarios, and the freeway segment analysis results are summarized in **Table 31**. It is important to note that a diverge analysis was not performed for the westbound I-64 off-ramp to Northampton Boulevard. The reason for this is because it is classified as a "Major Diverge" per the HCM, and therefore cannot be adequately analyzed using standard HCS 2010 methodologies. The HCM provides guidance indicating that complex major diverges should be evaluated with a microsimulation tool. This off-ramp junction will therefore be analyzed using CORSIM. Detailed HCS files are located in the **Appendix**. Detailed LOS results are graphically illustrated in the following figures:

- Figure 21 – Existing Conditions Analysis Results – HCS
- Figure 22 – 2015 No Build Conditions Analysis Results – HCS
- Figure 23 – 2015 Build Conditions Analysis Results – HCS
- Figure 24 – 2021 No Build Conditions Analysis Results – HCS
- Figure 25 – 2021 Build Conditions Analysis Results – HCS

Table 30—HCS Ramp/Weave Movement PM Peak Hour LOS and Density (pc/ln/mi)

Scenario	Movement	Existing (2012)	2015		2021	
			No Build	Build	No Build	Build
Westbound I-64	Diverge: I-64 Westbound Off-Ramp to Northampton Boulevard	Major Diverge. HCM indicates that microsimulation is the more accurate tool for analysis.				
	Merge: I-64 Westbound On-Ramp from Southbound Northampton Boulevard	E (35.2)	E (36.4)	E (36.7)	E (38.2)	E (38.5)
	Diverge: I-64 Westbound Off-Ramp to Robin Hood Road	D (33.1)	D (33.7)	D (33.7)	D (35.0)	D (34.9)
	Merge: I-64 Westbound On-Ramp from Robin Hood Road	D (28.2)	D (29.1)	D (29.2)	N/A*	N/A*
Eastbound I-64	Diverge: I-64 Eastbound Off-Ramp to Robin Hood Road	D (31.0)	D (31.6)	D (31.6)	D (32.8)	D (32.8)
	Diverge: I-64 Eastbound Off-Ramp to Southbound Military Highway	D (30.2)	D (30.9)	D (30.8)	D (32.1)	D (32.0)
	Diverge: I-64 Eastbound Off-Ramp to Northbound Northampton Boulevard	C (26.0)	C (26.6)	C (26.7)	C (27.9)	C (27.9)
	Merge: I-64 Eastbound On-Ramp from Northampton Boulevard	D (32.3)	D (34.2)	D (34.7)	N/A*	N/A*

Source: Kimley-Horn and Associates, Inc.

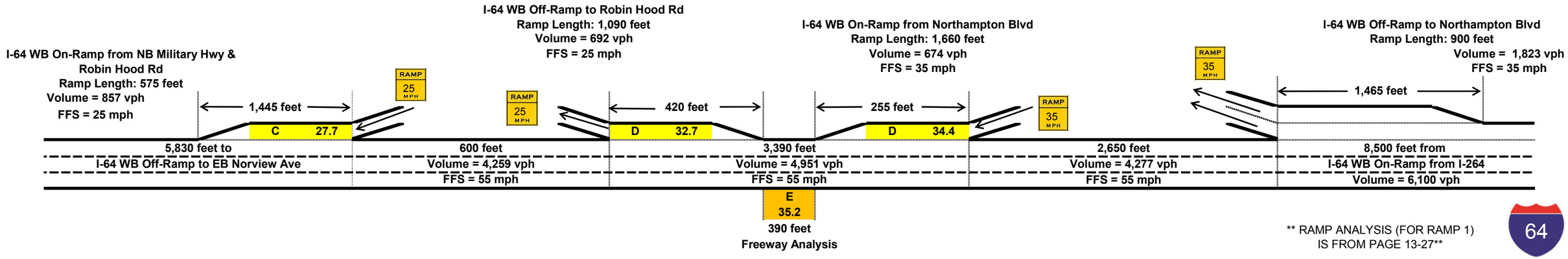
***Note: Demand exceeds capacity; location is oversaturated**

Table 31—HCS Freeway Segment PM Peak Hour LOS and Density (pc/ln/mi)

Scenario	Segment	Existing (2012)	2015		2021	
			No Build	Build	No Build	Build
Westbound I-64	I-64 Westbound On-Ramp from Southbound Northampton Boulevard to the I-64 Westbound Off-Ramp to Robin Hood Road	E (35.2)	E (36.7)	E (36.5)	E (40.0)	E (39.8)
Eastbound I-64	I-64 Eastbound Off-Ramp to Southbound Military Highway to the I-64 Westbound Off-Ramp to Northbound Northampton Boulevard	D (31.2)	D (32.3)	D (32.1)	D (34.7)	D (34.4)

Source: Kimley-Horn and Associates, Inc.

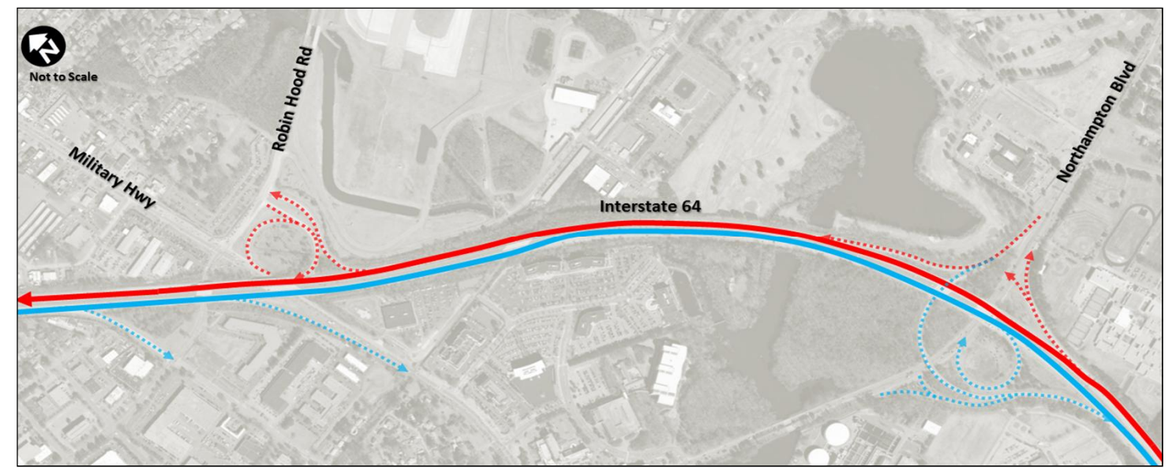
From **Table 30** and **Table 31**, it is observed that all ramp and freeway segment operations as well as their correlated levels of service are anticipated to be maintained between the no build and build conditions. Results illustrate a minor, negligible decrease in density between no build and build conditions due to the assumption that future mainline volumes are inclusive of background growth only while ramps are inclusive of background growth and site trips. This provides a conservative assumption for analyzing the ramp junctions. From this analysis it can be concluded that the anticipated site traffic associated with the proposed Simon Group Outlet Mall Retail Development will not result in adverse impacts to ramp or freeway operations in the vicinity of the subject interchanges along I-64.

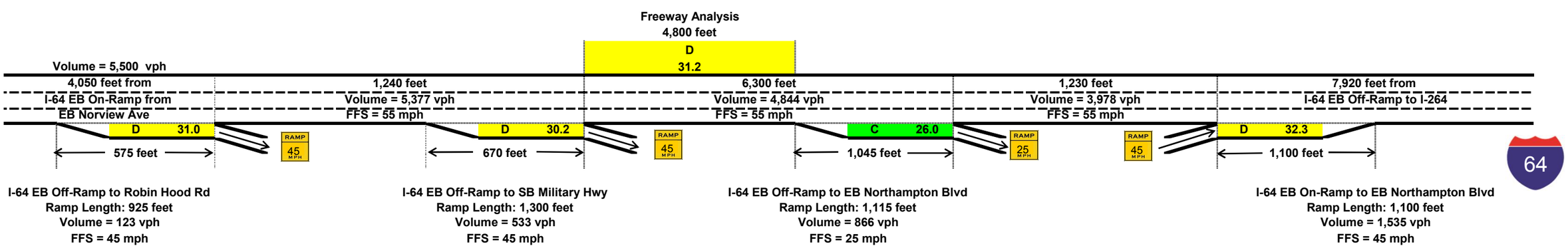


** RAMP ANALYSIS (FOR RAMP 1) IS FROM PAGE 13-27**

LEGEND - RAMPS		
LOS	DENSITY (pc/ln/mi)	COLOR
A	0-10	
B	10-20	
C	20-28	
D	28-35	
E	35+	
F	Demand Exceeds Capacity	

LEGEND - FREEWAY		
LOS	DENSITY (pc/ln/mi)	COLOR
A	0-11	
B	11-18	
C	18-26	
D	26-35	
E	35-45	
F	45+	



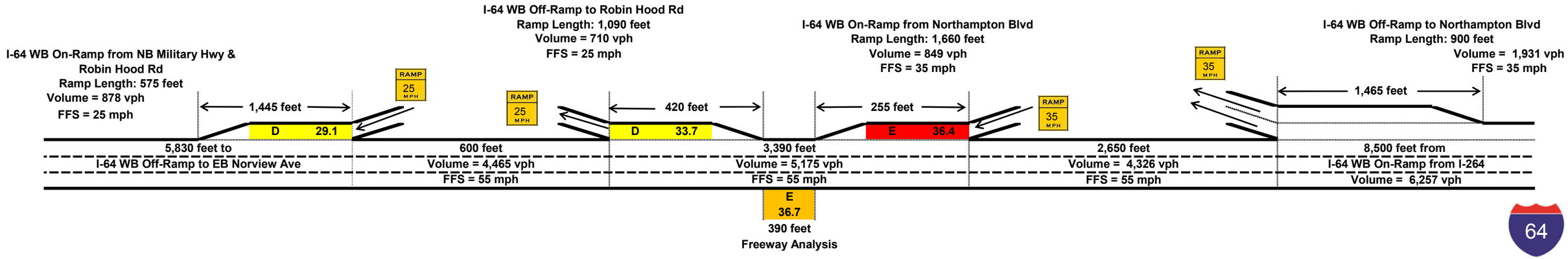


Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, Virginia

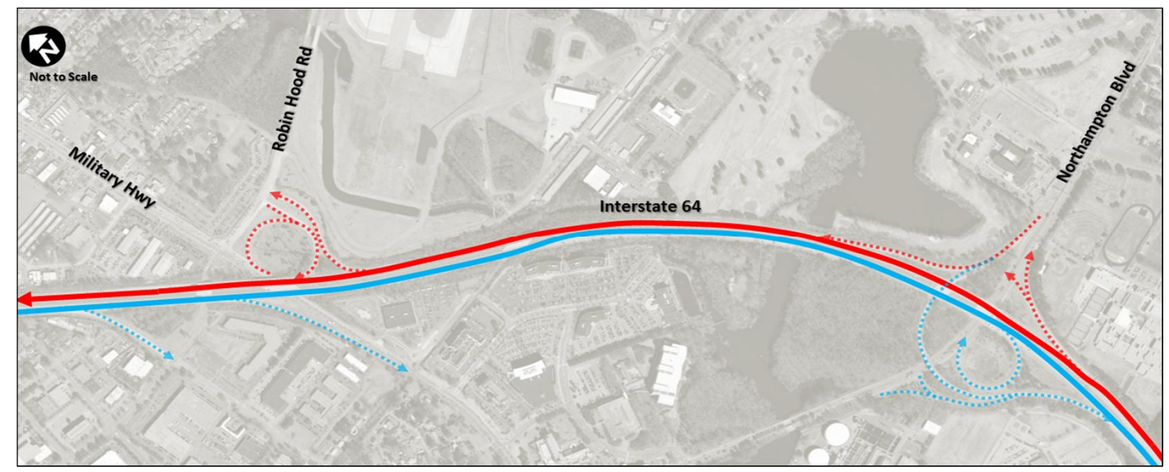
Existing Conditions Analysis Results
HCS

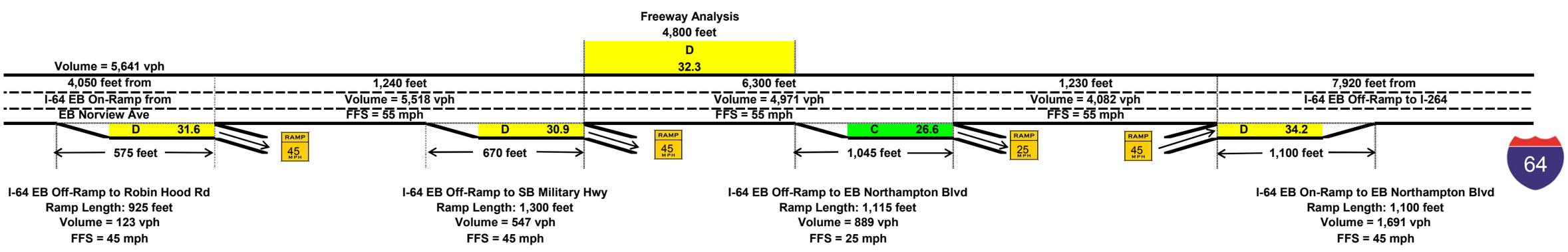
FIGURE
21



LEGEND - RAMPS		
LOS	DENSITY (pc/ln/mi)	COLOR
A	0-10	
B	10-20	
C	20-28	
D	28-35	
E	35+	
F	Demand Exceeds Capacity	

LEGEND - FREEWAY		
LOS	DENSITY (pc/ln/mi)	COLOR
A	0-11	
B	11-18	
C	18-26	
D	26-35	
E	35-45	
F	45+	



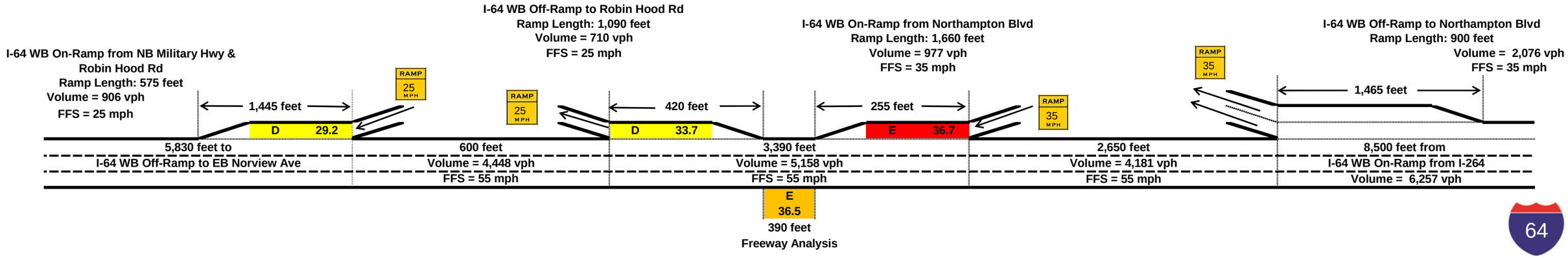


Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, Virginia

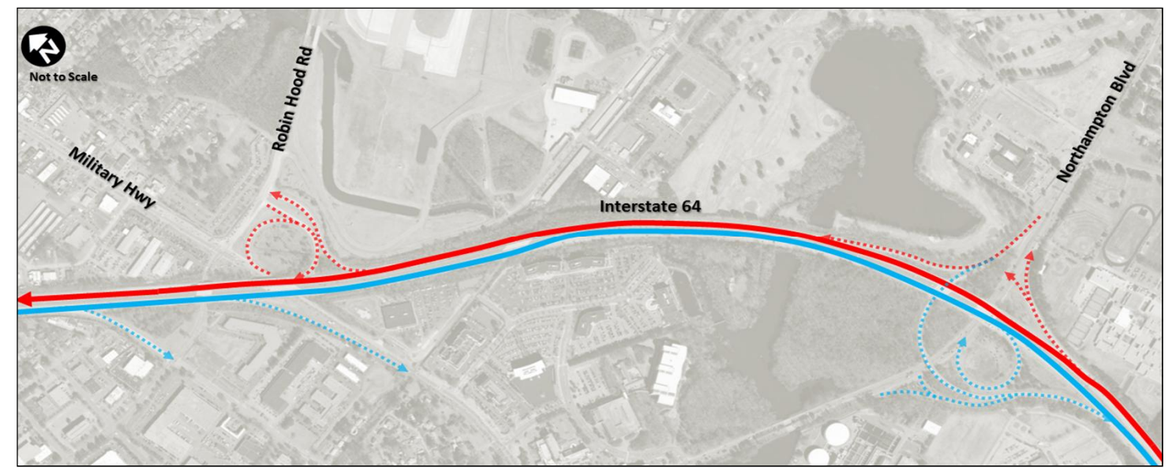
2015 No Build Conditions Analysis Results
HCS

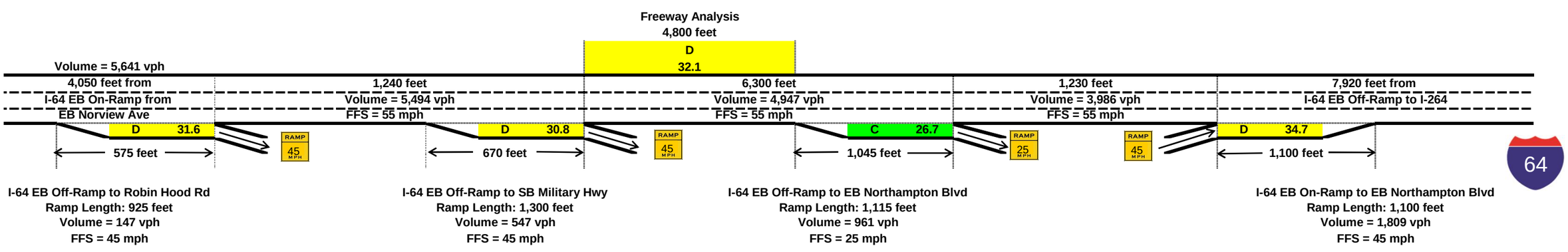
FIGURE
22



LEGEND - RAMPS		
LOS	DENSITY (pc/ln/mi)	COLOR
A	0-10	
B	10-20	
C	20-28	
D	28-35	
E	35+	
F	Demand Exceeds Capacity	

LEGEND - FREEWAY		
LOS	DENSITY (pc/ln/mi)	COLOR
A	0-11	
B	11-18	
C	18-26	
D	26-35	
E	35-45	
F	45+	





I-64 EB Off-Ramp to Robin Hood Rd
Ramp Length: 925 feet
Volume = 147 vph
FFS = 45 mph

I-64 EB Off-Ramp to SB Military Hwy
Ramp Length: 1,300 feet
Volume = 547 vph
FFS = 45 mph

I-64 EB Off-Ramp to EB Northampton Blvd
Ramp Length: 1,115 feet
Volume = 961 vph
FFS = 25 mph

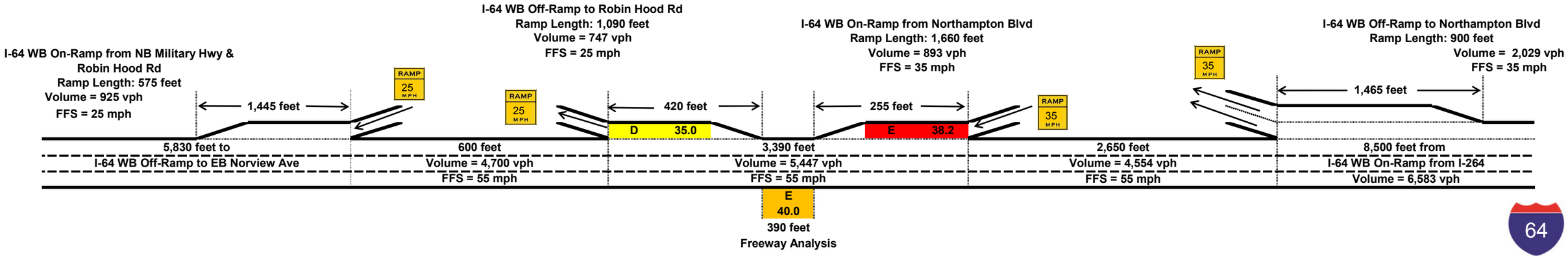
I-64 EB On-Ramp to EB Northampton Blvd
Ramp Length: 1,100 feet
Volume = 1,809 vph
FFS = 45 mph

Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, Virginia

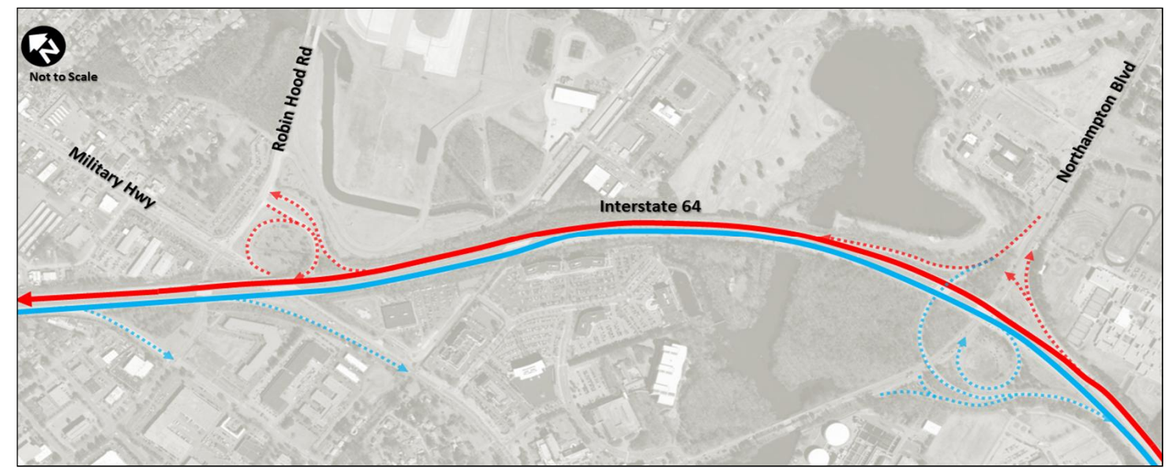
2015 Build Conditions Analysis Results
HCS

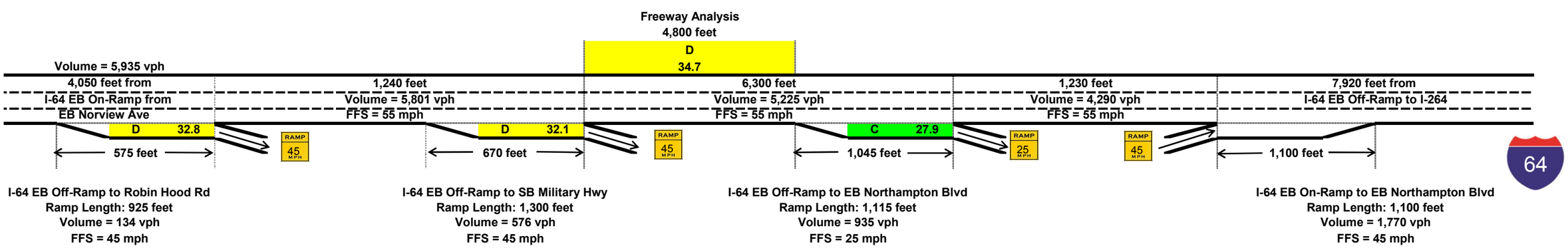
FIGURE
23



LEGEND - RAMPS		
LOS	DENSITY (pc/ln/mi)	COLOR
A	0-10	
B	10-20	
C	20-28	
D	28-35	
E	35+	
F	Demand Exceeds Capacity	

LEGEND - FREEWAY		
LOS	DENSITY (pc/ln/mi)	COLOR
A	0-11	
B	11-18	
C	18-26	
D	26-35	
E	35-45	
F	45+	



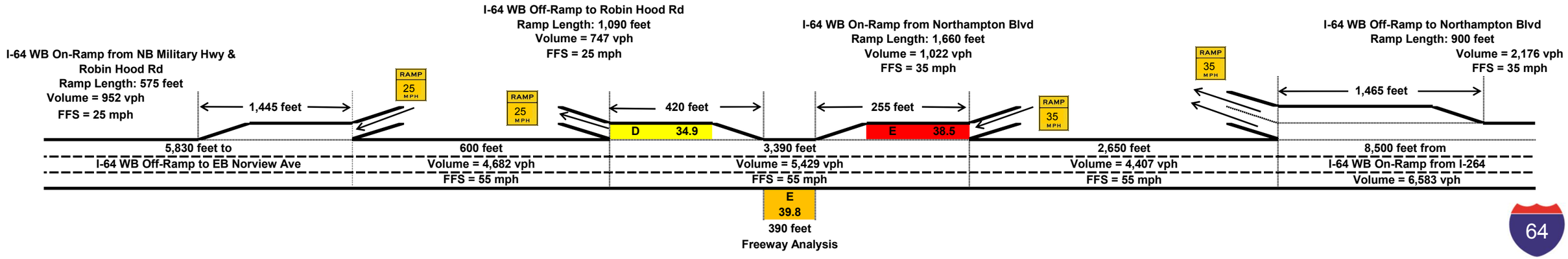


Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, Virginia

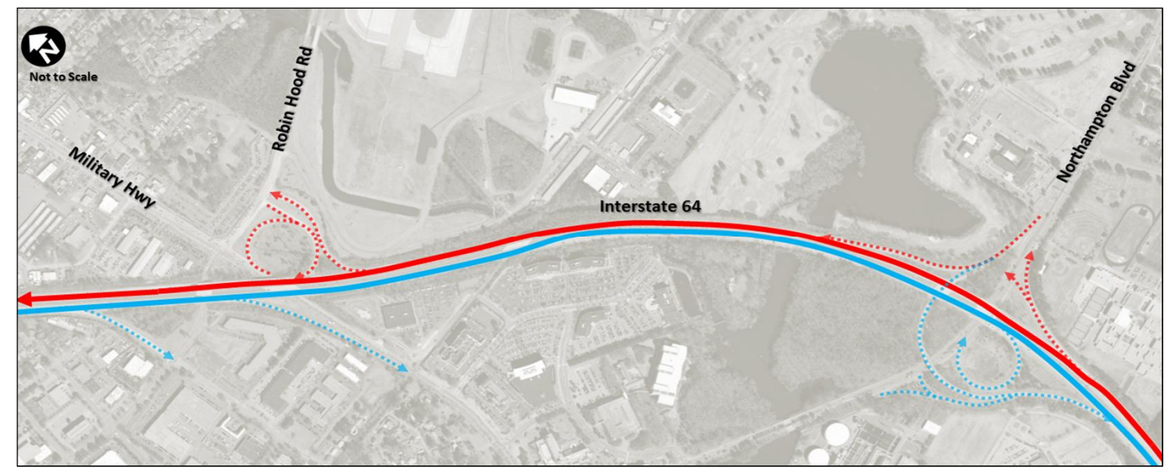
2021 No Build Conditions Analysis Results
HCS

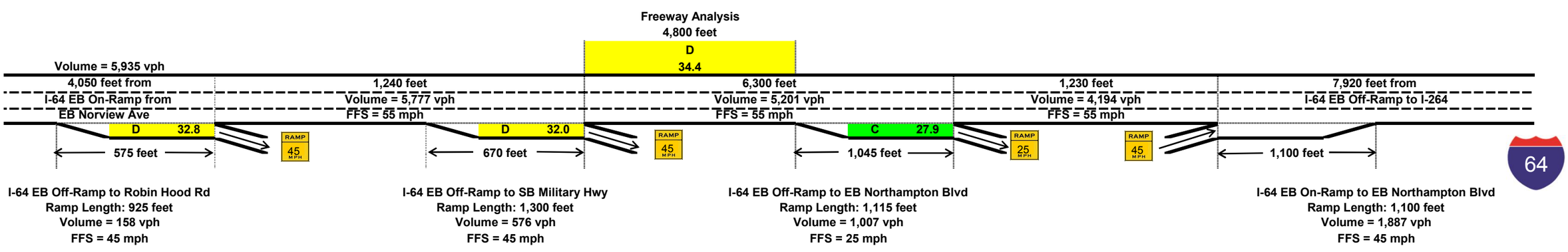
FIGURE
24



LEGEND - RAMPS		
LOS	DENSITY (pc/ln/mi)	COLOR
A	0-10	
B	10-20	
C	20-28	
D	28-35	
E	35+	
F	Demand Exceeds Capacity	

LEGEND - FREEWAY		
LOS	DENSITY (pc/ln/mi)	COLOR
A	0-11	
B	11-18	
C	18-26	
D	26-35	
E	35-45	
F	45+	





I-64 EB Off-Ramp to Robin Hood Rd
Ramp Length: 925 feet
Volume = 158 vph
FFS = 45 mph

I-64 EB Off-Ramp to SB Military Hwy
Ramp Length: 1,300 feet
Volume = 576 vph
FFS = 45 mph

I-64 EB Off-Ramp to EB Northampton Blvd
Ramp Length: 1,115 feet
Volume = 1,007 vph
FFS = 25 mph

I-64 EB On-Ramp to EB Northampton Blvd
Ramp Length: 1,100 feet
Volume = 1,887 vph
FFS = 45 mph

Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, Virginia

2021 Build Conditions Analysis Results
HCS

FIGURE
25

9.2 CORSIM Freeway Analysis

To supplement the HCS freeway analysis, a CORSIM simulation analysis was also performed. While the results of the HCS analysis are valid, they are based on a deterministic model, which provides a "snapshot" of traffic operations. The benefit of supplementing this type of static analysis with a CORSIM simulation analysis is that CORSIM uses dynamic algorithms, allowing more random assortments of vehicle and driver behavior characteristics. All CORSIM model setup and calibration parameters are consistent to those outlined in **Chapter 8**.

All CORSIM results are depicted graphically in lane schematic formats. Lane schematics include the following information:

- On- and off-ramp locations along the mainline (including distances)
- CORSIM node numbering and lane numbering
- Acceleration and deceleration lane lengths
- Actual and simulated volumes
- Travel speeds
- Vehicle density

LOS is not included because CORSIM density is reported as *vehicles*/mi/ln, and not *passenger cars*/mi/ln, which is consistent with the HCM. Because of this, an HCS LOS designation cannot be assigned, and typically, densities will appear higher in HCS with the passenger car equivalence being accounted for than in CORSIM. When comparing HCS results to those from CORSIM, it is important to evaluate the CORSIM results both by-link and by-lane. The lane schematics prepared for this TIA reflect CORSIM results in both formats – by overall roadway segment *and* by-lane.

Lane schematics are presented in the following figures:

- Figure 26 – Interchange Analysis – Eastbound PM Peak Hour MOE's – Existing PM Peak Hour
- Figure 27 – Interchange Analysis – Westbound PM Peak Hour MOE's – Existing PM Peak Hour
- Figure 28 – Interchange Analysis – Eastbound PM Peak Hour MOE's – No Build (2015) PM Peak Hour
- Figure 29 – Interchange Analysis – Westbound PM Peak Hour MOE's – No Build (2015) PM Peak Hour
- Figure 30 – Interchange Analysis – Eastbound PM Peak Hour MOE's – Build (2015) PM Peak Hour
- Figure 31 – Interchange Analysis – Westbound PM Peak Hour MOE's – Build (2015) PM Peak Hour
- Figure 32 – Interchange Analysis – Eastbound PM Peak Hour MOE's – No Build (2021) PM Peak Hour

- Figure 33 – Interchange Analysis – Westbound PM Peak Hour MOE's – No Build (2021) PM Peak Hour
- Figure 34 – Interchange Analysis – Eastbound PM Peak Hour MOE's – Build (2021) PM Peak Hour
- Figure 35 – Interchange Analysis – Westbound PM Peak Hour MOE's – Build (2021) PM Peak Hour

INTERSTATE 64 EASTBOUND

Overall Segment

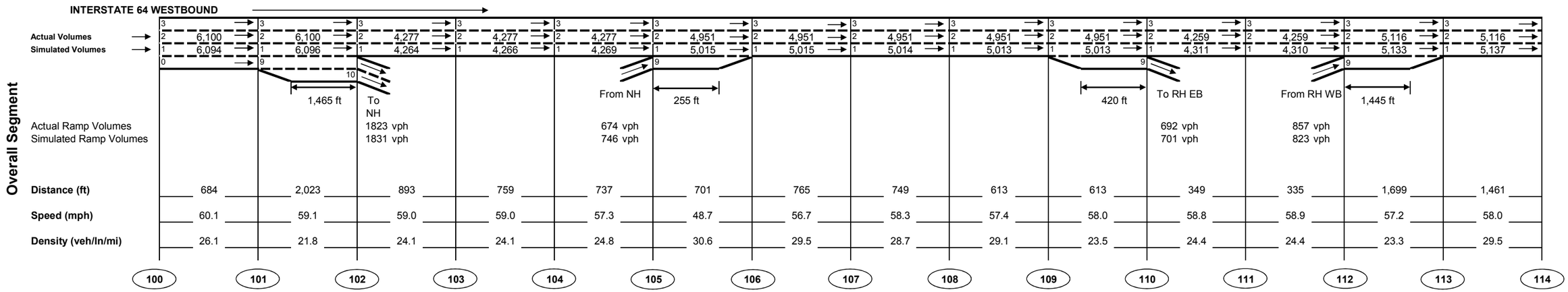
	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315
Actual Volumes	5,500	5,500	5,377	5,377	4,844	4,844	4,844	4,844	4,844	4,844	4,844	3,978	3,978	5,419	5,419	
Simulated Volumes	5,494	5,497	5,373	5,371	4,844	4,843	4,842	4,845	4,843	4,841	4,844	3,975	3,975	5,493	5,493	
Actual Ramp Volumes		575 ft	To RH 123 vph	670 ft	To MH 533 vph						1,045 ft	To NH NB 866 vph	From NH 1,441 vph	1,100 ft		
Simulated Ramp Volumes			124 vph		527 vph							869 vph	1,518 vph			
Distance (ft)	695	1,500	523	761	597	1,094	1,116	1,011	545	622	1,159	680	572	1,382	711	
Speed (mph)	59.7	58.9	58.2	57.7	58.3	58.3	58.2	58.0	58.0	57.2	58.0	59.0	58.8	54.1	57.0	
Density (veh/ln/mi)	31.5	27.6	30.8	24.0	27.7	27.7	27.8	27.8	27.8	28.2	21.4	22.5	22.6	26.8	32.1	

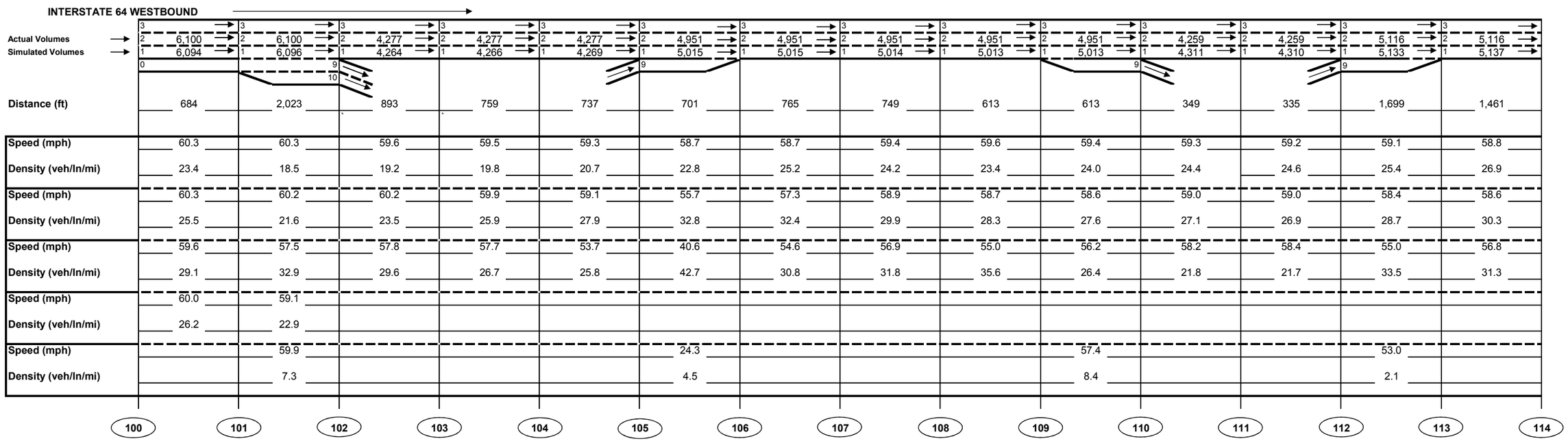
INTERSTATE 64 EASTBOUND

	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315
Actual Volumes	5,500	5,500	5,377	5,377	4,844	4,844	4,844	4,844	4,844	4,844	4,844	3,978	3,978	5,419	5,419	
Simulated Volumes	5,494	5,497	5,373	5,371	4,844	4,843	4,842	4,845	4,843	4,841	4,844	3,975	3,975	5,493	5,493	
Distance (ft)	695	1,500	523	761	597	1,094	1,116	1,011	545	622	1,159	680	572	1,382	711	
Speed (mph)	59.7	58.9	58.2	58.0	58.0	58.0	57.8	57.7	58.3	58.7	58.6	58.4	58.3	58.0	58.1	
Density (veh/ln/mi)	31.4	30.5	29.2	28.0	27.8	27.6	27.4	27.3	24.6	23.1	22.8	22.9	23.1	24.4	26.8	
Speed (mph)	59.7	59.2	58.6	57.6	58.7	58.9	58.9	58.7	58.9	58.8	59.3	59.4	59.2	57.2	57.7	
Density (veh/ln/mi)	31.5	30.6	30.4	29.0	28.0	28.2	28.6	28.9	28.3	27.3	24.9	24.8	25.0	30.0	33.3	
Speed (mph)	59.7	58.8	57.7	57.6	58.2	58.1	57.9	57.7	56.8	54.9	57.7	59.1	58.7	50.0	55.6	
Density (veh/ln/mi)	31.8	31.3	32.7	28.3	27.2	27.2	27.3	27.3	30.6	34.3	21.8	19.7	19.6	43.1	36.2	
Speed (mph)		58.3		57.5							55.4			51.9		
Density (veh/ln/mi)		0.9		7.8							13.8			4.1		

Kimley»Horn

Figure 26
Eastbound PM Peak Hour MOE's
Simon Group Outlet Mall Development TIA
Interchange Analysis
2012 Existing Scenario





	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114
Actual Volumes	6,100	6,100	4,277	4,277	4,277	4,951	4,951	4,951	4,951	4,951	4,259	4,259	5,116	5,116	
Simulated Volumes	6,094	6,096	4,264	4,266	4,269	5,015	5,015	5,014	5,013	5,013	4,311	4,310	5,133	5,137	
Distance (ft)	684	2,023	893	759	737	701	765	749	613	613	349	335	1,699	1,461	
Speed (mph)	60.1	59.1	59.0	59.0	57.3	48.7	56.7	58.3	57.4	58.0	58.8	58.9	57.2	58.0	
Density (veh/ln/mi)	26.1	21.8	24.1	24.1	24.8	30.6	29.5	28.7	29.1	23.5	24.4	24.4	23.3	29.5	

	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114
Actual Volumes	6,100	6,100	4,277	4,277	4,277	4,951	4,951	4,951	4,951	4,951	4,259	4,259	5,116	5,116	
Simulated Volumes	6,094	6,096	4,264	4,266	4,269	5,015	5,015	5,014	5,013	5,013	4,311	4,310	5,133	5,137	
Distance (ft)	684	2,023	893	759	737	701	765	749	613	613	349	335	1,699	1,461	
Speed (mph)	60.3	60.3	59.6	59.5	59.3	58.7	58.7	59.4	59.6	59.4	59.3	59.2	59.1	58.8	
Density (veh/ln/mi)	23.4	18.5	19.2	19.8	20.7	22.8	25.2	24.2	23.4	24.0	24.4	24.6	25.4	26.9	
Speed (mph)	60.3	60.2	60.2	59.9	59.1	55.7	57.3	58.9	58.7	58.6	59.0	59.0	58.4	58.6	
Density (veh/ln/mi)	25.5	21.6	23.5	25.9	27.9	32.8	32.4	29.9	28.3	27.6	27.1	26.9	28.7	30.3	
Speed (mph)	59.6	57.5	57.8	57.7	53.7	40.6	54.6	56.9	55.0	56.2	58.2	58.4	55.0	56.8	
Density (veh/ln/mi)	29.1	32.9	29.6	26.7	25.8	42.7	30.8	31.8	35.6	26.4	21.8	21.7	33.5	31.3	
Speed (mph)	60.0	59.1													
Density (veh/ln/mi)	26.2	22.9													
Speed (mph)		59.9				24.3				57.4			53.0		
Density (veh/ln/mi)		7.3				4.5				8.4			2.1		

Kimley»Horn

Figure 27
Westbound PM Peak Hour MOE's
Simon Group Outlet Mall Development TIA
Interchange Analysis
2012 Existing Scenario

INTERSTATE 64 EASTBOUND

Overall Segment

	300–301	301–302	302–303	303–304	304–305	305–306	306–307	307–308	308–309	309–310	310–311	311–312	312–313	313–314	314–315
Actual Volumes	5,641	5,641	5,518	#N/A	4,980	4,980	4,980	4,980	4,980	4,980	4,980	4,091	4,091	5,782	5,782
Simulated Volumes	5,630	5,630	5,506	5,506	4,969	4,968	4,968	4,969	4,969	4,972	4,972	4,082	4,083	5,787	5,787
		575 ft	To RH	670 ft	To MH						1,045 ft	To NH NB	From NH	1,100 ft	
Actual Ramp Volumes			123 vph		#N/A vph							889 vph	1,691 vph		
Simulated Ramp Volumes			124 vph		537 vph							890 vph	1,704 vph		
Distance (ft)	308	737	701	765	323	1,094	1,116	1,011	761	309	290	427	348	145	237
Speed (mph)	59.6	58.9	58.0	57.4	58.1	58.2	58.1	58.0	57.9	57.1	57.9	58.8	58.6	52.9	56.7
Density (veh/ln/mi)	32.3	28.3	31.6	24.7	28.5	28.4	28.5	28.6	28.6	29.1	22.0	23.1	23.2	28.8	34.1

300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315

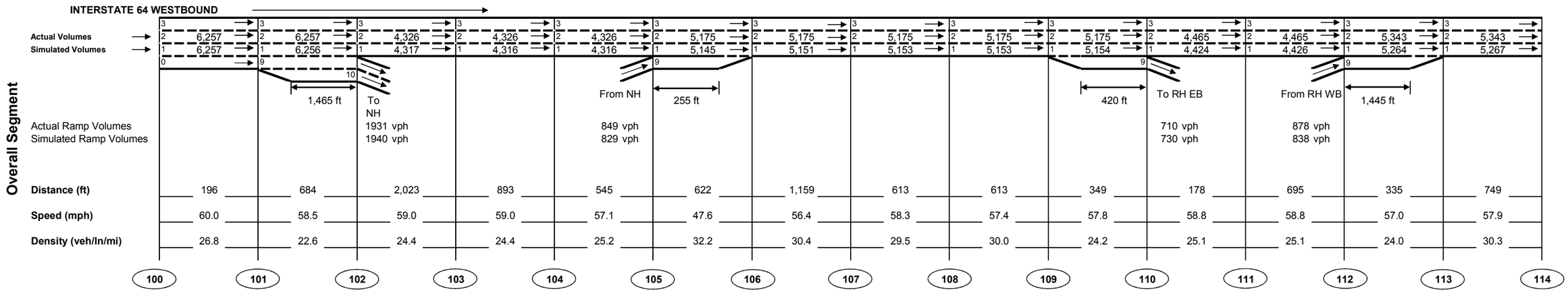
INTERSTATE 64 EASTBOUND

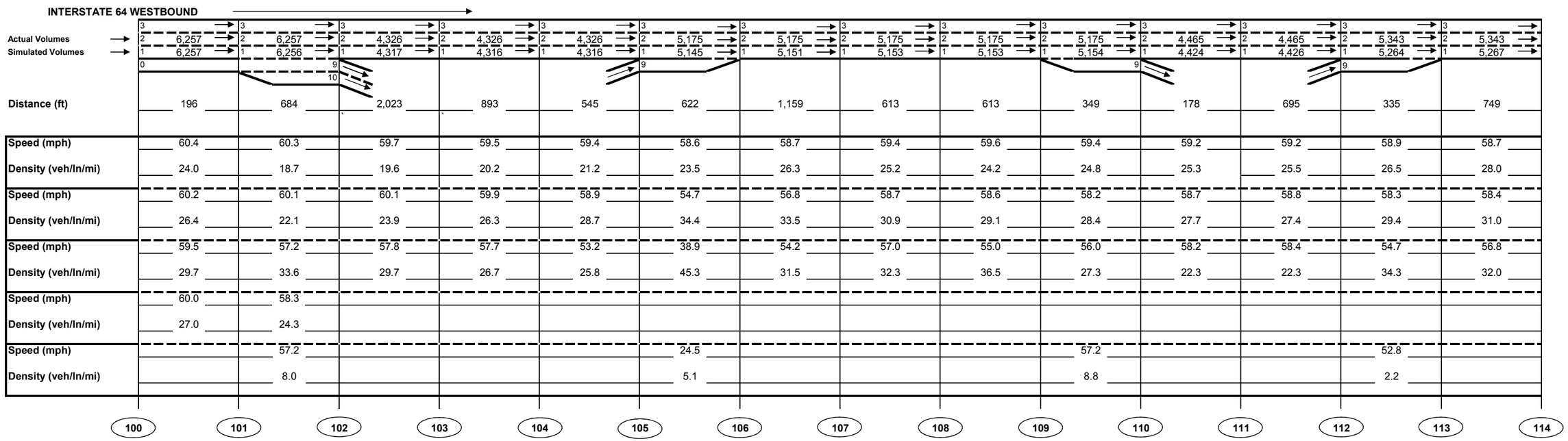
	300–301	301–302	302–303	303–304	304–305	305–306	306–307	307–308	308–309	309–310	310–311	311–312	312–313	313–314	314–315
Actual Volumes	5,641	5,641	5,518	#N/A	4,980	4,980	4,980	4,980	4,980	4,980	4,980	4,091	4,091	5,782	5,782
Simulated Volumes	5,630	5,630	5,506	5,506	4,969	4,968	4,968	4,969	4,969	4,972	4,972	4,082	4,083	5,787	5,787
Distance (ft)	308	737	701	765	323	1,094	1,116	1,011	761	309	290	427	348	145	237
Speed (mph)	59.7	59.0	58.2	58.0	58.0	58.0	57.9	57.7	58.3	58.7	58.6	58.4	58.3	57.9	57.9
Density (veh/ln/mi)	32.1	31.1	30.0	28.8	28.7	28.5	28.5	28.3	25.6	24.0	23.7	23.7	23.9	25.5	28.6
Speed (mph)	59.7	59.1	58.4	57.0	58.4	58.8	58.7	58.6	58.8	58.8	59.2	59.2	59.0	56.3	57.1
Density (veh/ln/mi)	32.3	31.5	31.4	30.0	28.8	28.8	29.1	29.4	29.0	27.9	25.3	25.4	25.7	31.8	35.3
Speed (mph)	59.6	58.6	57.5	57.3	58.0	57.9	57.7	57.6	56.7	54.6	57.4	58.9	58.4	48.1	55.3
Density (veh/ln/mi)	32.7	32.2	33.6	29.2	28.0	27.9	27.9	28.0	31.3	35.3	22.5	20.3	20.1	47.1	38.2
Speed (mph)		58.4		57.4							55.3			50.3	
Density (veh/ln/mi)		0.9		7.9							14.2			5.0	

300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315

Kimley»Horn

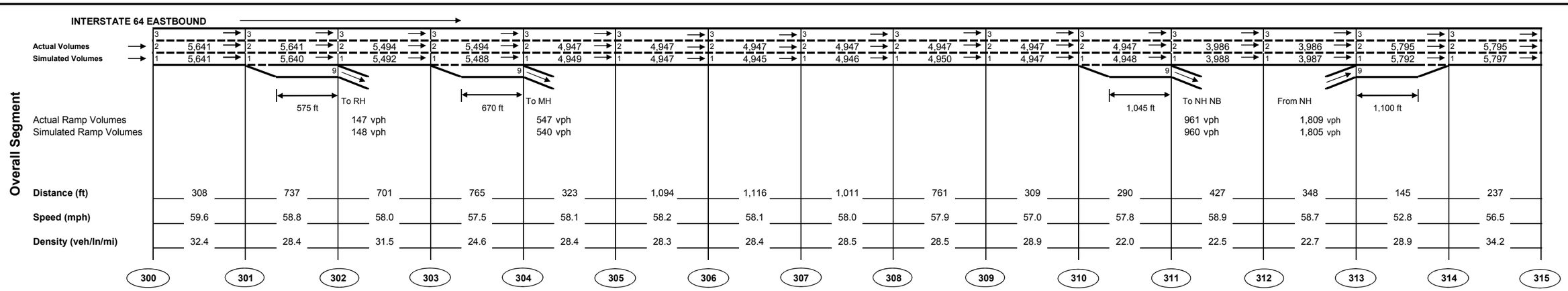
Figure 28
Eastbound PM Peak Hour MOE's
Simon Group Outlet Mall Development TIA
Interchange Analysis
2015 No Build Scenario

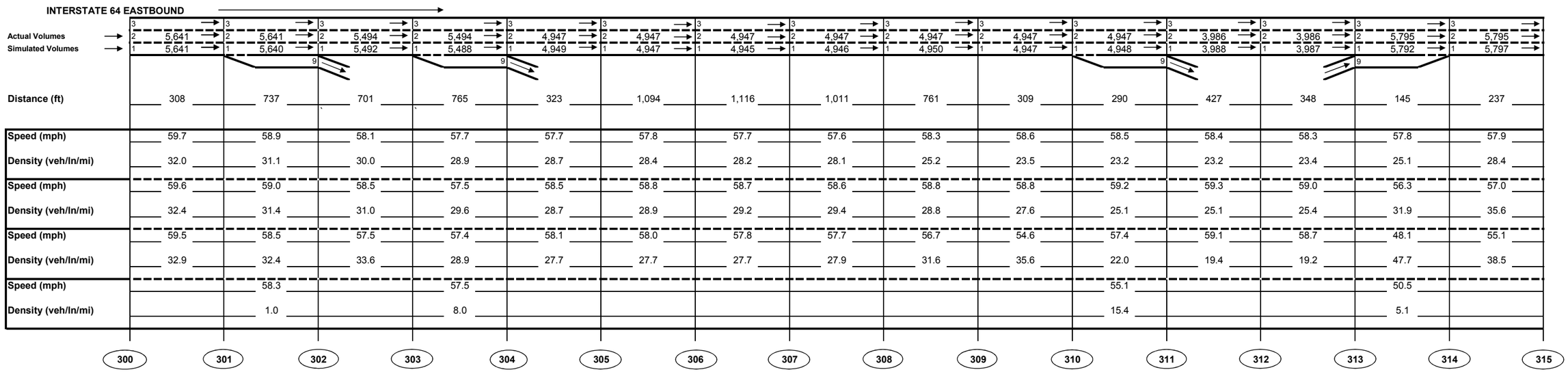




Kimley»Horn

Figure 29
Westbound PM Peak Hour MOE's
Simon Group Outlet Mall Development TIA
Interchange Analysis
2015 No Build Scenario





Kimley»Horn

Figure 30
Eastbound PM Peak Hour MOE's
Simon Group Outlet Mall Development TIA
Interchange Analysis
2015 Build Scenario

INTERSTATE 64 WESTBOUND

Overall Segment

	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114
Actual Volumes	6,257	6,257	4,181	4,181	4,181	5,158	5,158	5,158	5,158	5,158	4,448	4,448	5,354	5,354	
Simulated Volumes	6,254	6,257	4,201	4,200	4,202	5,136	5,131	5,130	5,131	5,133	4,406	4,408	5,280	5,287	
		1,465 ft	To NH		From NH	255 ft				420 ft	To RH EB	From RH WB	1,445 ft		
Actual Ramp Volumes			2076 vph		977 vph						710 vph	906 vph			
Simulated Ramp Volumes			2056 vph		934 vph						727 vph	872 vph			
Distance (ft)	196	684	2,023	893	545	622	1,159	613	613	349	178	695	335	749	
Speed (mph)	59.9	58.4	59.0	59.0	56.4	46.1	56.2	58.2	57.2	57.8	58.8	58.8	56.9	57.9	
Density (veh/ln/mi)	26.8	22.7	23.7	23.8	24.9	33.1	30.5	29.4	29.9	24.1	25.0	25.0	24.1	30.5	

INTERSTATE 64 WESTBOUND

	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114
Actual Volumes	6,257	6,257	4,181	4,181	4,181	5,158	5,158	5,158	5,158	5,158	4,448	4,448	5,354	5,354	
Simulated Volumes	6,254	6,257	4,201	4,200	4,202	5,136	5,131	5,130	5,131	5,133	4,406	4,408	5,280	5,287	
Distance (ft)	196	684	2,023	893	545	622	1,159	613	613	349	178	695	335	749	
Speed (mph)	60.3	60.3	59.7	59.5	59.3	58.5	58.4	59.3	59.5	59.4	59.2	59.1	58.9	58.6	
Density (veh/ln/mi)	23.9	18.2	18.9	19.6	20.6	23.2	26.2	24.9	23.9	24.5	24.9	25.1	26.1	27.9	
Speed (mph)	60.2	60.1	60.1	59.8	58.8	54.2	56.5	58.7	58.4	58.4	58.8	58.9	58.2	58.4	
Density (veh/ln/mi)	26.4	21.7	23.3	25.9	28.3	34.4	33.4	30.6	29.1	28.4	27.8	27.6	29.6	31.2	
Speed (mph)	59.5	57.3	57.8	57.7	51.3	37.2	53.9	56.9	54.8	56.0	58.3	58.4	54.5	56.7	
Density (veh/ln/mi)	29.8	33.0	29.0	25.8	25.6	47.6	31.9	32.6	36.7	27.2	22.3	22.3	34.8	32.3	
Speed (mph)	59.9	57.7				22.8				57.2			52.9		
Density (veh/ln/mi)	27.2	25.7				6.0				8.8			2.4		
Speed (mph)		57.4													
Density (veh/ln/mi)		8.4													

Kimley»Horn

Figure 31
Westbound PM Peak Hour MOE's
Simon Group Outlet Mall Development TIA
Interchange Analysis
2015 Build Scenario

INTERSTATE 64 EASTBOUND

Overall Segment

	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315
Actual Volumes	5,935	5,935	5,802	#N/A	5,226	5,226	5,226	5,226	5,226	5,226	5,226	4,290	4,290	6,060	6,060	
Simulated Volumes	5,934	5,935	5,800	5,802	5,222	5,220	5,219	5,221	5,221	5,223	5,220	4,287	4,284	6,050	6,045	
Actual Ramp Volumes			133 vph		#N/A vph							936 vph	1,770 vph			
Simulated Ramp Volumes			135 vph		580 vph							933 vph	1,766 vph			
Distance (ft)	308	737	701	765	323	1,094	1,116	1,011	761	309	290	427	348	145	237	
Speed (mph)	59.6	58.7	57.9	57.4	58.1	58.1	58.0	57.9	57.7	56.8	57.8	58.8	58.6	52.2	56.2	
Density (veh/ln/mi)	34.1	29.9	33.4	26.0	30.0	30.0	30.0	30.1	30.2	30.6	23.2	24.3	24.4	30.5	35.8	

575 ft — To RH
670 ft — To MH
1,045 ft — To NH NB
From NH — 1,100 ft

INTERSTATE 64 EASTBOUND

	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315
Actual Volumes	5,935	5,935	5,802	#N/A	5,226	5,226	5,226	5,226	5,226	5,226	5,226	4,290	4,290	6,060	6,060	
Simulated Volumes	5,934	5,935	5,800	5,802	5,222	5,220	5,219	5,221	5,221	5,223	5,220	4,287	4,284	6,050	6,045	
Distance (ft)	308	737	701	765	323	1,094	1,116	1,011	761	309	290	427	348	145	237	
Speed (mph)	59.6	58.7	58.0	57.8	57.8	57.8	57.7	57.6	58.2	58.6	58.5	58.3	58.2	57.7	57.6	
Density (veh/ln/mi)	33.9	33.0	31.8	30.6	30.4	30.1	29.9	29.7	26.9	25.2	25.0	25.0	25.2	27.2	30.8	
Speed (mph)	59.5	58.8	58.3	57.1	58.3	58.6	58.6	58.5	58.6	58.4	59.0	59.1	58.9	55.8	56.6	
Density (veh/ln/mi)	34.1	33.2	32.8	31.2	30.3	30.3	30.6	30.8	30.4	29.3	26.6	26.6	27.0	33.6	37.1	
Speed (mph)	59.5	58.4	57.3	57.2	58.0	57.9	57.7	57.6	56.6	54.4	57.3	59.0	58.6	47.1	54.8	
Density (veh/ln/mi)	34.5	34.1	35.7	30.7	29.3	29.4	29.5	29.7	33.2	37.3	23.8	21.2	20.9	49.5	39.7	
Speed (mph)		58.2		57.3							55.2			49.9		
Density (veh/ln/mi)		0.9		8.6							15.0			5.5		

Kimley»Horn

Figure 32
Eastbound PM Peak Hour MOE's
Simon Group Outlet Mall Development TIA
Interchange Analysis
2021 No Build Scenario

INTERSTATE 64 WESTBOUND

Overall Segment

	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114
Actual Volumes	6,583	6,583	4,554	4,554	4,554	5,447	5,447	5,447	5,447	5,447	4,700	4,700	5,625	5,625	
Simulated Volumes	6,581	6,582	4,544	4,544	4,543	5,418	5,412	5,410	5,412	5,415	4,651	4,651	5,528	5,533	
		1,465 ft	To NH		From NH	255 ft				420 ft	To RH EB		From RH WB	1,445 ft	
Actual Ramp Volumes			2029 vph		893 vph						747 vph		925 vph		
Simulated Ramp Volumes			2038 vph		875 vph						764 vph		877 vph		
Distance (ft)	196	684	2,023	893	545	622	1,159	613	613	349	178	695	335	749	
Speed (mph)	59.9	58.1	58.8	58.8	56.4	46.4	56.0	58.0	57.1	57.5	58.6	58.7	56.7	57.6	
Density (veh/ln/mi)	28.3	24.0	25.8	25.8	26.9	34.7	32.2	31.1	31.6	25.6	26.5	26.4	25.4	32.0	

INTERSTATE 64 WESTBOUND

	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114
Actual Volumes	6,583	6,583	4,554	4,554	4,554	5,447	5,447	5,447	5,447	5,447	4,700	4,700	5,625	5,625	
Simulated Volumes	6,581	6,582	4,544	4,544	4,543	5,418	5,412	5,410	5,412	5,415	4,651	4,651	5,528	5,533	
Distance (ft)	196	684	2,023	893	545	622	1,159	613	613	349	178	695	335	749	
Speed (mph)	60.1	60.2	59.5	59.3	59.2	58.3	58.3	59.1	59.4	59.0	58.9	58.9	58.6	58.4	
Density (veh/ln/mi)	25.5	19.7	20.6	21.4	22.5	25.2	28.2	26.9	25.9	26.5	26.9	27.1	28.0	29.7	
Speed (mph)	60.1	60.0	59.9	59.7	58.7	54.2	56.3	58.4	58.3	58.1	58.5	58.6	58.0	58.0	
Density (veh/ln/mi)	27.9	23.5	25.4	27.8	30.2	36.3	35.3	32.4	30.5	29.8	29.3	29.0	31.0	32.6	
Speed (mph)	59.4	56.8	57.5	57.5	51.6	37.2	53.6	56.8	54.6	55.8	58.2	58.5	54.3	56.6	
Density (veh/ln/mi)	31.3	35.4	31.3	28.1	27.9	49.5	33.2	33.9	38.5	28.5	23.2	23.2	36.1	33.7	
Speed (mph)	59.8	57.7													
Density (veh/ln/mi)	28.3	25.7													
Speed (mph)		55.4				23.8				57.1			52.8		
Density (veh/ln/mi)		8.7				5.7				9.3			2.4		

Kimley»Horn

Figure 33
Westbound PM Peak Hour MOE's
Simon Group Outlet Mall Development TIA
Interchange Analysis
2021 No Build Scenario

INTERSTATE 64 EASTBOUND

Overall Segment

	300–301	301–302	302–303	303–304	304–305	305–306	306–307	307–308	308–309	309–310	310–311	311–312	312–313	313–314	314–315
Actual Volumes	5,935	5,935	5,777	5,777	5,201	5,201	5,201	5,201	5,201	5,201	5,201	4,194	4,194	6,081	6,081
Simulated Volumes	5,927	5,927	5,776	5,777	5,225	5,222	5,222	5,220	5,220	5,221	5,221	4,214	4,215	6,070	6,070
Actual Ramp Volumes			158 vph		576 vph							1007 vph	1,887 vph		
Simulated Ramp Volumes			152 vph		552 vph							1008 vph	1,854 vph		
Distance (ft)	308	737	701	765	323	1,094	1,116	1,011	761	309	290	427	348	145	237
Speed (mph)	59.5	58.7	57.9	57.0	57.7	58.0	57.9	57.8	57.6	56.6	57.6	58.8	58.6	51.8	56.1
Density (veh/ln/mi)	34.1	29.9	33.3	26.1	30.2	30.0	30.0	30.1	30.2	30.7	23.2	23.9	24.0	30.9	36.1

575 ft — To RH; 670 ft — To MH; 1,045 ft — To NH NB; From NH; 1,100 ft

300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315

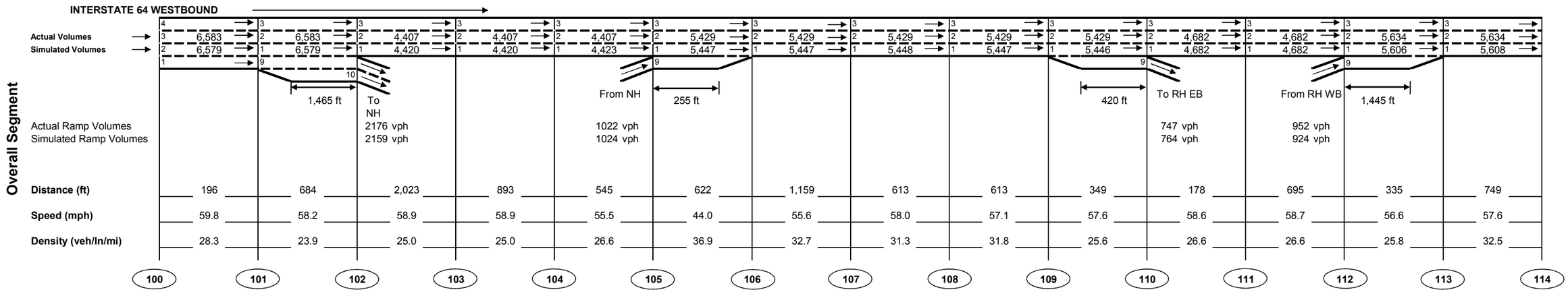
INTERSTATE 64 EASTBOUND

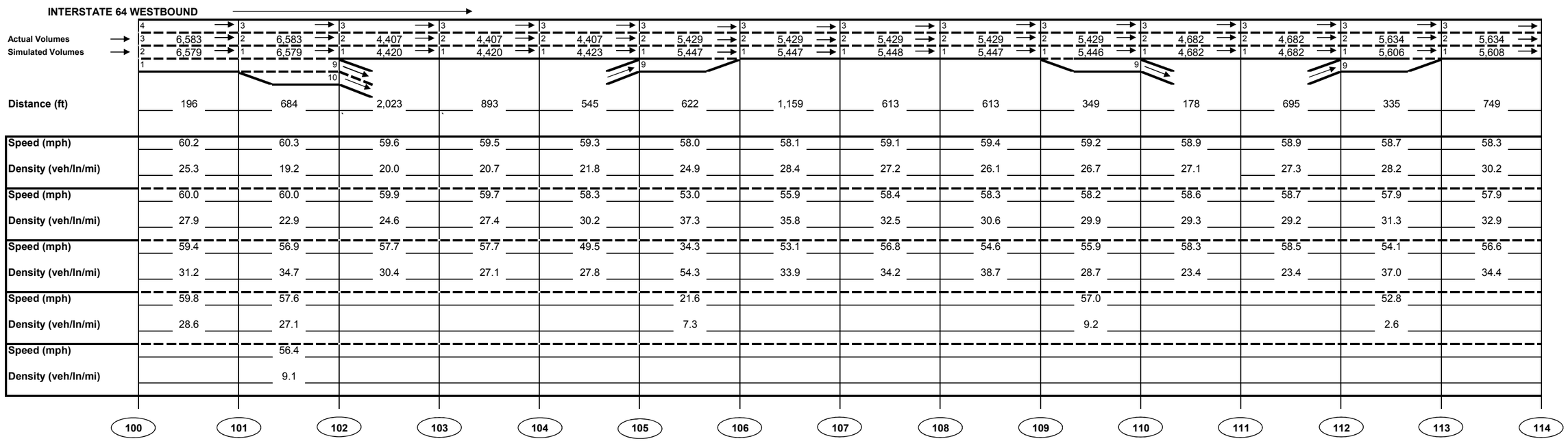
	300–301	301–302	302–303	303–304	304–305	305–306	306–307	307–308	308–309	309–310	310–311	311–312	312–313	313–314	314–315
Actual Volumes	5,935	5,935	5,777	5,777	5,201	5,201	5,201	5,201	5,201	5,201	5,201	4,194	4,194	6,081	6,081
Simulated Volumes	5,927	5,927	5,776	5,777	5,225	5,222	5,222	5,220	5,220	5,221	5,221	4,214	4,215	6,070	6,070
Distance (ft)	308	737	701	765	323	1,094	1,116	1,011	761	309	290	427	348	145	237
Speed (mph)	59.5	58.7	57.9	57.4	57.5	57.6	57.5	57.4	58.0	58.5	58.4	58.1	58.1	57.4	57.4
Density (veh/ln/mi)	34.0	32.9	31.7	30.6	30.4	30.1	30.0	29.7	26.7	24.8	24.4	24.5	24.7	26.8	30.7
Speed (mph)	59.6	58.9	58.3	56.3	58.0	58.5	58.5	58.4	58.6	58.5	59.0	59.1	58.9	55.6	56.6
Density (veh/ln/mi)	34.0	33.2	32.9	31.8	30.5	30.5	30.8	31.0	30.6	29.4	26.6	26.5	26.9	33.9	37.4
Speed (mph)	59.5	58.4	57.4	57.1	57.7	57.8	57.8	57.6	56.5	54.0	57.0	59.1	58.6	46.5	54.7
Density (veh/ln/mi)	34.4	34.0	35.2	30.7	29.6	29.5	29.4	29.6	33.3	38.0	23.6	20.7	20.5	50.8	40.1
Speed (mph)		58.4		57.4							55.0			49.2	
Density (veh/ln/mi)		1.1		8.3							16.1			5.7	

300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315

Kimley»Horn

Figure 34
Eastbound PM Peak Hour MOE's
Simon Group Outlet Mall Development TIA
Interchange Analysis
2021 Build Scenario





Kimley»Horn

Figure 35
Westbound PM Peak Hour MOE's
Simon Group Outlet Mall Development TIA
Interchange Analysis
2021 Build Scenario

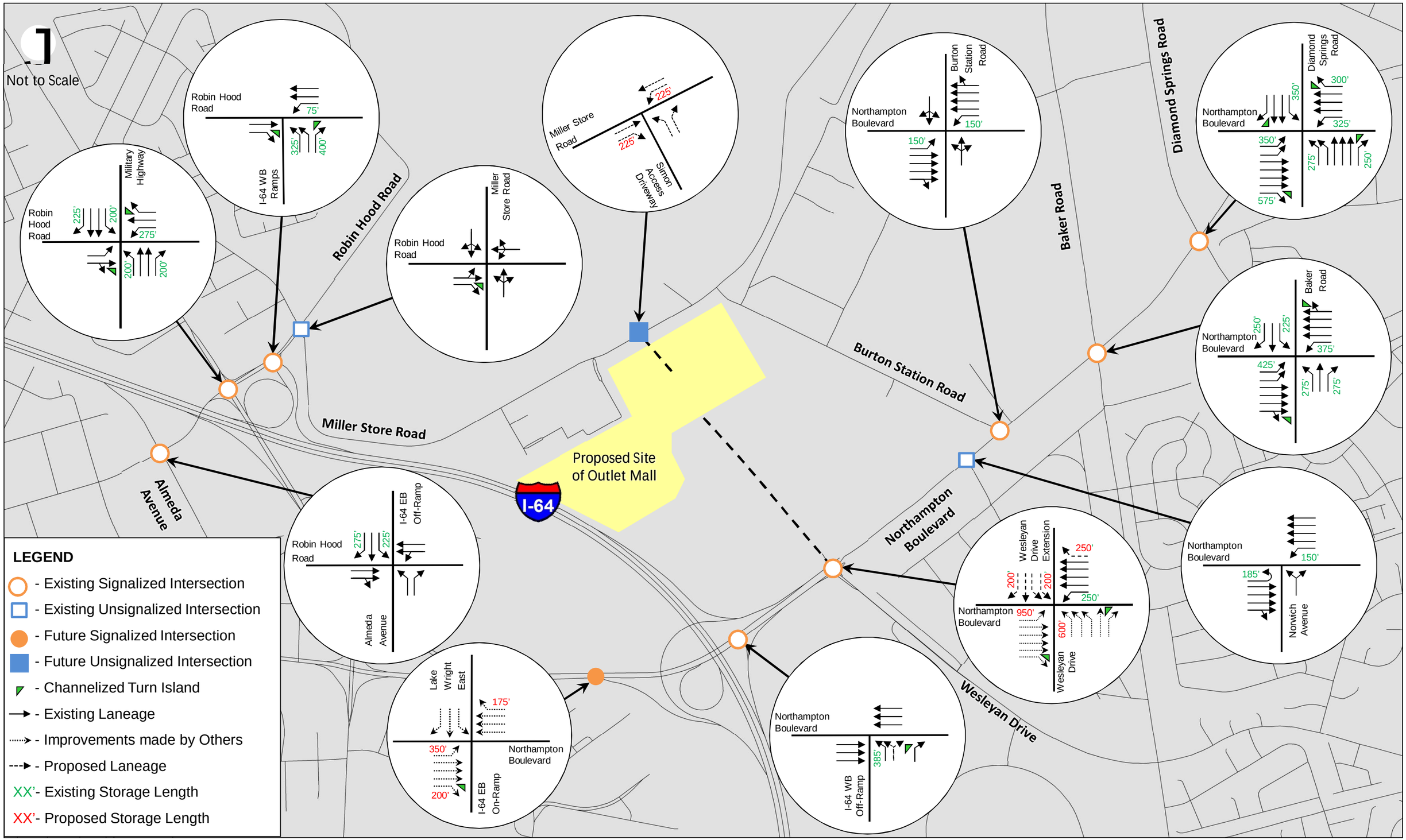
10.0 Conclusions and Recommendations

Based on the assumptions established during the project scope of work meeting on October 21, 2013, the majority of site traffic (i.e., 95-percent) will access the proposed outlet mall development via Wesleyan Drive Extension from Northampton Boulevard. The remaining portion of development related traffic will access the site via Simon Access Driveway from Miller Store Road. The proposed outlet mall development will increase traffic volumes along Northampton Boulevard by approximately 20-percent at the proposed new signalized intersection of Wesleyan Drive Extension. Beyond the proposed intersection, site traffic will account for approximately less than 10-percent of the additional volume at a given intersection under future 2021 build conditions. Therefore, the deficient signal operations for particular movements at several intersections, including, Northampton Boulevard/Diamond Springs Road, and Military Highway/Robin Hood Road, cannot be directly attributed to the development and associated site generated trips. Mitigation of these operational deficiencies would require improvements that are beyond the influence of the proposed development. However, to mitigate any potential operational issues and deteriorations in future LOS as a result of this development, the following improvements are recommended for implementation prior to opening day:

- Network-Wide - Optimize signal timing and lead/lag phasing to improve the coordinated signal operations along the Northampton Boulevard and Robin Hood Road/Military Highway corridors, particularly with the introduction of a new signalized intersection along Northampton Boulevard at the proposed Wesleyan Drive Extension
- Northampton Boulevard/Wesleyan Drive/Wesleyan Drive Extension (primary access point) – modify the signalized intersection allowing for full movement with the following laneage:
    - Northbound Northampton Boulevard– four (4) exclusive through lanes, one (1) exclusive left-turn lane (operating as a protected only movement), and one exclusive channelized right-turn lane with yield control
        - Left-turn lane should be extended to provide approximately 950 feet of storage and a minimum 100-foot taper.
        - Install/construct a physical barrier to channelize the exclusive left-turn lane to prevent driver maneuvers between the westbound I-64 off ramp and the left-turn lane.
            - The physical barrier channelizing the left-turn lane should extend back from the stop bar a distance of 850 feet.
        - Signage should be provided on the westbound I-64 off-ramp to notify drivers destined for the Simon Outlet Mall they must use the right-turn lane at the westbound I-64 Off-Ramp/Northampton Boulevard signalized intersection to access the exclusive left-turn lane serving the site.
    - Southbound Northampton Boulevard – four (4) exclusive through lanes, one (1) exclusive left-turn lane, and one (1) exclusive right-turn lane (operating with a right-turn overlap)

        - Right-turn lane should be constructed to provide 250 feet of storage and a 100-foot taper
    - Eastbound Wesleyan Drive Extension – two (2) exclusive left-turn lanes and one (1) exclusive through lane (operating as split phase), and one (1) exclusive right-turn lane (operating with a right-turn overlap)
        - Inside exclusive left-turn lane should be constructed to provide 200-feet of storage and a 100-foot taper
        - The outside exclusive left-turn lane will be a "trap" lane for the eastbound inside through lanes (no storage required).
        - Construct an exclusive right-turn lane with 200-feet of storage and a 100-foot taper
            - Since the Wesleyan Drive approaches to the intersection will operate as split phase, continue to monitor traffic volumes and periods of congestion/delay for the eastbound approach.
            - Additionally, consider restriping the exclusive through lane to function as a shared through and right-turn lane or potentially a shared left, through, and right-turn lane when or if it is deemed appropriate.
    - Westbound Wesleyan Drive – three (3) exclusive left-turn lanes (operating as split phase), one (1) exclusive through lane, and one (1) exclusive channelized right-turn lane with yield control. (no change from improvements by others)
- Miller Store Road/Simon Access Driveway (secondary access point) – modify the existing unsignalized intersection to provide the following laneage:
    - Eastbound Miller Store Road – one (1) exclusive through lane and one (1) exclusive right-turn lane (uncontrolled approach)
        - Right-turn lane should be constructed to provide 225-feet of storage and a 100-foot taper
    - Westbound Miller Store Road – one (1) exclusive through lane and one (1) exclusive left-turn lane (uncontrolled approach)
        - Left-turn lane should be constructed to provide 225-feet of storage and a 100-foot taper
    - Simon Access Driveway – one (1) exclusive left-turn lane and one (1) exclusive right-turn lane (stop controlled approach)
        - The exclusive left and right-turn lanes will each be a "trap" lane for the northbound through lanes (no storage required)

Figure 36 provides an overview of the proposed laneage of the project study area and identifies recommended roadway improvements.



Kimley»Horn

Simon Group Outlet Mall Development Traffic Impact Analysis
Norfolk, VA

Proposed Laneage and Roadway Improvements

FIGURE
36

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.