NCDOT STIP
R-2721/R-2828/R-2829

DETAILED STUDY ALTERNATIVES (DSA) TRAFFIC ANALYSIS – **TECHNICAL MEMORANDUM**

COMPLETE 540
Triangle Expressway
Southeast Extension

Wake County & Johnston County

PREPARED FOR:

North Carolina Department of Transportation
Project Development &
Environmental Analysis Branch

PREPARED BY:

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February 2015

NCDOT STIP PROJECTS R-2721, R-2828 & R-2829
Complete 540 (Triangle Expressway Southeast Extension)

WAKE AND JOHNSTON COUNTIES

Detailed Study Alternatives (DSA) Traffic Analysis

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2-23-15

February 2015

EXECUTIVE SUMMARY

1. Introduction

The North Carolina Department of Transportation (NCDOT) is studying ways to improve regional mobility in southern and eastern Wake County. NCDOT State Transportation Improvement Program (STIP) Projects R-2721, R-2828, and R-2829, known collectively as Complete 540 – Triangle Expressway Southeast Extension, in Wake and Johnston Counties currently feature 17 Detailed Study Alternatives (DSAs) that are approximately 28 miles long, extending from the NC 55 Holly Springs Bypass to I-40 near the US 70 Clayton Bypass (Southern Wake Freeway) and then to US 64 / US 264 Knightdale Bypass (Eastern Wake Freeway). The Complete 540 project is being considered and studied as a possible candidate toll facility. **Figure ES.1** shows the Detailed Study Alternative corridors. ***Appendix A*** contains all figures described in this report.

HNTB North Carolina, PC has been contracted by the NCDOT, to develop base and future year traffic capacity analyses for the Complete 540 project. The analyses and results for the base and future design year scenarios of the No-Build Alternative and 17 DSAs will be used to develop the environmental documentation required by the National Environmental Policy Act (NEPA).

For the purposes of the environmental document, it was decided in a project scoping meeting on July 8, 2014, and through coordination with NCDOT, that the base year scenario would use a base year of 2012 and the future design year scenario would be for the year 2035. In this meeting, a traffic analysis project study area was also defined that would satisfy the requirements of NEPA and include all potential impacts for 17 DSAs. Separate No-Build and Build DSA traffic capacity analyses were conducted for both the 2012 base year and 2035 design year. **Figure 2** shows the project study area for the traffic analyses.

The purpose of this traffic capacity analysis is to identify existing and projected roadway facility, interchange and intersection operations and any potential deficiencies for the major roadways surrounding and intersecting the Complete 540 functional designs for the 17 DSAs under 2012 Base Year and 2035 Design Year conditions. In addition to being included in NEPA documentation, the results of the analysis will be used to support the alternatives development process and preliminary designs for the project.

Traffic volumes used in this traffic capacity analysis were based on the *Complete 540 - Triangle Expressway Southeast Extension NCDOT STIP Project R-2721, R-2828 & R-2829 Traffic Forecast Technical Memorandum* prepared by HNTB in April 2014. The traffic capacity analysis references the following forecast volumes for the 2012 and 2035 analysis scenarios:

- 2012 Base Year No-Build
- 2012 Base Year Build DSA 1-17
- 2035 Design Year No-Build
- 2035 Design Year Build DSA 1-17

Complete 540 functional designs and interchange forms evaluated in this traffic capacity analysis were based on the designs and interchange form recommendations prepared by Lochner, based upon ongoing coordination, planning, analysis and design. The designs have been reviewed and approved by the NCDOT Roadway Design Unit.

As described in more detail within the report, several DSAs feature the same (or nearly identical) projected traffic volumes and interchange forms, depending on individual DSA corridor alignments. For example, DSAs 1-5 and 13-17 all follow the Orange or Orange-Lilac corridor from NC 55 Bypass to I-40 in southern Wake County, have similar projected traffic volumes and produce similar capacity analysis results. Similarly, DSAs 6 and 7 follow the Orange-Red corridor from NC 55 Bypass to I-40, have similar projected traffic volumes and produce similar capacity analysis results. DSAs 8-12 all follow the Orange-Purple-Blue-Lilac corridor from NC 55 Bypass to I-40, have similar projected traffic volumes and produce similar capacity analysis results. From I-40 to US 64 / US 264 in eastern Wake County, the Green, Mint, Brown, Tan and Teal DSA corridors are closer in proximity and there is relatively less variation in projected traffic volumes between DSAs and interchange configurations. Since there are generally three distinct corridors based on project traffic volumes and operations, DSAs 1, 6 and 8 are presented in additional detail in the report tables and figures as representative corridors for comparison. Additional detailed capacity analysis results for all DSAs 1-17 are located in the Appendices.

The following sections describe existing and future transportation conditions in the project study area, the capacity analysis methodology, capacity analysis results for the 2012 base year and 2035 design year, microsimulation operations analysis, and conclusions and recommendations derived from the capacity analyses related to current functional designs for the Complete 540 DSAs.

2. Existing and Future Conditions

The Complete 540 DSA corridor alignments in the project study area run primarily east-west between the existing Triangle Expressway termini at NC 55 Bypass in Apex to the existing I-40 corridor near Clayton. Corridor alignments then run primarily north-south between I-40 and the existing I-540 system interchange with US 64 / US 264 in Knightdale. The corridor alignments cross multiple existing freeway, arterial, and local roadway facilities. The 17 Complete 540 DSAs studied are shown on Figure ES.1.

Under existing conditions, there are five major access-controlled freeways, numerous major and minor arterial facilities, nine existing interchanges, one planned future interchange (STIP Project # R-2635D), and 18 existing at-grade intersections on Y-line facilities that are directly impacted by the 17 DSA alignments in the project study area.

Existing traffic control information was provided by NCDOT for all signalized intersections. Other relevant study information and analysis inputs for the existing study area facilities and corridors was collected from existing aerial photography, traffic forecast and field verified in 2014 by HNTB staff.

Under future conditions, the Complete 540 project, Triangle Expressway Southeast Extension, will complete the Raleigh 540 outer loop. Construction is currently scheduled to be completed in phases. Phase I (southern portion) is between NC 55 Bypass in Apex and I-40 near the Johnston County line. Phase II (eastern portion) continues the project at I-40 and ends at US 64 / US 264 in Knightdale. The project is located primarily in Wake County with a small portion of the project that extends into Johnston County.

Transportation demands, social and economic demands and mobility considerations are the basis for additional transportation infrastructure in southeastern Wake County. Complete 540 will link the towns of Clayton, Garner, Fuquay-Varina, Holly Springs, Apex, Cary, Knightdale, and Raleigh. It will also connect major roadways in southern Raleigh and aid in easing congestion on the I-40, I-440 (Raleigh Beltline), NC 42, NC 55, Ten Ten Road and other arterial surface streets by providing a high-speed, reliable transportation option. The Complete 540 project would increase the overall capacity of the existing study area roadway network and be expected to divert traffic from secondary roads. The Complete 540 DSA corridors are approximately 30 miles in length, beginning at the existing Toll NC 540 (Triangle Expressway) and NC 55 Bypass service interchange and terminating at the existing I-540 and US 64 / US 264 system interchange.

With construction of Complete 540, there are approximately 19 existing/future interchanges and 36 existing/future intersections on Y-line facilities and at interchange ramp terminals that are directly impacted by the 17 DSA alignments in the project study area, depending on the DSAs.

3. Capacity Analysis Methodology

Per standards for the preparation of capacity analyses for TIP projects used by the NCDOT Congestion Management Section, the Complete 540 project study area and DSAs were analyzed using methodologies set forth in the *Highway Capacity Manual 2010* (Transportation Research Board, December 2010) and the accompanying Highway Capacity Software 2010 (HCS Version 6.60) for freeway facilities and unsignalized intersections. Signalized intersections were analyzed in Synchro Professional Version 7. Results for AM and PM peak hour timeframes are given as a Level-of-Service (LOS) for segments of freeway and intersections that correspond to a letter grade of LOS A through LOS F. In general, LOS D is the minimum threshold for acceptable peak hour traffic operations on the freeway segments and study area intersections, and was used as a benchmark in testing the DSA functional design geometrics for the 2012 and 2035 analysis years. Details for each analysis type are included in **Table ES-1**.

Table ES-1. Capacity Analysis Details

Analysis Type	Details
Freeway System Analysis	Segmented the DSA alignment networks into separate basic freeway, weaving, merge, and diverge areas in HCS Freeway Facilities Module (FreeVal). Calculated both individual segment vehicular density and LOS and overall directional system operational statistics per HCM 2010 methods.
Signalized Intersection Analysis	Created Synchro networks that included individual intersections and corridors in the vicinity of the proposed interchange ramp terminals and incorporated signal plan information. Build networks analyzed all Complete 540 interchange ramp terminal intersections as signalized intersections in the design year.
Unsignalized Intersection Analysis	Created unsignalized intersection files in HCS for the existing unsignalized study area intersections. Signal warrants analyses were conducted to determine intersection control type in the design year analyses. Added additional Build DSA unsignalized intersections if DSA designs included changes to No-Build network.

4. Development of Alternatives

The No-Build Alternative assumes that no further development of the Complete 540 project will occur within the project study area limits, but any other background improvements that are committed to and funded by NCDOT, local municipalities, or private development projects would occur by the 2035 design year. Additional capital improvements include the proposed Old Holly Springs-Apex Road interchange (R-2635D), widening of study area facilities (I-40, I-540 and other planned facilities) and basic traffic signal retiming.

The Build Alternatives assume construction of Complete 540 in addition other background improvements that are committed to and funded by NCDOT, local municipalities, or private development projects would occur by the 2035 design year. The 17 Complete 540 DSAs studied are shown on **Figure ES.1**. Each DSA roadway design (alignment, interchange form, geometrics, design criteria) was provided by Lochner for use in the traffic capacity analysis.

5. 2012 Base Year / 2035 Design Year Traffic Volume Development

Peak hour traffic volume estimates for the 2012 base year and 2035 design year No-Build and Build scenarios were developed using daily traffic forecast information from the *Complete 540 - Triangle Expressway Southeast Extension NCDOT STIP Project R-2721, R-2828 & R-2829 Traffic Forecast Technical Memorandum* prepared by HNTB North Carolina, PC and approved by NCDOT TPB in April 2014. Daily traffic data, such as Average Annual Daily Traffic (AADT) estimates for study area roadway segments, truck percentages, design hour volumes (DHV-factor), and peak directional flows (D-factor) were entered into NCDOT Congestion Management Section peak hour traffic volume breakout spreadsheets for each intersection and/or interchange. This traffic volume data were then entered into capacity analysis software, as appropriate.

6. Capacity Analysis Results

For Complete 540, all DSA freeway segments, interchange designs configurations, and interchange ramp terminal intersections are projected to operate at LOS D or better in the 2012 base year and 2035 design year based on the current functional designs for a Complete 540 six-lane, toll facility. For this reason, only the 2035 design year worst-case AM and PM peak hour LOS freeway summary results are presented in **Table ES-2**. Of the 115 to 137 freeway segments analyzed, depending on the individual DSA alignment, only one weaving segment between US 64 / US 264 and Poole Road in the westbound PM peak experiences projected operational deficiencies. To further investigate and assess expected freeway system performance in this weaving segment, supplemental VISSIM microsimulation analyses were prepared and showed acceptable weaving segment operations of a comparable LOS D or better for the simulation runs, as shown in **Table ES-4**. Of the 29 to 36 study area intersections analyzed at interchange ramp terminals or adjacent Y-lines, depending on the individual DSA alignment, only 1 to 4 intersections are projected to experience operational deficiencies, depending on the DSA as shown in **Table ES-3**. None of the intersections potentially experiencing operational deficiencies are interchange ramp terminal intersections directly impacting Complete 540 mainline freeway operations. The intersections projected to operate at LOS E or F either include unsignalized, minor Y-line intersections or signalized Y-line intersections that incorporate reasonably feasible geometric improvements to optimize intersection traffic operations. Overall, all seventeen (17) DSAs operate with nearly identical freeway and intersection measures of effectiveness (MOEs) and levels-of-service, even though each DSA includes different volumes, corridor alignments, interchange configurations, interchange access points and impacts to crossing freeway and arterial facilities.

Table ES-2. 2035 Design Year No-Build & Build Freeway Operations Summary

Scenario	Complete 540											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
No-Build	3	3	5	0	0	0	3	11	1	0	0	0
DSA 1	2	32	33	1	0	0	1	27	39	1	1	0
DSA 2	2	32	33	1	0	0	1	27	39	1	1	0
DSA 3	1	38	26	1	0	0	1	27	37	1	1	0
DSA 4	3	29	33	1	0	0	1	27	37	1	1	0
DSA 5	3	37	27	1	0	0	1	31	35	1	1	0
DSA 6*	0	14	40	2	0	0	0	34	24	0	1	0
DSA 7*	0	15	39	2	0	0	0	34	24	0	1	0
DSA 8	1	31	31	1	0	0	1	32	33	0	1	0
DSA 9	1	31	31	1	0	0	1	32	33	0	1	0
DSA 10	1	28	32	1	0	0	1	30	33	0	1	0
DSA 11	1	28	32	1	0	0	1	30	33	0	1	0
DSA 12	1	34	28	1	0	0	1	36	29	1	0	0
DSA 13	1	29	33	1	0	0	1	25	39	1	1	0
DSA 14	1	29	33	1	0	0	1	26	38	1	1	0
DSA 15	2	23	36	1	0	0	1	25	37	1	1	0
DSA 16	2	24	35	1	0	0	1	25	37	1	1	0
DSA 17	2	33	28	1	0	0	1	31	33	1	1	0

**DSA 6, 7 includes analysis of collector-distributor segment along Complete 540.*

Table ES-3. 2012 & 2035 No-Build & Build Intersection Capacity Analysis Summary

Scenario	Number of Intersections Operating at Given LOS in at Least One AM or PM Peak Hour*											
	2012 Base Year						2035 Design Year					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
No-Build	1	4	6	0	***3***	***2***	0	2	4	1	***4***	***5***
DSA 1	11	17	4	0	***1***	***0***	2	15	10	4	***1***	***1***
DSA 2	11	17	4	0	***1***	***0***	2	15	10	4	***1***	***1***
DSA 3	9	15	5	0	***0***	***0***	4	11	11	2	***1***	***1***
DSA 4	9	15	5	0	***0***	***0***	5	10	11	2	***1***	***1***
DSA 5	8	18	4	0	***1***	***0***	4	12	10	3	***1***	***1***
DSA 6	17	12	4	1	***1***	***0***	2	15	6	8	***3***	***1***
DSA 7	17	12	4	1	***1***	***0***	2	15	6	8	***3***	***1***
DSA 8	16	17	2	0	***1***	***0***	5	16	8	6	***1***	***0***
DSA 9	16	17	2	0	***1***	***0***	5	16	8	6	***1***	***0***
DSA 10	13	17	3	0	***0***	***0***	6	13	9	4	***1***	***0***
DSA 11	13	17	3	0	***0***	***0***	7	12	9	4	***1***	***0***
DSA 12	14	17	2	0	***1***	***0***	7	13	8	5	***1***	***0***
DSA 13	14	15	3	0	***1***	***0***	2	16	9	4	***1***	***0***
DSA 14	14	15	3	0	***1***	***0***	2	16	9	4	***1***	***0***
DSA 15	11	15	4	0	***0***	***0***	4	12	10	2	***1***	***0***
DSA 16	11	15	4	0	***0***	***0***	5	11	10	2	***1***	***0***
DSA 17	11	15	3	0	***1***	***0***	4	13	9	3	***1***	***0***

*-For signalized intersections, overall intersection LOS. For unsignalized intersections, worst-case critical movement.

7. Microsimulation Operations Analysis

Initial 2035 PM peak hour HCS FreeVal results at the northern/eastern project termini for the southbound Complete 540 weaving segment from US 64/US 264 to Poole Road produced densities that correspond to LOS D or E for Build DSAs 1-17. Since FreeVal methodologies are not set up to evaluate this area to the same level of detail as microscopic analysis, a microsimulation model was developed to test the weaving segment in greater detail and more realistically evaluate this area with demands nearing capacity and higher turbulence. Microsimulation results for the 2035 design year Build DSA 3, 4, 15, 16 indicate that the Complete 540 weaving segment between US 64 / US 264 and Poole Road in the westbound PM peak is projected to operate at LOS D or better and more efficiently than FreeVal results, as shown in **Table ES-4**. Thus, all of the Build Detailed Study Alternatives are expected to provide adequate traffic operations for this particular area of the project.

Table ES-4. 2035 VISSIM Measures of Effectiveness PM Peak Results

Segment Performance	Complete 540 DSA 3, 4, 15, 16 Southbound Weaving Segment	
	HCS Freeval	VISSIM
Volume [veh/hour]	5,404	5,354
Density [veh/mile]	***34.00***[2]	25.58[1]
Speed [mph]	47.0	53.6

BOLD/ITALIC – Segment Density Exceeds LOS D Thresholds
1 - VISSIM density reported in average density (veh/mi/ln).
2 - HCS density reported in (veh/mi/ln) for comparison. Corresponding (pc/mi/ln) is 38.30 and LOS E.

8. Summary and Recommendations

The Complete 540 study area traffic capacity analysis was completed to evaluate base year (2012) and design year (2035) peak hour traffic operations for 17 Complete 540 Detailed Study Alternatives and surrounding freeway facilities and nearby intersections within the traffic analysis study area. The capacity analysis report incorporates the ongoing coordination efforts between project planning, design and analysis study teams to produce DSAs that provide sufficient capacity, efficient operations, and acceptable future levels of service. The recommended freeway, arterial, interchange and intersection geometrics and intersection control for Complete 540 DSAs 1, 6 and 8 are schematically presented in ***Appendix A***. Recommended and analyzed geometrics for all DSAs are included in the detailed capacity analysis outputs from HCS FreeVal, Synchro and HCS unsignalized intersections in ***Appendices E, F*** and ***G***, respectively.

Based on the 2035 design year capacity analysis, the following conclusions and recommendations are presented for study area facilities and intersections:

Complete 540 Corridors

All Complete 540 DSA freeway segments, interchange designs configurations, and interchange ramp terminal intersections are projected to operate at LOS D or better in the 2035 design year, based on the current functional designs for a Complete 540 six-lane, toll facility. Overall, all 17 DSAs operate with very similar freeway and intersection measures of effectiveness and levels of service, even though each DSA includes different volumes, corridor alignments, interchange configurations, interchange access points and impacts to crossing freeway and arterial facilities.

Figures ES.2-3, ES.4-5 and **ES.6-7** provide a summary of freeway and intersection level of service operations for three representative DSAs, DSA 1, 6, and 8, respectively.

NC 540 Corridor

Based on the 2035 design year Build DSA analysis results, the existing section of NC 540 from US 1 to NC 55 Bypass is projected to operate at acceptable LOS D or better for all DSAs with construction of Complete 540 and the Old Holly Springs-Apex Road interchange (R-2635D).

I-540 Corridor

The existing section of I-540 from US 64 / US 264 to US 64 Business is projected to operate at acceptable LOS D or better for all DSAs with construction of Complete 540 and I-540 planned widening to an 8-lane facility.

I-40 Corridor

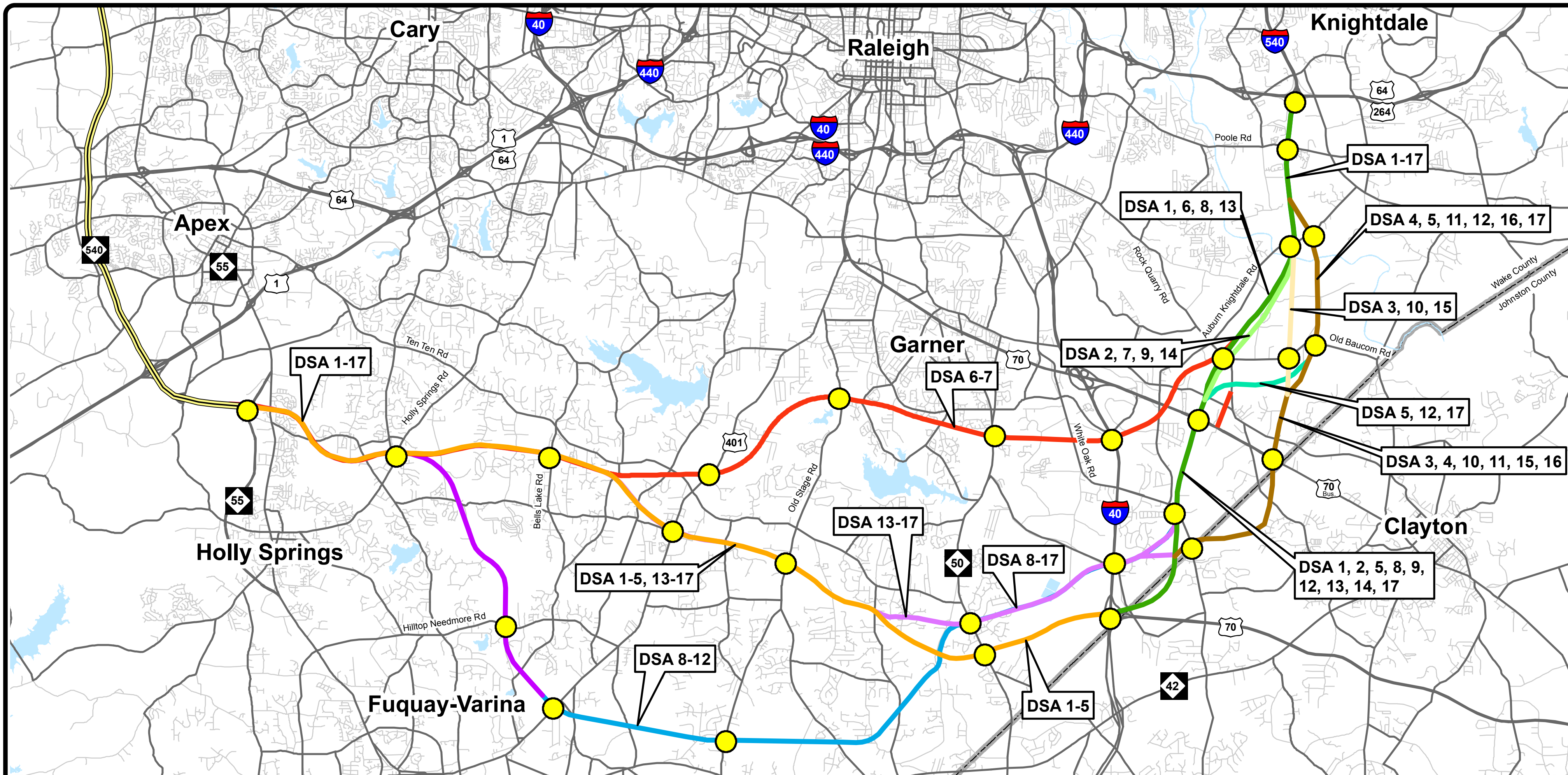
I-40 from US 70 Business to NC 42 is projected to operate at acceptable LOS D or better for all DSAs with construction of Complete 540 and I-40 planned widening to an 8-lane facility. DSAs 1-5 and 8-17 propose a five-leg system interchange with I-40 and US 70 and provide acceptable interchange spacing between US 70 and NC 42. DSAs 6 and 7 connect with I-40 as a four-leg system interchange further to the north and do not provide desirable interchange spacing between the I-40 and US 70 Business interchange. Therefore, DSA 6 and 7 propose collector-distributors on I-40 through the US 70 Business and Complete 540 system interchanges. DSA 6 and 7 also do not provide direct interchange access at US 70 Business due to undesirable interchange spacing from I-40. Rocky Quarry Road Extension is proposed to provide direct access from Complete 540 at the Rock Quarry Road interchange to US 70 Business. The potential impacts of Complete 540 on I-40, US 70, US Business and the system interchange operations should be re-evaluated at the appropriate time for an interchange access request study.

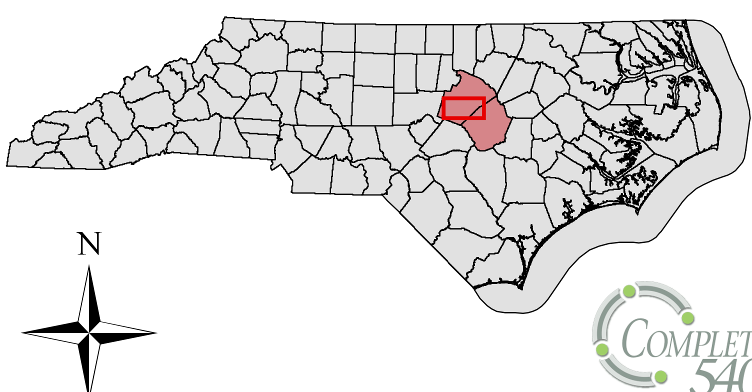
US 70 Corridor

The existing section of US 70 from I-40 to NC 42 is projected to operate at acceptable LOS D or better for all DSAs with construction of Complete 540.

US 64 / US 264 Corridor

Capacity analysis results indicate that US 64 / 264 is operating near or over capacity with operational deficiencies in the 2035 design year AM and PM peak hours with or without construction of Complete 540. Based on the 2035 design year No-Build DSA analysis results, US 64 / US 264 from Hodge Road to Smithfield Road is projected to operate at LOS E or F for 6 of 11 eastbound segments and 9 of 11 westbound segments as a six-lane freeway facility. In all Build DSAs, similar facility volumes and operational results are projected. Construction of Complete 540 proposes modifying the existing directional system interchange with US 64 / US 264 and I-540 by connecting the forth leg and constructing a flyover and a loop ramp. The system interchange was planned, designed and constructed to accommodate the future completion and connection of the 540 loop. This interchange modification would add one eastbound and one westbound freeway merge on US 64 / US 264. The potential impacts of Complete 540 on US 64 / US 264, I-540 and the system interchange operations should be re-evaluated at the appropriate time for an interchange access request study.





Detailed Study Alternative Corridors

Legend

- Interchanges
- Triangle Expressway
- Major Roads
- Counties

DSA Corridors

- Orange
- Green
- Mint
- Brown
- Tan
- Teal
- Lilac
- Red
- Blue
- Purple

STIP: R-2721, R-2828, R-2829

WBS: 37673.1.TA2, 35516.1.TA1, 35517.1.TA1

COUNTY: Wake/Johnston

DIVISION: 5/4

DATE: February 2015

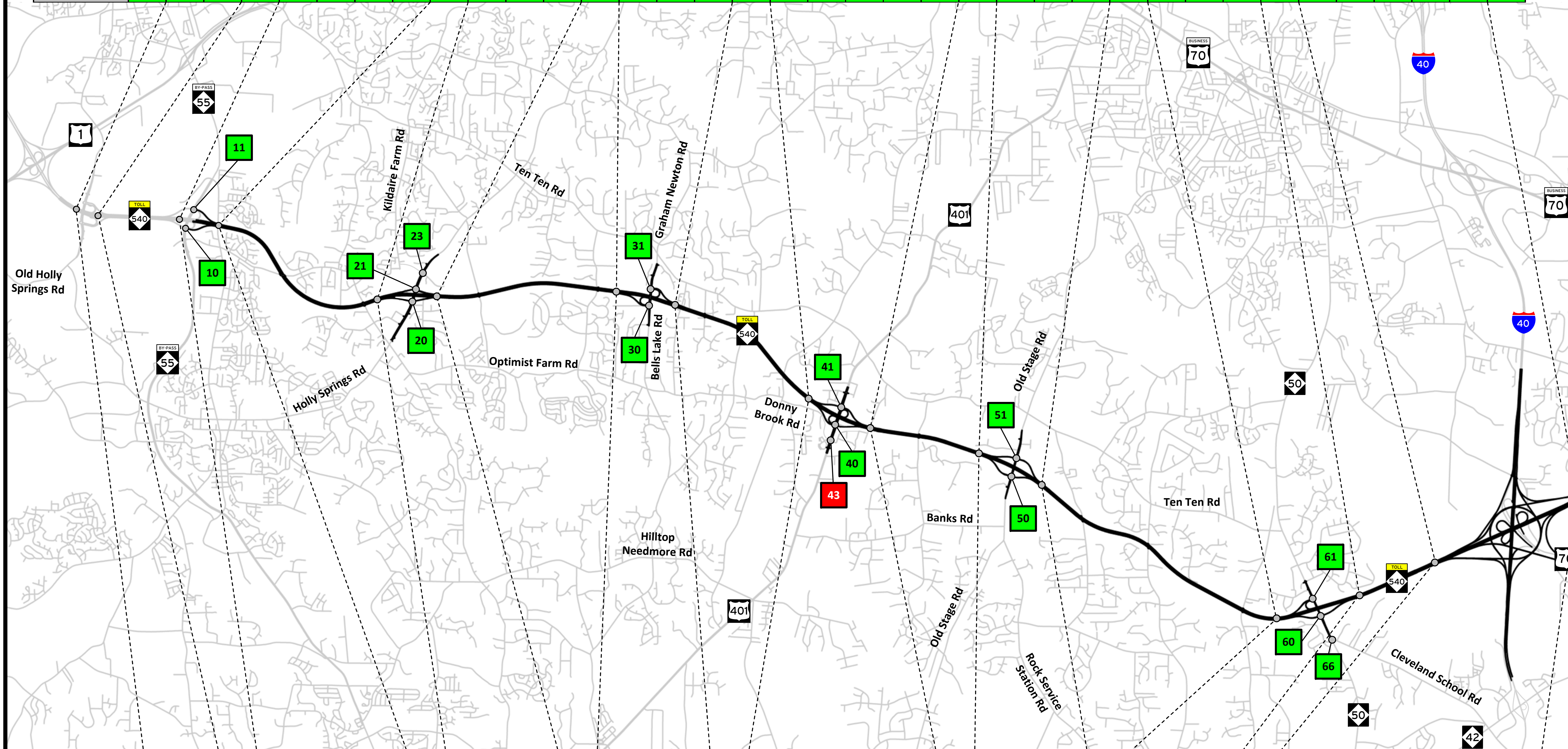
PREPARED BY: HNTB North Carolina, P.C.
343 E. Six Forks Rd, Suite 200
Raleigh, NC 27609

LOCATION: NC 55 Bypass (Holly Springs) to US 64 Bypass (Knightdale)

PROJECT: Complete 540
Triangle Expressway
Southeast Extension

Figure ES.1

Facility	Complete 540																																				
Interchange		OHS-A Rd			NC 55 Bypass					Holly Springs Rd				Bells Lake Rd				US 401						Old Stage Rd				NC 50				I-40 and US 70					
Westbound	B137	M136	B135	W134	B133	M132	B131	D130	B129	M128	B127	D126	B125	M124	B123	D122	B121	M120	B119	M118	B117	D116	B115	M114	B113	D112	B111	M110	B109	D108	B107	M106	B105	W104	B103	D102	B101



Eastbound	B1	D2	B3	W4	B5	D6	B7	M8	B9	D10	B11	M12	B13	D14	B15	M16	B17	D18	B19	M20	B21	M22	B23	D24	B25	M26	B27	D28	B29	M30	B31	D32	B33	D34	B35	M36	B37	M38	B39
Interchange		OHS-A Rd			NC 55 Bypass					Holly Springs Rd				Bells Lake Rd				US 401						Old Stage Rd				NC 50				I-40 and US 70							
Facility	Complete 540																																						

LEGEND

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics – Time Period Demand/Capacity Ratio > 1

Intersection ID # = XX

Freeway ID # = **B XX**, Basic
= **M XX**, Merge
= **D XX**, Diverge
= **W XX**, Weave

XX = Freeway Segment Breaks

XX = Unsignalized Intersection

XX = Signalized Intersection

N

NOT TO SCALE

S.T.I.P. R-2721, R-2828, R-2829

Complete 540
Triangle Expressway Southeast Extension

Wake and Johnston Counties

2035 DESIGN YEAR BUILD
DSA 1-2: ORANGE CORRIDOR

LOS & SEGMENT ID #

DATE: February 2015 **DIVISION:** 5

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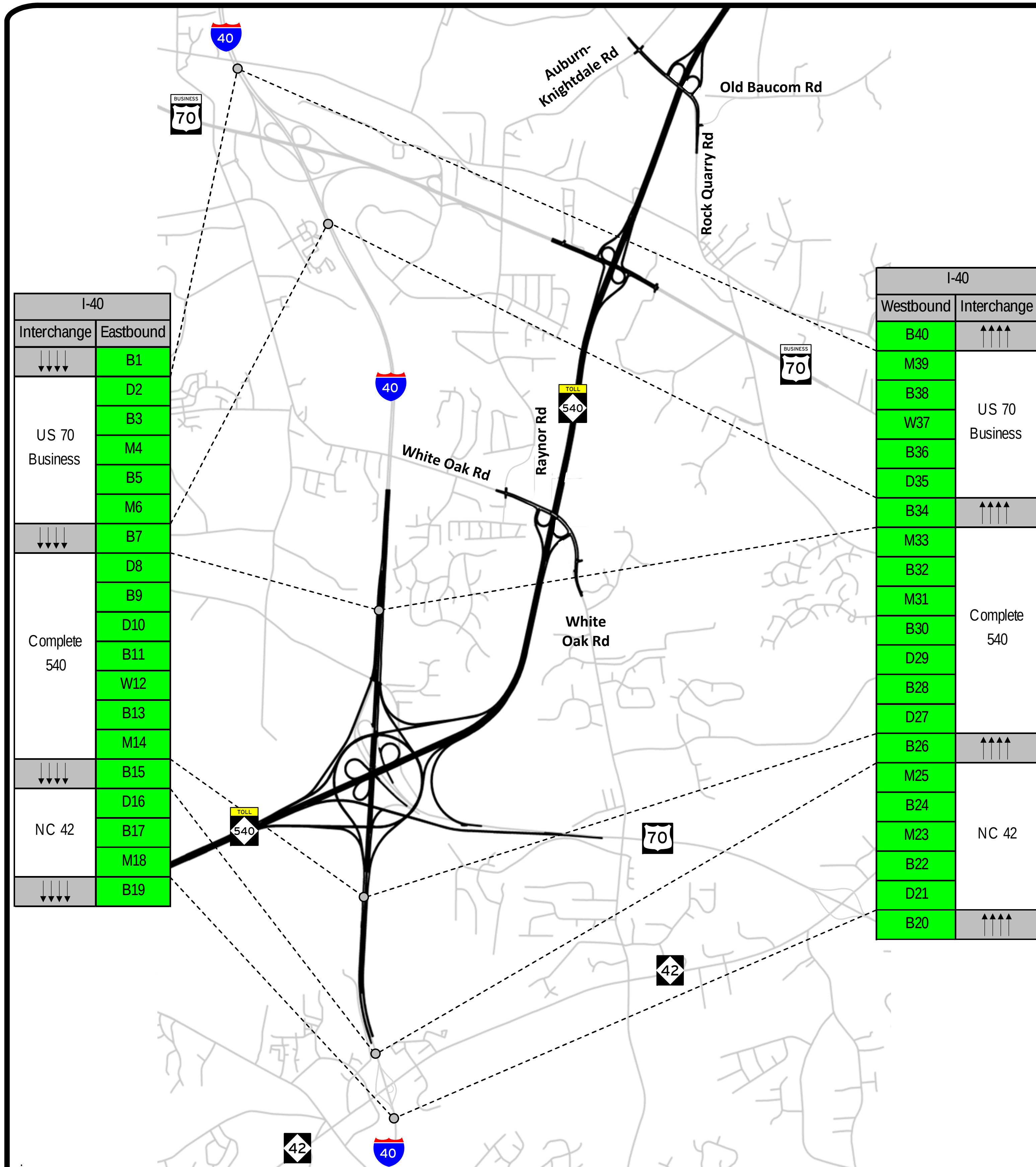
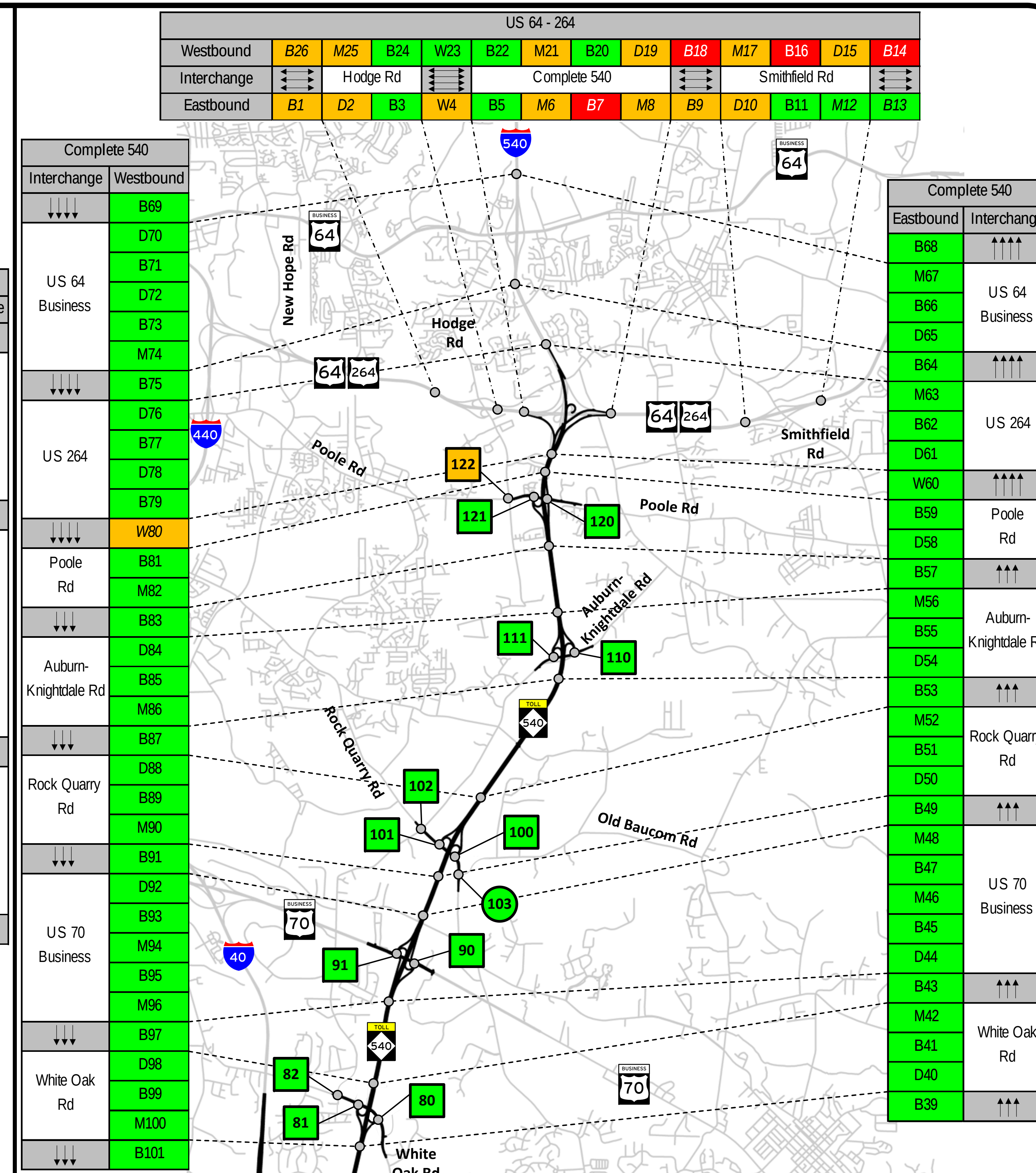
Figure ES.2



I-40	
Interchange	Eastbound
	B1
US 70 Business	D2
	B3
	M4
	B5
	M6
	B7
Complete 540	D8
	B9
	D10
	B11
	W12
	B13
	M14
	B15
NC 42	D16
	B17
	M18
	B19

I-40	
Westbound	Interchange
B40	
M39	US 70 Business
B38	
W37	
B36	
D35	
B34	
M33	Complete 540
B32	
M31	
B30	
D29	
B28	
D27	
B26	
M25	NC 42
B24	
M23	
B22	
D21	
B20	



US 64 - 264													
Westbound	B26	M25	B24	W23	B22	M21	B20	D19	B18	M17	B16	D15	B14
Interchange		Hodge Rd			Complete 540					Smithfield Rd			
Eastbound	B1	D2	B3	W4	B5	M6	B7	M8	B9	D10	B11	M12	B13

Complete 540	
Interchange	Westbound
	B69
US 64 Business	D70
	B71
	D72
	B73
	M74
	B75
US 264	D76
	B77
	D78
	B79
	W80
Poole Rd	B81
	M82
	B83
Auburn-Knightdale Rd	D84
	B85
	M86
	B87
Rock Quarry Rd	D88
	B89
	M90
	B91
US 70 Business	D92
	B93
	M94
	B95
	M96
	B97
White Oak Rd	D98
	B99
	M100
	B101

Complete 540	
Eastbound	Interchange
B68	
M67	US 64 Business
B66	
D65	
B64	
M63	US 264
B62	
D61	
W60	
B59	Poole Rd
D58	
B57	
M56	Auburn-Knightdale Rd
B55	
D54	
B53	
M52	Rock Quarry Rd
B51	
D50	
B49	
M48	US 70 Business
B47	
M46	
B45	
D44	
B43	
M42	White Oak Rd
B41	
D40	
B39	

LEGEND

AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics – Time Period Demand/Capacity Ratio > 1

Intersection ID # = XX

Freeway ID # = B XX, Basic
= M XX, Merge
= D XX, Diverge
= W XX, Weave

XX = Freeway Segment Breaks
XX = Unsignalized Intersection
XX = Signalized Intersection

N

NOT TO SCALE

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540
TRIANGLE EXPRESSWAY SOUTHEAST EXTENSION

WAKE AND JOHNSTON COUNTIES

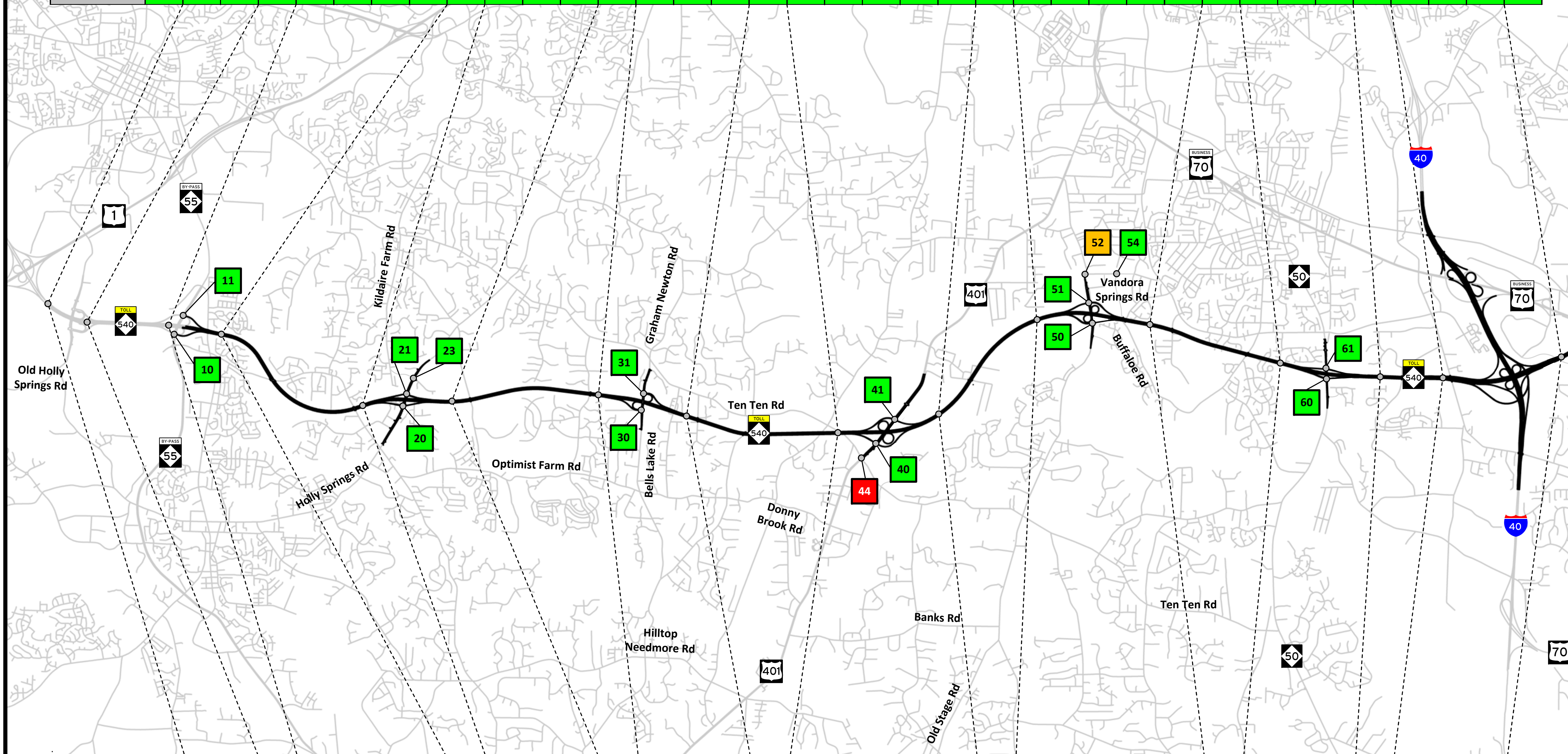
2035 DESIGN YEAR BUILD
DSA 1-2: GREEN CORRIDOR
LOS & SEGMENT ID #

DATE: February 2015 | DIVISION: 5

PREPARED BY: HNTB North Carolina, P.C. 343 E. Six Forks Rd., Ste. 200 Raleigh, North Carolina 27609

Figure ES.3

Facility	Complete 540																																				
Interchange		OHS-A Rd			NC 55 Bypass					Holly Springs Rd				Bells Lake Rd				US 401						Old Stage Rd						NC 50				I-40 and US 70			
Westbound	B115	M114	B113	W112	B111	M110	B109	D108	B107	M106	B105	D104	B103	M102	B101	D100	B99	M98	B97	M96	B95	D94	B93	M92	B91	M90	B89	D88	B87	M86	B85	D84	B83	M82	B81	D80	B79



Eastbound	B1	D2	B3	W4	B5	D6	B7	M8	B9	D10	B11	M12	B13	D14	B15	M16	B17	D18	B19	D20	B21	M22	B23	D24	B25	M26	B27	M28	B29	D30	B31	M32	B33	D34	B35	M36	B37
Interchange		OHS-A Rd			NC 55 Bypass					Holly Springs Rd				Bells Lake Rd				US 401						Old Stage Rd						NC 50				I-40 and US 70			
Facility	Complete 540																																				

LEGEND

AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics – Time Period Demand/Capacity Ratio > 1

Intersection ID # = XX

Freeway ID # = B XX, Basic
= M XX, Merge
= D XX, Diverge
= W XX, Weave

XX = Freeway Segment Breaks
XX = Unsignalized Intersection
XX = Signalized Intersection

N

NOT TO SCALE

S.T.I.P. R-2721, R-2828, R-2829

Complete 540
Triangle Expressway Southeast Extension

Wake and Johnston Counties

2035 DESIGN YEAR BUILD
DSA 6-7: ORANGE/RED CORRIDOR
LOS & SEGMENT ID #

DATE: February 2015 **DIVISION:** 5

PREPARED BY: HNTB North Carolina, P.C.
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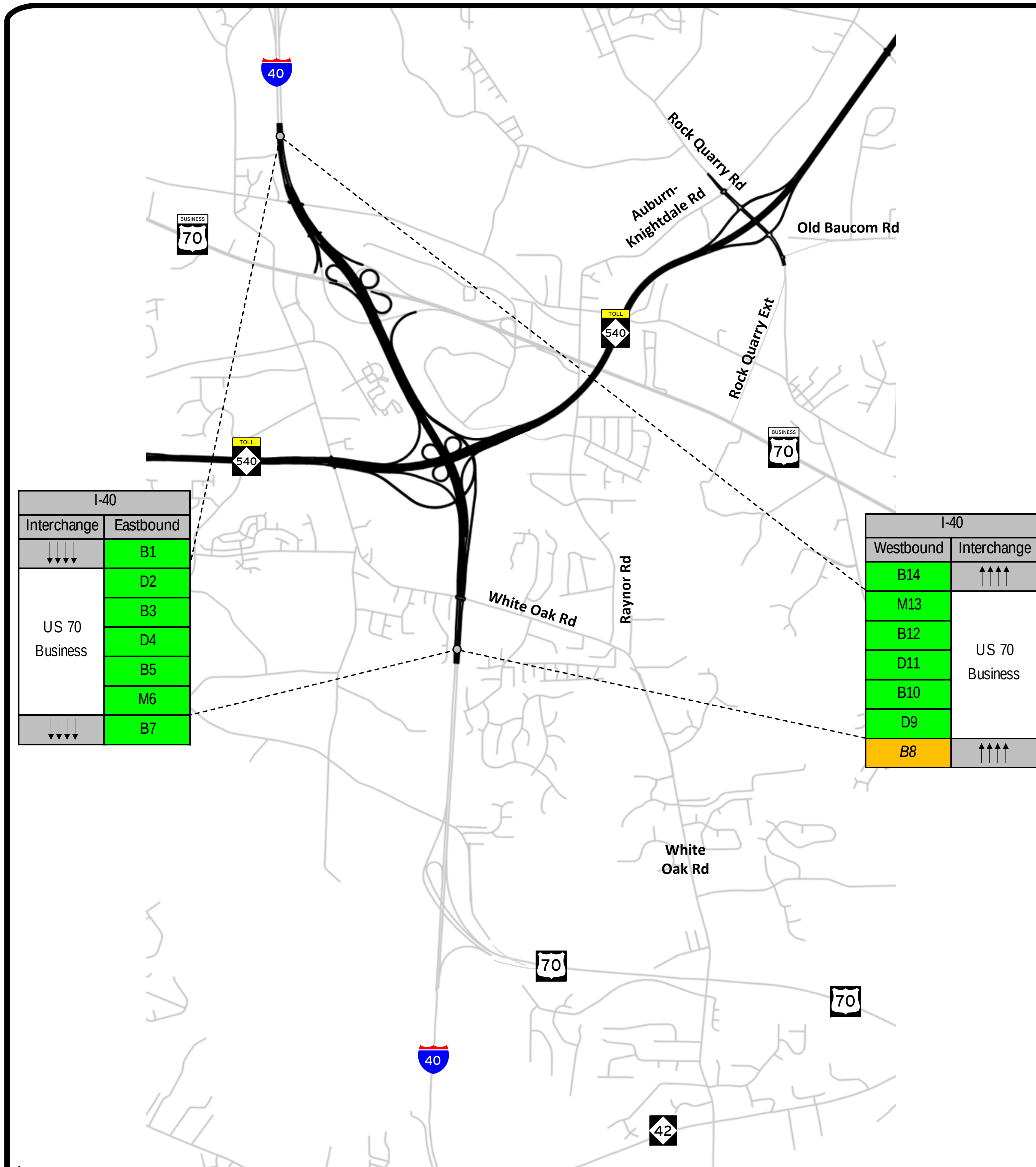
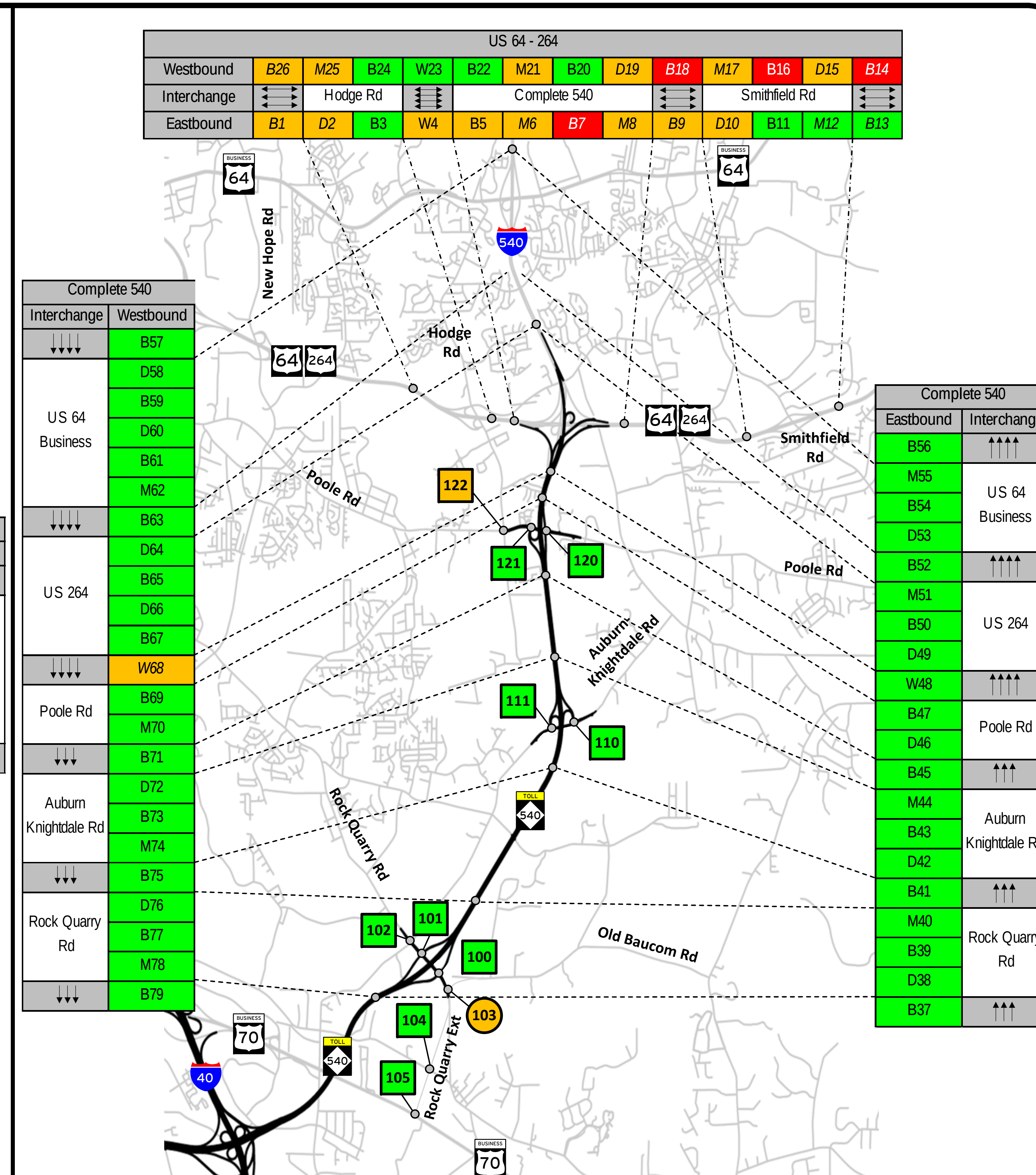
Raleigh, North Carolina 27609

Figure ES.4



I-40	
Interchange	Eastbound
	B1
US 70 Business	D2
	B3
	D4
	B5
	M6
	B7

I-40	
Westbound	Interchange
B14	
M13	US 70 Business
B12	
D11	
B10	
D9	
B8	



US 64 - 264													
Westbound	*B26*	*M25*	B24	W23	B22	M21	B20	*D19*	*B18*	*M17*	B16	*D15*	*B14*
Interchange		Hodge Rd			Complete 540					Smithfield Rd			
Eastbound	*B1*	*D2*	B3	W4	B5	*M6*	*B7*	*M8*	*B9*	*D10*	B11	*M12*	*B13*

Complete 540	
Interchange	Westbound
	B57
US 64 Business	D58
	B59
	D60
	B61
	M62
	B63
US 264	D64
	B65
	D66
	B67
	W68
Poole Rd	B69
	M70
	B71
Auburn Knightdale Rd	D72
	B73
	M74
	B75
Rock Quarry Rd	D76
	B77
	M78
	B79

Complete 540	
Eastbound	Interchange
B56	
M55	US 64 Business
B54	
D53	
B52	
M51	US 264
B50	
D49	
W48	
B47	Poole Rd
D46	
B45	
M44	Auburn Knightdale Rd
B43	
D42	
B41	
M40	Rock Quarry Rd
B39	
D38	
B37	

LEGEND

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics – Time Period Demand/Capacity Ratio > 1

Intersection ID # = XX

Freeway ID # = B XX, Basic
= M XX, Merge
= D XX, Diverge
= W XX, Weave

XX = **Freeway Segment Breaks**
XX = **Unsignalized Intersection**
XX = **Signalized Intersection**

N

NOT TO SCALE

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540 TRIANGLE EXPRESSWAY SOUTHEAST EXTENSION

WAKE AND JOHNSTON COUNTIES

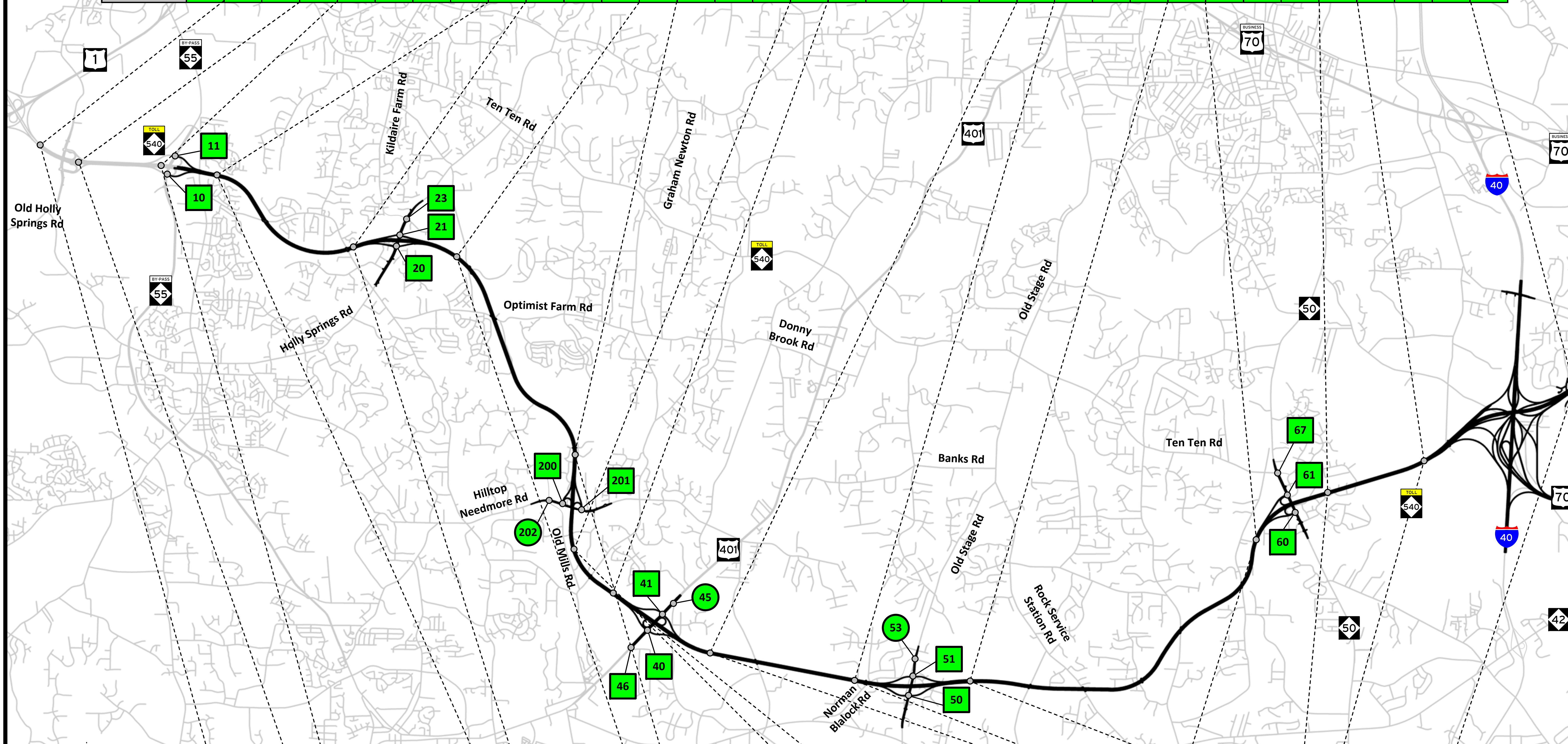
2035 DESIGN YEAR BUILD
DSA 6-7: RED/GREEN CORRIDOR
LOS & SEGMENT ID #

DATE: February 2015 | **DIVISION:** 5

PREPARED BY: HNTB North Carolina, P.C. 343 E. Six Forks Rd., Ste. 200 Raleigh, North Carolina 27609

Figure ES.5

Facility	Complete 540																																		
Interchange		OHS-A Rd			NC 55 Bypass					Holly Springs Rd				Hilltop Needmore Rd				US 401					Old Stage Rd				NC 50				I-40 and US 70			
Westbound	B131	M130	B129	W128	B127	M126	B125	D124	B123	M122	B121	D120	B119	M118	B117	D116	B115	M114	B113	M112	B111	D110	B109	M108	B107	D106	B105	M104	B103	D102	B101	M100	B99	W98	B97



Eastbound	B1	D2	B3	W4	B5	D6	B7	M8	B9	D10	B11	M12	B13	D14	B15	M16	B17	D18	B19	M20	B21	M22	B23	D24	B25	M26	B27	D28	B29	M30	B31	D32	B33	D34	B35
Interchange		OHS-A Rd			NC 55 Bypass					Holly Springs Rd				Hilltop Needmore Rd				US 401					Old Stage Rd				NC 50				I-40 and US 70			
Facility	Complete 540																																		

LEGEND

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics – Time Period Demand/Capacity Ratio > 1

Intersection ID # = XX

Freeway ID # = B XX, Basic
= **M XX**, Merge
= **D XX**, Diverge
= **W XX**, Weave

XX = **Freeway Segment Breaks**

XX = **Unsignalized Intersection**

XX = **Signalized Intersection**

N

NOT TO SCALE

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540
TRIANGLE EXPRESSWAY SOUTHEAST EXTENSION

WAKE AND JOHNSTON COUNTIES

2035 DESIGN YEAR BUILD
DSA 8-9: PURPLE/BLUE/LILAC CORRIDOR

LOS & SEGMENT ID #

DATE: February 2015 **DIVISION:** 5

PREPARED BY: HNTB North Carolina, P.C.
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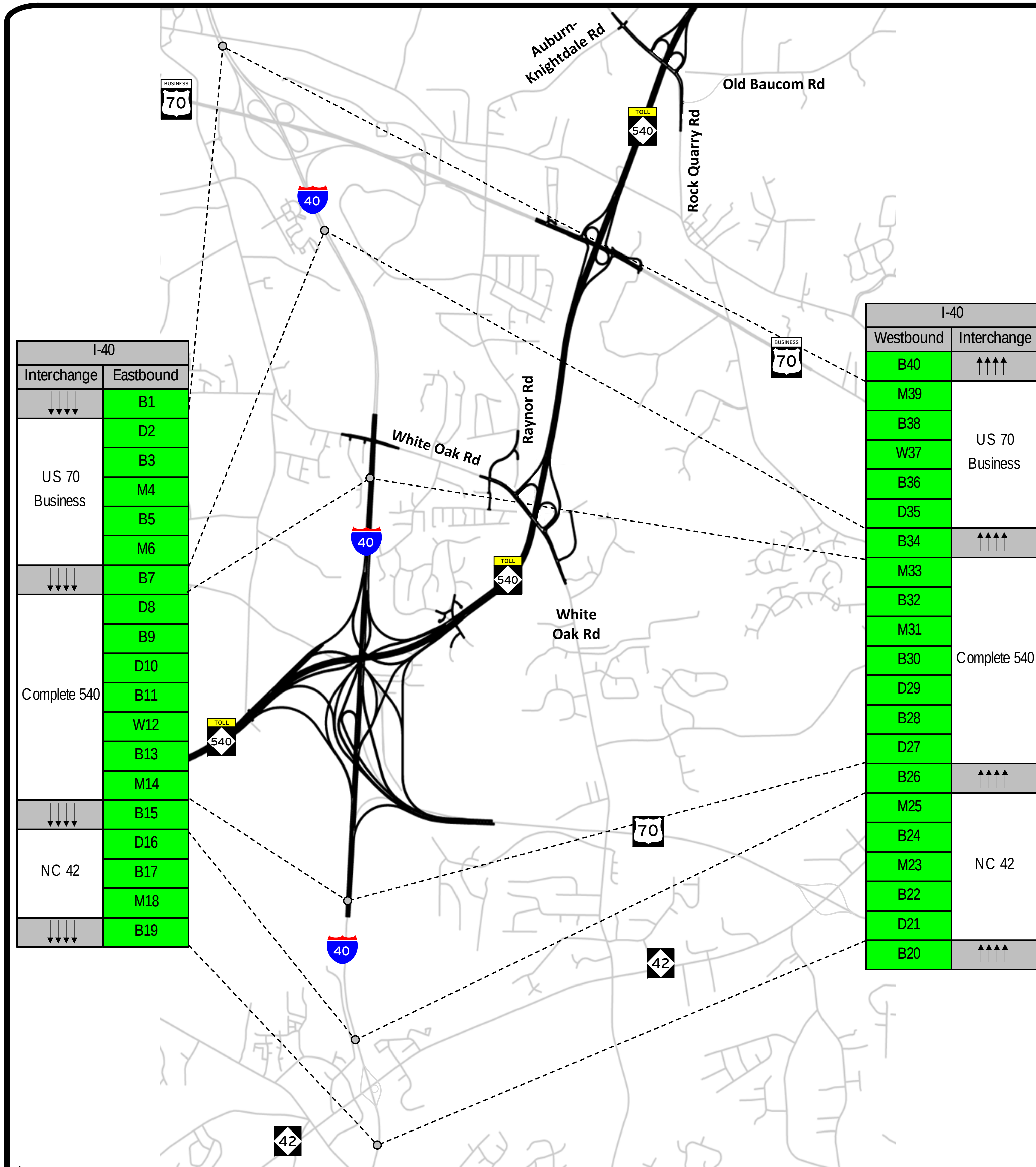
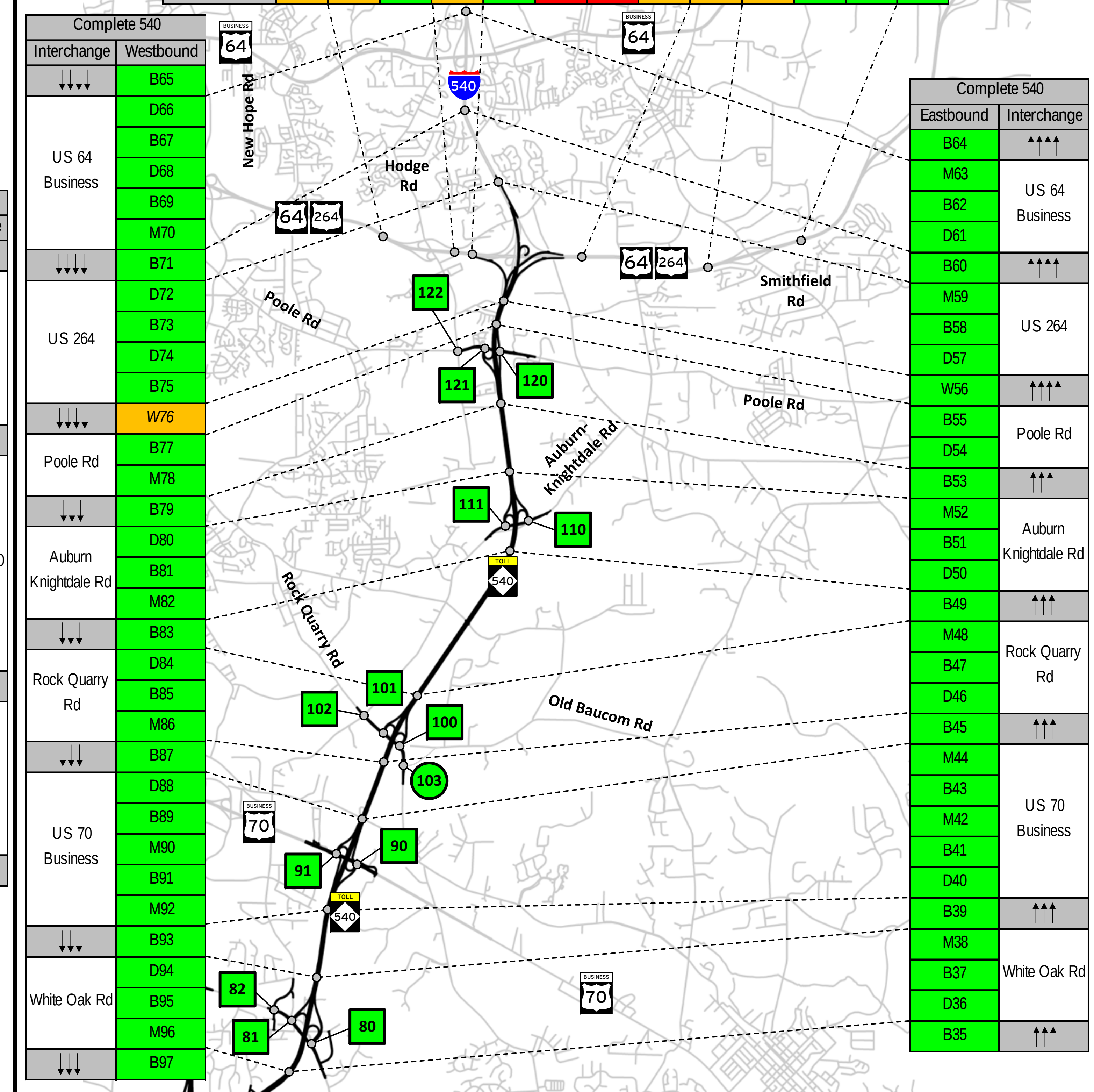
Figure ES.6



I-40	
Interchange	Eastbound
	B1
US 70 Business	D2
	B3
	M4
	B5
	M6
	B7
Complete 540	D8
	B9
	D10
	B11
	W12
	B13
	M14
	B15
NC 42	D16
	B17
	M18
	B19

I-40	
Westbound	Interchange
B40	
M39	US 70 Business
B38	
W37	
B36	
D35	
B34	
M33	Complete 540
B32	
M31	
B30	
D29	
B28	
D27	
B26	
M25	NC 42
B24	
M23	
B22	
D21	
B20	

US 64 - 264													
Westbound	*B26*	*M25*	B24	W23	B22	M21	B20	*D19*	*B18*	*M17*	B16	*D15*	*B14*
Interchange		Hodge Rd			Complete 540					Smithfield Rd			
Eastbound	*B1*	*D2*	B3	W4	B5	*M6*	*B7*	*M8*	*B9*	*D10*	B11	*M12*	*B13*



Complete 540	
Interchange	Westbound
	B65
US 64 Business	D66
	B67
	D68
	B69
	M70
	B71
US 264	D72
	B73
	D74
	B75
	W76
Poole Rd	B77
	M78
	B79
Auburn Knightdale Rd	D80
	B81
	M82
	B83
Rock Quarry Rd	D84
	B85
	M86
	B87
US 70 Business	D88
	B89
	M90
	B91
	M92
	B93
White Oak Rd	D94
	B95
	M96
	B97

Complete 540	
Eastbound	Interchange
B64	
M63	US 64 Business
B62	
D61	
B60	
M59	US 264
B58	
D57	
W56	
B55	Poole Rd
D54	
B53	
M52	Auburn Knightdale Rd
B51	
D50	
B49	
M48	Rock Quarry Rd
B47	
D46	
B45	
M44	US 70 Business
B43	
M42	
B41	
D40	
B39	
M38	White Oak Rd
B37	
D36	
B35	

LEGEND

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics – Time Period Demand/Capacity Ratio > 1

Intersection ID # = XX

Freeway ID # = B XX, Basic
= M XX, Merge
= D XX, Diverge
= W XX, Weave

XX = Freeway Segment Breaks
XX = Unsignalized Intersection
XX = Signalized Intersection

N

NOT TO SCALE

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540 TRIANGLE EXPRESSWAY SOUTHEAST EXTENSION

WAKE AND JOHNSTON COUNTIES

2035 DESIGN YEAR BUILD
DSA 8-9: LILAC/GREEN CORRIDOR

LOS & SEGMENT ID #

DATE: February 2015 **DIVISION:** 5

PREPARED BY: HNTB North Carolina, P.C.
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Figure ES.7

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APPENDICES

FIGURES

TABLES **Page**

1. INTRODUCTION

The North Carolina Department of Transportation (NCDOT) is studying ways to improve regional mobility in southern and eastern Wake County. NCDOT State Transportation Improvement Program (STIP) Projects R-2721, R-2828, and R-2829, known as collectively as Complete 540 – Triangle Expressway Southeast Extension, in Wake and Johnston Counties currently feature 17 Detailed Study Alternatives (DSAs) that are approximately 28 miles long, extending from the NC 55 Holly Springs Bypass to I-40 near the US 70 Clayton Bypass (Southern Wake Freeway) and then to US 64 / US 264 Knightdale Bypass (Eastern Wake Freeway). The Complete 540 project is being considered and studied as a possible candidate toll facility. **Figure 1** shows the Detailed Study Alternative corridors. ***Appendix A*** contains all figures described in this report.

HNTB North Carolina, PC has been contracted by the NCDOT, to develop base and future year traffic capacity analyses for the Complete 540 project. The analyses and results for the base and future design year scenarios of the No-Build Alternative and 17 DSAs will be used to develop the environmental documentation required by the National Environmental Policy Act (NEPA).

For the purposes of the environmental document, it was decided in a project scoping meeting on July 8, 2014 and through coordination with NCDOT that the base year scenario would use a base year of 2012 and the future design year scenario would be for the year 2035. In this meeting, a traffic analysis project study area was also defined that would satisfy the requirements of NEPA and include all potential impacts for 17 DSAs. Separate No-Build and Build DSA traffic capacity analyses were conducted for both the 2012 base year and 2035 design year. **Figure 2** shows the project study area for the traffic analyses. **Figures 3 – 6** provide sheet keys for No-Build and Build DSAs.

The purpose of this traffic capacity analysis is to identify existing and projected roadway facility, interchange and intersection operations and any potential deficiencies for the major roadways surrounding and intersecting the Complete 540 functional designs for the 17 DSAs under 2012 Base Year and 2035 Design Year conditions. In addition to being included in NEPA documentation, the results of the analysis will be used to support the alternatives development process and preliminary designs for the project.

Traffic volumes used in this traffic capacity analysis were based on the *Complete 540 - Triangle Expressway Southeast Extension NCDOT STIP Project R-2721, R-2828 & R-2829 Traffic Forecast Technical Memorandum* prepared by HNTB in April 2014. This forecast has been approved by the NCDOT Transportation Planning Branch. ***Appendix B*** contains the traffic forecast output used in this report. The traffic capacity analysis references the following forecast volumes for the 2012 and 2035 analysis scenarios:

- 2012 Base Year No-Build
- 2012 Base Year Build DSA 1-17
- 2035 Design Year No-Build
- 2035 Design Year Build DSA 1-17

Complete 540 functional designs and interchange forms evaluated in this traffic capacity analysis were based on the designs and interchange form recommendations prepared by

Lochner, based upon ongoing coordination, planning, analysis and design. The designs have been reviewed and approved by the NCDOT Roadway Design Unit.

As described in more detail within the report, several DSAs feature the same (or nearly identical) projected traffic volumes and interchange configurations, depending on individual DSA corridor alignments. For example, DSAs 1-5 and 13-17 all follow the Orange or Orange-Lilac corridor from NC 55 Bypass to I-40 in southern Wake County, have similar projected traffic volumes and produce similar capacity analysis results. Similarly, DSAs 6 and 7 follow the Orange-Red corridor from NC 55 Bypass to I-40, have similar projected traffic volumes and produce similar capacity analysis results. DSAs 8-12 all follow the Orange-Purple-Blue-Lilac corridor from NC 55 Bypass to I-40, have similar projected traffic volumes and produce similar capacity analysis results. From I-40 to US 64 / US 264 in eastern Wake County, the Green, Mint, Brown, Tan and Teal DSA corridors are closer in proximity and there is relatively less variation in projected traffic volumes between DSAs and interchange configurations. Since there are generally three distinct corridors based on project traffic volumes and operations, DSAs 1, 6 and 8 are presented in additional detail in the report tables and figures as representative corridors for comparison. Additional detailed capacity analysis results for all DSAs 1-17 are located in the Appendices.

The following sections describe existing transportation conditions in the project study area, the capacity analysis methodology, capacity analysis results for the 2012 base year and 2035 design year, microsimulation operations analysis, and conclusions and recommendations derived from the capacity analyses related to current functional designs for the Complete 540 DSAs.

2. EXISTING CONDITIONS

The following pages describe the context of the proposed project, the existing transportation system in the Complete 540 project study area and data collection activities conducted for the study.

2.1 Project Corridor Description

The Complete 540 DSA corridor alignments in the project study area run primarily east-west between the existing Triangle Expressway termini at NC 55 Bypass in Apex to the existing I-40 corridor near Clayton. Corridor alignments then run primarily north-south between I-40 and the existing I-540 system interchange with US 64 / US 264 in Knightdale. The corridor alignments cross multiple existing freeway, arterial, and local roadway facilities. Most of the project study area features lower density rural/suburban development.

Future DSA interchange spacing, in most cases, is well over one mile between interchanges, with exceptions from US 64 / US 264 to Poole Road for all DSAs and on Complete 540, I-40 and US 70 Business for DSA 6 and 7. In addition to proposed interchanges, the DSA corridors will have numerous grade separations with natural features and minor y-line local roadways. There are numerous existing roadway facilities, primarily surface arterial roadways, that parallel the proposed corridor alignments. The paralleling facilities directly impacted by DSA corridor functional designs were specifically studied in this analysis.

The proposed Complete 540 DSAs are being studied as a toll facility and designed for a 65 mph speed limit, with access limited to service and system interchanges with existing y-line facilities. Similar to existing Triangle Expressway, Complete 540 is being planned for all-electronic tolling with overhead toll gantries. No toll booths or speed reductions are required with this type of toll facility. No specific lane restrictions, truck climbing lanes, transit/non-motorized transportation/High-Occupancy Vehicle (HOV) features are planned for Complete 540.

Figure 2 shows the general project study area and the spatial relationship of the DSA corridor alignments to connecting transportation facilities, municipalities and notable physical and natural features in the region.

2.2 Study Area Transportation Facilities

Figure 2 shows schematics of the project study area which include the future location of DSA alignments in relation to existing No-Build surface street intersections and existing freeway crossings and freeway segments included in the No-Build and Build analyses. General descriptions and information about existing study area roadways to be included in the Complete 540 intersection and freeway capacity analyses are found in **Table 1**.

Table 1. Existing Study Area Roadways

Build Corridor Interchange #	Build Corridor Analysis Intersection ID#s	SR Number / Shield	Road Name	Functional Classification*	Study Area Cross Sections	2013 AADT	Speed Limit
1	10-11	55	NC 55 Bypass	Other Principal Arterial	4 lane divided	26,000	55
2	20-26	1152	Holly Springs Road	Minor Arterial	2 lane undivided	12,000	45
2	23	1300	Kildaire Farm Road	Local	2 lane undivided	20,000	45
3	30-31	1386	Bells Lake Road	Local	2 lane undivided	4,100	45
4	40-46	401	US 401	Other Principal Arterial	4 lane divided	25,000 - 30,000	55
4	44	1010	Ten Ten Road	Minor Arterial	2 lane undivided	16,000	45
4	42	1503	Donny Brook Road	Local	2 lane undivided	N/A	45
4	42	2779	Old McCullers Road	Local	2 lane undivided	N/A	35
4	45	2753	Dwight Rowland Road	Local	2 lane undivided	N/A	45
4	46	2886	Meadow Drive	Local	2 lane undivided	N/A	25
5	50-52	1006	Old Stage Road	Minor Arterial / Major Collector	2 lane undivided	3,800 – 16,000	45
5	52, 54	2711	Vandora Springs Road	Minor Arterial	2 lane undivided	7,300	35
5	53	2750	Norman Blalock Road	Local	2 lane undivided	1,600	45
5	54	2711	Buffaloe Road	Major Collector	2 lane undivided	3,200	35
6	60-67	50	NC 50	Other Principal Arterial	2 lane undivided	15,000 – 17,000	55
6	66	1010	Cleveland School Road	Major Collector	2 lane undivided	7,500	55
6	67	1010	Ten Ten Road	Minor Arterial	2 lane undivided	6,800	45
8	80-82	2700	White Oak Road	Local	2 lane undivided	9,000 – 23,000	45
8	82	2555	Raynor Road	Local	2 lane undivided	6,300^^	45
9	90-91, 105	BUS 70	US 70 Business	Other Principal / Minor Arterial	4 lane divided	35,000	55
10	100-101, 103	5204	Old Baucom Road	Local	2 lane undivided	960	55
10	100-104	2542	Rock Quarry Road	Major Collector	2 lane undivided	4,200	55
11	102, 110-111	2555	Auburn-Knightdale Road	Local	2 lane undivided	3,400	55
12	120-122	1007	Poole Road	Minor Arterial	2 lane undivided	8,900	45
12	122	2516	Hodge Road	Local	2 lane undivided	11,000	45
20	200-202	1393	Hilltop Needmore Road	Major Collector	2 lane undivided	7,500	45
20	202	1421	Old Mills Road	Local	2 lane undivided	600^	45
7	*N/A*	40	I-40	Interstate	4-6 lane divided	58,000 – 80,000	65
7, 19	*N/A*	BYPASS 70	US 70 Bypass (Clayton Bypass)	Other Principal Arterial	4 lane divided	26,000	55
1-12, 20	*N/A*	540	NC 540	Other Freeway	4 lane divided	7,200	55
13-14	*N/A*	540	I-540	Interstate	6 lane divided	44,000	65
13, 15-16	*N/A*	BYPASS 64	US 64 Bypass	Other Freeway	6 lane divided	72,000	65
14	*N/A*	BUSINESS 64	US 64 Business	Other Principal Arterial	6 lane divided	32,000	45

* - As defined on the *NCDOT Urban Functional Classification Map (2012)*   ^2011 AADT   ^^AADT station beyond studied portion of corridor

Study Area Roadways

There are five major access-controlled freeways in the vicinity of the traffic forecast study area: I-40, I-540, NC 540, US 64 / US 264 (Knightdale Bypass) and US 70 (Clayton Bypass). The following are descriptions of the major roadways within the traffic forecast study area:

- **I-40** is the primary freeway corridor for regional connectivity between Raleigh, RTP, Durham and Chapel Hill in the Triangle. I-40 varies from a four-lane to a six-lane freeway in the traffic analysis study area. The posted speed limit is 65 miles per hour (mph) through the traffic analysis study area.

- **I-540** is an existing loop freeway around the northern portions of Wake County. It currently spans from I-40 on the western side of Wake County to US 64 / US 264 near Knightdale in eastern Wake County. The facility features a six-lane cross section in the study area, with auxiliary lanes at interchanges and a posted speed limit of 70 mph.

- **NC 540** is an existing freeway facility that is an extension of I-540 in western Wake County from I-40 to NC 54 near RTP. The facility features a six-lane cross section with a posted speed limit of 70 mph. NC 540 from NC 54 to NC 55 Bypass is a toll facility.

- **US 64 / US 264 (Knightdale Bypass)** is an existing controlled access freeway in the traffic forecast study area providing access to areas of east Wake County to I-440 and further to I-95. In the traffic forecast study area, US 64 / US 264 features a six-lane cross-section, with auxiliary lanes at interchanges and a posted 65 mph speed limit.

- **US 70 (Clayton Bypass)** is an existing controlled access freeway in the traffic forecast study area providing access to areas of Johnston County to I-40. In the traffic forecast study area, US 70 contains a four-lane cross-section, with auxiliary lanes at interchanges and a posted speed limit of 65 mph.

Other major/minor arterial roadways that are specifically included in the project study area include, NC 50, NC 55, US 70, US 401, Holly Springs Road, Bells Lake Road, Ten Ten Road, Old Stage Road, Rock Quarry Road, Auburn-Knightdale Road and Poole Road. These existing thoroughfares are primarily multi-lane and two-lane facilities with 35, 45, or 55 mph speed limits in the traffic forecast study area and provide regional connectivity and access throughout Wake County, with future interchange connections to the proposed DSA corridors.

Y-Lines and Grade Separated Facilities

Along the 17 proposed DSA corridors, there are 39 proposed grade separations of the NC 540 freeway with intersecting minor study area roadways that have no interchange access to NC 540. These roadway facilities within the Complete 540 project corridor are currently planned to cross NC 540 via overpasses or underpasses, depending on preliminary functional designs. The grade separated facilities are identified in ***Appendix C***, but were not studied specifically for any traffic operations impacts in this document, since they will not directly impact Complete 540 operations.

Along the 17 proposed DSA corridors, multiple Y-line facilities are impacted and re-routed/re-aligned based on proximity to the DSA corridors and interchange ramp terminals. Below is a list of notable Y-line facilities impacted and the corresponding DSAs:

- Kildaire Farm realigned (DSA 1-17)
- Doughtymews Lane extension (DSA 8-12)
- Donny Brook Road realigned (DSA 1-5, 13-17)
- Old McCullers Rd severed from US 401 and realigned to Wake Tech internal circulation (DSA 1-5, 13-17)
- Dwight Rowland Road severed and realigned via Meadow Drive (DSA 8-12)
- Vandora Springs Road and Buffaloe Road realigned (DSA 6-7)
- Norman Blalock Road realigned (DSA 8-12)
- Raynor Road and Tiffany Creek Drive realigned (DSA 1-2,5,8-9,12,13-14,17)
- Old Baucom Road realigned (DSA 1-2, 6-9, 13-14)
- Red Brick Road Connector (DSA 8-17)

2.3 Study Area Interchanges / Intersections

The following paragraphs describe existing geometrics and traffic control at all study area interchanges and intersections. Refer to **Figures 7.1** to **7.5** for additional schematic details, including laneage between intersections.

<u>Existing Study Area Interchanges</u>

Toll NC 540 (Triangle Expressway) & NC 55 Bypass

Existing Toll NC 540 six-lane freeway facility currently terminates at the NC 55 Bypass four-lane divided facility. This service interchange is a partial cloverleaf design and features loop ramps in the northeast and southeast interchange quadrants with free-flowing entry/exit movements for each facility. Single lane on-ramp and off-ramps connect the two facilities. This interchange is designed to accommodate future Complete 540.

I-40 & US 70 Business

The US 70 Business interchange with I-40 is a partial cloverleaf design with loop ramps in the northeast, southeast, and northwest interchange quadrants. The interchange features single and dual lane on-ramps and off-ramps with free-flowing entry/exit movements for each facility. The US 70 Business is an existing four-lane divided facility.

I-40 & US 70 (Clayton Bypass)

US 70 (Clayton Bypass), opened to traffic in 2008, terminates at a system interchange with I-40. This system interchange is a trumpet interchange design with two lanes on the I-40 eastbound off-ramp flyover and a single lane on all other ramps.

US 64 / US 264 (Knightdale Bypass) & Hodge Road
The Hodge Road service interchange with US 64 / US 264 is a partial cloverleaf design with loop ramps in the northwest and southwest interchange quadrants. Signalized ramp terminals exist on both sides of the Hodge Road overpass. Per direction from NCDOT staff, these intersection ramp terminals are not included in this study.

I-540 & US 264 / US 64 (Knightdale Bypass)
I-540 currently terminates at a system interchange with US 64 / US 264. This system interchange is a trumpet interchange design with a one lane flyover and loop ramp. This interchange is designed to accommodate future Complete 540.

US 264 / US 64 (Knightdale Bypass) & Smithfield Road
The Smithfield Road service interchange with US 64 / US 264 is a traditional diamond interchange design. Signalized ramp terminals exist on both sides of the US 64 / US 264 overpass. Per direction from NCDOT staff, these intersection ramp terminals are not included in this study.

US 64 Business & I-540
The US 64 Business service interchange with I-540 is a diamond interchange design with a loop ramp in the southwest interchange quadrant. Signalized ramp terminals exist on both sides of the US 64 Business overpass. Per direction from NCDOT staff, these intersection ramp terminals are not included in this study.

Existing Study Area Intersections

There are 18 existing at-grade intersections in the project study area that were analyzed in the No-Build and Build scenarios, as they are expected to be impacted by the Complete 540 DSA alignments. Not all intersections are impacted by every design scenario, and only those intersections that are directly impacted by the proposed functional designs are studied in each Build DSA analysis. **Table 2** provides a list of existing intersections and their existing traffic control details.

Table 2. Existing Study Area Intersection Details

Intersection	Study ID #	Traffic Control	Signal Phases	Signal Operation	Cross walk	Ped Signals
NC 55 Bypass and NC 540 EB Ramps	10	Unsig	N/A	N/A	No	No
NC 55 Bypass and NC 540 WB Ramps	11	Unsig	N/A	N/A	No	No
Holly Springs Road (SR 1152) and Kildaire Farm Road (SR 1300)	23	Signal	3	Coord	No	No
US 401 and Donny Brook Road (SR 1503) / Old McCullers Rd (SR 2779)	42	Signal	5	Coord	No	No
US 401 and Wake Tech Drive	43	Signal	5	Coord	Yes	Yes
US 401 and Ten Ten Road (SR 1010)	44	Signal	8	Coord	No	No
US 401 and Dwight Rowland Road (SR 2753)	45	Unsig	N/A	N/A	No	No
US 401 and Meadow Drive (SR 2886)	46	Unsig	N/A	N/A	No	No
Old Stage Road (SR 1006) and Vandora Springs Road (SR 2711)	52	Signal	2	Free-Run	No	No
Old Stage Road (SR 1006) and Norman Blalock Road (SR 2750)	53	Unsig	N/A	N/A	No	No
Vandora Springs Road (SR 2711) and Buffaloe Road (SR 2711)	54	Unsig*	N/A	N/A	Yes	No
NC 50 and Cleveland Road (SR 1010) / Stevens Oaks Drive (SR 5324)	66	Signal	3	Free-Run	No	No
NC 50 and Ten Ten Road (SR 1010)	67	Signal	3	Free-Run	No	No
White Oak Road (SR 2700) and Raynor Road (SR 2555)	82	Unsig	N/A	N/A	No	No
Rock Quarry Road (SR 2542) and Auburn-Knightdale Road (SR 2555)	102	Signal	2	Free-Run	No	No
Rock Quarry Road (SR 2542) and Old Baucom Road (SR 5204)	103	Unsig	N/A	N/A	No	No
Poole Road (SR 1007) and Hodge Road (SR 2516)	122	Signal	3	Free-Run	No	No
Hilltop Needmore Road (SR 1393) and Old Mills Road (SR 1421)	202	Unsig	N/A	N/A	No	No

Unsig = Unsignalized/Stop-Controlled Intersection * = Roundabout
Coord = Coordinated Signal Control (Closed Loop System)

2.4 Data Collection

Field verification of existing conditions and operations within the study area, including geometrics, traffic control devices, speed limits, and traffic patterns, was completed in September 2014. In August 2014 HNTB received the most recent traffic signal plans in the study area from the NCDOT Transportation Mobility and Safety Division. The 2035 LRTP and 2040 MTP documents were obtained from Capital Area Metropolitan Planning Organization (CAMPO).

2.5 Peak Hour Traffic Counts

The *Complete 540 - Triangle Expressway Southeast Extension NCDOT STIP Project R-2721, R-2828 & R-2829 Traffic Forecast Technical Memorandum*, prepared by HNTB North Carolina, PC in April 2014 and approved by the NCDOT Transportation Planning Branch (TPB), was used to develop the AM and PM peak hour traffic volumes analyzed in this study. ***Appendix B*** contains the traffic forecast used in this report. Refer to the original traffic forecast documentation for additional details on the traffic counts conducted to support the traffic forecast.

Raw count data was not directly used in the 2012 base year traffic analyses for Complete 540. 2012 base year volumes that were analyzed in this report are a product of the final traffic forecast data that included daily traffic estimates/directional splits/design hourly volume estimates that were reduced to AM and PM peak hour information. ***Appendix D*** contains the traffic forecast breakout peak hour traffic volumes.

3. CAPACITY ANALYSIS METHODOLOGY

Evaluating traffic operations on suburban arterials and uninterrupted flow freeway facilities is generally done by the determination of level of service (LOS) criteria. The level of service on a freeway segment, arterial corridor, or individual intersection correlates qualitative aspects of traffic flow to quantitative terms. This enables transportation professionals to take the qualitative issues, such as congestion and substandard geometrics, and translate them into measurable quantities, such as operating speeds, flow densities, and vehicular delays. The *2010 Highway Capacity Manual (HCM 2010)* characterizes level of service by letter designations A through F. Level of service A represents ideal low-volume traffic operations, and level of service F represents over-saturated, high-volume traffic operations.

LOS for intersections is determined by average delay per vehicle, while LOS for freeway facilities is primarily determined by vehicular density of a defined freeway segment, merge/diverge area or weaving section. Level of service letter designations and criteria for arterial intersections (seconds of delay per vehicle) and for freeway facilities (average density in passenger cars per mile per lane (pc/mi/ln)) are described in **Table 3**.

The AM and PM peak hour results of this analysis are based on the LOS and delay procedures presented in the *HCM 2010*. To obtain optimized signal timings for the future traffic conditions, the timing optimization software Synchro Professional Version 7.0 was used to evaluate an optimal cycle length and phasing for the projected peak hour traffic volumes. Existing intersection signal plans were used in the analysis to develop cycle lengths, phasing, splits and intersection coordination along the project study area's arterial facilities (where applicable). NCDOT Congestion Management Section Capacity Analysis Guidelines were used in developing all other scenario timings for Build scenarios and/or future year analyses.

All freeway analyses, such as basic freeway segments and ramp merges and diverges, were analyzed using the Highway Capacity Software (HCS) 2010 freeway facilities system module (FreeVal). FreeVal allows the integration of individual segment analyses into corridor analysis to study potential multi-segment operational issues.

To simplify the process of organizing analysis results for all No-Build Alternative and Build Alternative scenarios, an identification scheme was developed for all freeway segments and study area intersections. In general, between 113 to 137 Build Complete 540 freeway segments (depending on a specific DSA alignment) were analyzed in the HCS FreeVal software package for all 17 DSAs in the 2012 and 2035 analysis years, for the AM and PM peak hours, and in the eastbound and westbound directions. Segments are numbered sequentially in the eastbound/northbound direction and then the westbound/southbound direction (with several segment numbers added/subtracted to account for changing designs between DSAs in 2012 and 2035 analyses). Each identification also includes a preceding letter designation for basic freeways (B), diverge ramp areas (D), merge ramp areas (M) and weaving sections (W) in the project study area.

To aid in the organizational process for analyzing surface street at-grade intersections and to assist in individual corridor signal coordination optimization, each Y-line facility intersecting Completing 540 was separated and numbered as individual zones in Synchro (1-12 and 20). Individual signalized and unsignalized study area intersections are then numbered 10-202 moving from west to east and south to north through the study area to correspond with the analysis zone (i.e. Zone 12 includes Intersections 120, 121 and 122). **Tables 13** and **20** show the identification of all analyzed intersections for 2012 and 2035.

Table 3. Intersection & Freeway Segment Level of Service (LOS) Characteristics

Level of Service Description	Intersection		Freeway	
	Per Vehicle Delay Signal Control	Per Vehicle Delay Stop Control	Basic Freeway Segment Density (pc/mi/ln)	Merge / Diverge / Weaving Area Density (pc/mi/ln)
LOS A ➢ Free flow ➢ Freedom to select desired speed / maneuver is extremely high ➢ General level of comfort and convenience for motorists is excellent	**< 10.0 seconds**	**< 10.0 seconds**	**0 – 11.0**	**<= 10.0**
LOS B ➢ Stable flow ➢ Other vehicles in the traffic stream become noticeable ➢ Reduction in freedom to maneuver from LOS A	**10.0 – 20.0 seconds**	**10.0 – 15.0 seconds**	**>11.0 – 18.0**	**>10.0 – 20.0**
LOS C ➢ Stable flow ➢ Maneuverability/operating speed are significantly affected by other vehicles ➢ General level of comfort and convenience declines noticeably	**20.0 – 35.0 seconds**	**15.0 – 25.0 seconds**	**>18.0 – 26.0**	**>20.0 – 28.0**
LOS D ➢ High density but stable flow ➢ Speed and freedom to maneuver are severely restricted ➢ General level of comfort / convenience is poor ➢ Small increases in traffic will generally cause operational problems	**35.0 – 55.0 seconds**	**25.0 – 35.0 seconds**	**>26.0 – 35.0**	**>28.0 – 35.0**
LOS E ➢ Unstable flow ➢ Speed reduced to lower but relatively uniform value ➢ Volumes at or near capacity level ➢ Comfort and convenience are extremely poor ➢ Small flow increases/minor traffic disturbances will cause breakdowns	**55.0 – 80.0 seconds**	**35.0 – 50.0 seconds**	**>35.0 – 45.0**	**>35.0**
LOS F ➢ Forced or breakdown flow ➢ Volumes exceed roadway capacity ➢ Formation of unstable queues ➢ Stoppages for long periods of time because of traffic congestion	**> 80.0 seconds**	**> 50.0 seconds**	**> 45.0**	**Demand exceeds capacity**

Transportation Research Board, *Highway Capacity Manual*. Washington, D.C.: National Research Council, 2010.

3.1 Freeway Analysis Methodology

The initial procedure for freeway analysis input into the HCS 2010 freeway facilities module (FreeVal) involved the segmentation of existing (NC 540, I-40, US 70, US 64 / US 264, I-540) and the proposed freeway facility (Complete 540). Functional design files for all 17 DSAs were reviewed and each DSA was segmented appropriately depending on its unique alignment, proposed interchange forms and geometric characteristics. Segments fall into the following categories – basic freeway segments, merge areas, diverge areas, weaving segments and collector-distributor facilities.

After segmentation, geometric and traffic flow inputs were entered into the HCS FreeVal software module for each segment. For a basic freeway segment, these inputs (and typical values used in this analysis) include:

- Traffic Volume (From NCDOT Forecast non-adjustable peak hour breakouts for the first entering mainline segment only)
- Peak Hour Factor (Assume 0.90). Four 15-minute time periods with demand adjustment factors of 0.89, 1.00, 1.11 and 1.00 were applied to the hourly demand to replicate a 0.90 PHF. See ***Appendix E*** for additional information.
- Number of lanes (Varies depending on existing geometrics, planned LRTP improvements to existing freeway facilities or DSA designs – standard DSA design is for a six-lane divided facility in most locations, with three travel lanes in each direction)
- Terrain Type (Assumed to be “Rolling” for this area per Design Criteria)
- Base Free Flow Speed (Assumed to be 5 mph greater than posted speed limits. See ***Appendix E*** for supporting Toll 540 and I-540 speed data)
- Truck Percentage (Taken from Traffic Forecast – Duals+TTST/2 for peak hour mainline – study area entry segment only. All other mainline segments calculated based on on/off-ramp percentages)
- Lane Width (12 feet – default)
- Right Shoulder Lateral Clearance (6 feet – default)
- Segment Lengths (as determined by aerial photography or functional designs between upstream/downstream merge/diverge points)

The FreeVal inputs for merging and diverging areas contain additional input parameters beyond the basic freeway segment information. These parameters, and typical values used in this analysis, include:

- On-Ramp/Off-Ramp Volumes (NCDOT Forecast peak hour breakouts)
- Location of Ramp Relative to Freeway – Left or Right (Right)
- Acceleration/Deceleration Lane Lengths (From aerial photography, field measurement or functional designs)
- Free Flow Speeds on Ramps (50 mph for cloverleaf/flyover on/off ramps/diamond on/off ramps and 30 mph for loop ramps)
- Truck Percentage (Taken from Traffic Forecast – Duals+TTST/2 for peak hour Y-line)

The FreeVal inputs for weaving areas contain additional input parameters beyond the basic freeway segment and ramp segment information. These parameters, and typical values used in this analysis, include:

- On-Ramp/Off-Ramp Volumes (From Factored Counts or Forecast)
- Location of Ramp Relative to Freeway – Left or Right (Right)
- Acceleration/Deceleration Lane Lengths (From aerial photography, field measurement or functional designs)
- Free Flow Speeds on Ramps (30 mph for loop ramps)

After inputs were entered into FreeVal and checked, output data for each segment was collected for the segment density and corresponding LOS. In addition, system-wide information (by freeway direction) from FreeVal was compiled and compared for the study alternatives. Detailed output from FreeVal can be found in ***Appendix E***.

The following FreeVal analysis assumptions were also implemented in the development of the FreeVal network files:

- On-Ramp/Off-Ramp Volumes (Maximum 1-lane ramp demand of 2,200 vehicles per hour. Where ramp demands exceeded 2,200 vehicles per hour, ramp lane was increased from 1 to 2-lanes. This only occurred in the 2035 No-Build scenarios.)
- Acceleration/Deceleration Lane Lengths (Maximum input distance of 1,500 feet. All distances exceeding 1,500 feet were reduced to 1,500 feet).
- Drop Lanes (Due to FreeVal analysis limitations, an off-ramp was analyzed to remove volumes from the mainline to create the effect of a drop lane.)
- 2012 Build Complete 540 Westbound AM Volume Adjustment (Freeval input corridor volumes analyzed were increased on Complete 540 at I-40 to equal individual DSA breakout volumes at this location. The initial balanced FreeVal corridor volumes produced unreasonably low volumes based on incremental differences between individual peak hour breakouts.)

3.2 Signalized Intersection Analysis Methodology

Signalized intersection capacity analyses were performed using Synchro Professional Software Version 7.0 for all scenarios. GIS-based roadway centerline information and geo-referenced aerial photography were obtained from NCDOT and NC OneMap to establish a base map for developing the proper spatial orientation of the Synchro roadway network for the separate y-line arterial roadway corridors that have existing interchanges with I-40/US 264 or future DSA interchanges with Complete 540 corridors that are being analyzed for this study. Per direction from NCDOT Congestion Management staff, no analysis of the Y-line ramp terminal intersections intersecting I-40, US 64 / US 264 or US 64 Business beyond actual DSA design footprints were made for this study.

HNTB traffic forecast 2012 base year traffic volume data for the AM and PM peak hours was entered into the Synchro networks. Current signal plans were obtained from NCDOT and used for the 2012 No-Build Alternative inputs for signal phasing and timing (cycle length, splits, offset, and coordination). Additional signal timing details that comply with NCDOT Congestion Management practices and recommendations were also updated (lost time, no right-turn-on-red, PHF, etc…) for the AM and PM peak hours.

2012 Build Alternative analyses and 2035 design year No-Build and Build analyses included updates to Synchro inputs and parameters as follows:

- Traffic volume updates for each alternative from traffic forecast breakouts
- Reoptimization of cycle lengths/splits/offsets for the 2012 Base Year Build alternatives – holding cycle lengths constant between alternatives with similar interchange forms for relevant comparison of Build alternative impacts
- Reoptimization of cycle lengths/splits/offsets for 2035 No-Build conditions
- Further reoptimization checks for 2035 Build alternatives – keeping cycle lengths constant between alternatives with similar interchange forms
- Updating intersection control from unsignalized to signalized between No-Build and Build and/or base and future year scenarios, if warranted based on unsignalized intersection capacity analysis results and *Manual on Uniform Traffic Control Devices* (MUTCD) peak hour signal warrant criteria/thresholds
- Permissible changes in signal phasing in situations where phase orders could improve performance and complied with NCDOT Congestion Management policies/guidelines
- Synchro default lane utilization factors (LUFs) were updated at intersections where dual left turns and/or downstream lane drops were present using the calculation methods outlined in the NCDOT research report titled *False Capacity for Lane Drops* by Lee, et al. (2005).

Detailed Synchro output reports, including both LOS and delay results for all analyses, is included in ***Appendix F***.

3.3 Unsignalized Intersection Analysis Methodology

Unsignalized intersection capacity analyses were performed using the HCS software module for two-way stop-controlled intersections. There are six existing unsignalized, two-way stop-controlled intersections in the project study area that were included in this analysis:

- Hilltop-Needmore Road and Old Mills Road
- US 401 and Dwight Rowland Road
- US 401 and Meadow Drive
- Old Stage Road and Norman Blalock Road
- White Oak Road and Raynor Road
- Rock Quarry Road and Old Baucom Road

In addition, the DSA Build alternatives introduced unsignalized intersections at Vandora Springs Road and Buffaloe Road (conversion from an existing single-lane roundabout) and Rock Quarry Road and Rock Quarry Road Extension. Inputs into the unsignalized intersection analysis module included:

- Direction of major street
- Laneage for all approaches
- Traffic Volumes for all approaches
- Median Type (no median)
- Peak Hour Factor (Assume 0.90)
- Truck Percentages (Taken from Traffic Forecast – Duals+TTST/2 for peak hour)

Detailed output from the unsignalized HCS module can be found in ***Appendix G***.

3.4 Roundabout Intersection Analysis Methodology

Roundabout intersection capacity analysis for the existing roundabout at the intersection of Vandora Springs Road and Buffaloe Road was performed using SIDRA Version 5.1.6.2039. This intersection was evaluated as a single-lane roundabout in the 2012 No-Build alternative and as a two-lane roundabout in the 2035 No-Build alternative due to the widening of Vandora Springs from a two-lane to four-lane cross-section in the 2035 long-range transportation plan (LRTP).

Detailed SIDRA output is located in ***Appendix H***.

4. DEVELOPMENT OF ALTERNATIVES

The following sections describe the alternatives analyzed in this report. During the project scoping process, it was agreed by all project stakeholders that seventeen (17) Build DSA alternatives would be compared to No-Build scenarios in the base (2012) and design (2035) year. These alternatives are discussed in detail below.

4.1 No-Build Alternative

The No-Build Alternative assumes that no further development of the Complete 540 project will occur within the project study area limits, but any other background improvements that are committed to and funded by NCDOT, local municipalities, or private development projects would occur by the 2035 design year. Based on information collected to date for the Complete 540 project, the additional improvements shown in **Table 4** are currently anticipated (or approved in the 2035 CAMPO LRTP) in the project study area by the 2035 design year. After the beginning of the project process, CAMPO adopted a 2040 Metropolitan Transportation Plan (MTP). Therefore, the project is currently using assumptions from the 2035 LRTP and will consider 2040 MTP assumptions at the most appropriate time in the future project process.

Additionally, NCDOT STIP Project # R-2635D, also referred to as Access 540, proposes to convert the existing bridge on Old Holly Springs-Apex Road at Triangle Expressway (Toll NC 540) to a partial cloverleaf interchange and construct auxiliary lanes between US 1 and NC 55 Bypass. The project is currently scheduled to be open to traffic in 2017. The 2035 design year No-Build and Build freeway analyses include this future planned interchange.

It was assumed that all existing roadway geometrics, laneage, and traffic control would remain consistent with 2012 base year information along all other areas. The only additional improvement assumed in the No-Build Alternative between the 2012 and 2035 analysis years was signal timing optimization for all arterial corridors in the project study area.

Table 4. LRTP Changes to Study Area Roadways

SR Number	Road Name	Segment	Existing Laneage	2035 LRTP Laneage
-	I-40	Exit 303 (Jones Sausage Road) to Exit 306 (US 70 Business)	6	8
	I-40	Exit 306 (US 70 Business) to Exit 312 (NC 42)	4	8
-	I-540	Exit 24 (US 64 Business) to Exit 26 (US 64/264)	6	8
-	US 64 / US 264	Exit 422 (Hodge Road) to Exit 425 (Smithfield Road)	6	6
-	US 70	Exit 318 (I-40) to Exit 320 (NC 42)	4	4
	US 401	Simpkins Road to Ten Ten Road	4	6
-	US 401	Ten Ten Road to Tech Road	4	6
	US 401	Hilltop Road to Johnson Pond Road	4	6
-	NC 50	Timber Drive to Ten Ten Road	2	4
	NC 50	Ten Ten Road to Cleveland School Road	2	4
-	NC 55 Bypass	E Williams Street to Old Smithfield Road	4	4
-	US 70 Business	I-40 to NC 42	4	4
1007	Poole Road	Hodge Road to Clifton Road	2	4
1010	Ten Ten Road	Lake Wheeler Road to Old McCullers Road	2	2
1010	Ten Ten Road	Jordan Road to NC 50	2	2
1152	Holly Springs Road	Ten Ten Road to Kildaire Farm Road	2	6[1]
1152	Holly Springs Road	Kildaire Farm Road to Sunset Lake Road	2	2
2713	Vandora Springs Road	Old Stage Road to Timber Drive	2	4
2711	Buffaloe Road	Vandora Springs Road to Aversboro Road	2	2
1006	Old Stage Road	US 401 to Ten Ten Road	2	2[2]
1006	Old Stage Road	Ten Ten Road to Banks Road	2	2
1006	Old Stage Road	Fanny Brown Road to Panther Lake Road	2	2
1010	Cleveland School Road	NC 50 to NC 42	2	2
1393	Hilltop Needmore Road	Sunset Lake Road to Johnson Pond Road	2	2
2542	Rock Quarry Road	Battle Bridge Road to E. Garner Road	2	4
1386	Bells Lake Road	Ten Ten Road to Optimist Farm Road	2	2
2700	White Oak Road	Raynor Road to Carley Circle	2	4
2555	Auburn-Knightdale Road	Battle Bridge Road to Grasshopper Road	2	2
1300	Kildaire Farm Road	Ten Ten Road to Kildaire Farm Connector	2	4
1503	Donny Brook Road	Lake Wheeler Road to US 401	2	2
2555	Raynor Road	White Oak Road to Twain Drive	2	2
5204	Old Baucom Road	Rock Quarry Road to Brown Field Road	2	2
2516	Hodge Road	US 264/64 to Poole Road	2	2
2779	Old McCullers Road	US 401 to Ten Ten Road	2	2
1421	Old Mills Road	Hilltop-Needmore Road to Rivington Road	2	2
2750	Norman Blalock Road	Johnny Baker Road to Old Stage Road	2	2
2753	Dwight Rowland Road	US 401 to Ken Drive	2	2
2886	Meadow Drive	US 401 to Long Street	2	2

1 – Analyzed 6-lane section at NC 540 interchange and 4-lane section at project limits.
2 – Analyzed 4-lane section to improve intersection operations and efficiency.

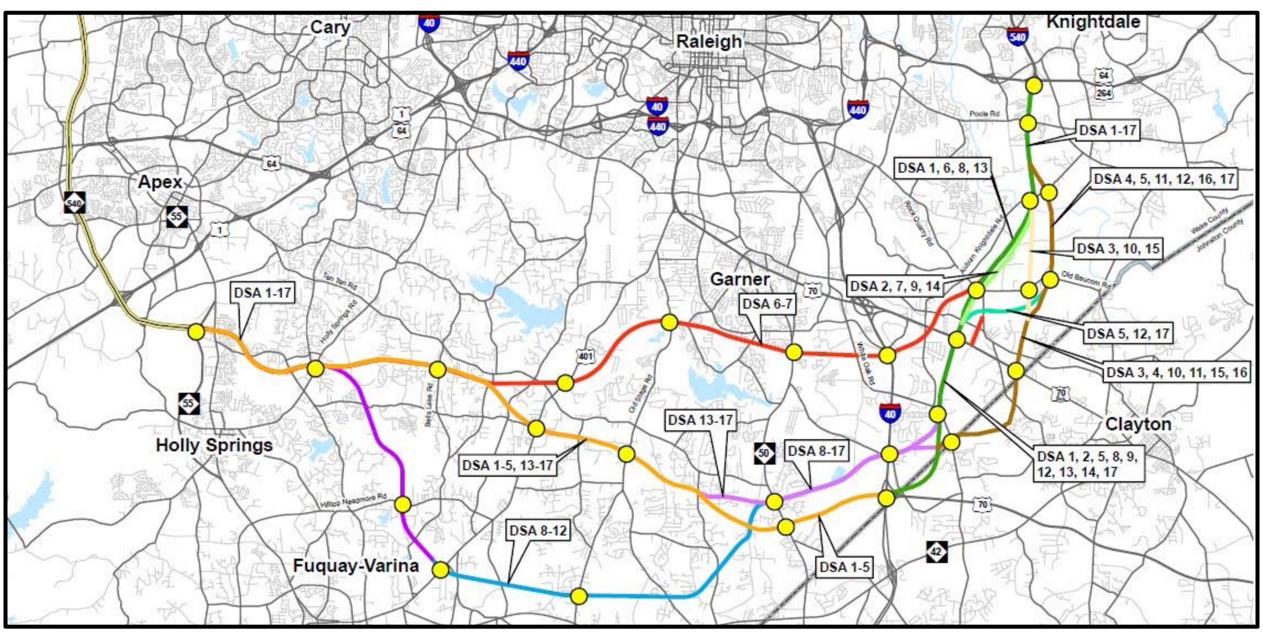
4.2 Build DSA Alternative Descriptions

The DSA Complete 540 corridors incorporate the ongoing coordination efforts between project planning, design and analysis for development in the NEPA process. **Table 5** represents a basic description of the specific corridor segmentation and the resultant 17 DSA combinations, as shown on **Exhibit 1** below and in ***Appendix A***.

Table 5. Detailed Study Alternatives

Detailed Study Alternative	NC 55 Bypass to I-40	I-40 to US 64 / US 264
1	Orange	Green
2	Orange	Green-Mint-Green
3	Orange	Brown-Tan-Green
4	Orange	Brown-Green
5	Orange	Green-Teal-Brown-Green
6	Orange-Red	Green
7	Orange-Red	Mint-Green
8	Orange-Purple-Blue-Lilac	Green
9	Orange-Purple-Blue-Lilac	Green-Mint-Green
10	Orange-Purple-Blue-Lilac	Brown-Tan-Green
11	Orange-Purple-Blue-Lilac	Brown-Green
12	Orange-Purple-Blue-Lilac	Green-Teal-Brown-Green
13	Orange-Lilac	Green
14	Orange-Lilac	Green-Mint-Green
15	Orange-Lilac	Brown-Tan-Green
16	Orange-Lilac	Brown-Green
17	Orange-Lilac	Green-Teal-Brown-Green

Exhibit 1. Detailed Study Alternatives Corridors



Detailed Study Alternative 1 – This alternative features the Orange Corridor for the southern section of the project. The Orange Corridor, also known as the NCDOT Protected Corridor (August 1996, *North Carolina Transportation Corridor Official Map Act*, N.C.G.S. § 136-44.50), begins at the Triangle Expressway and NC 55 interchange in Holly Springs and travels eastward to the I-40 and US 70 interchange near the border of Wake and Johnston Counties. The Orange Corridor primarily runs to the south of and parallel to SR 1010 (Ten Ten Road) for the majority of its alignment. The Orange Corridor includes planned interchanges at NC 55, SR 1152 (Holly Springs Road), SR 1386 (Bells Lake Road), US 401, SR 1006 (Old Stage Road), NC 50 and I-40.

DSA 1 includes the Green Corridor for the eastern section of the project. The Green Corridor begins at the I-40 and US 70 interchange and heads north/northeast to the existing I-540 and US 64/264 interchange. The Green Corridor has planned interchanges with I-40, SR 2700 (White Oak Road), US 70 Business, SR 2542 (Rock Quarry Road), SR 2555 (Auburn-Knightdale Road), SR 1007 (Poole Road) and US 64/264.

Detailed Study Alternative 2 – DSA 2 utilizes the Orange Corridor (see description above) for the southern section. The eastern section includes the Green and Mint Corridors. The Mint Corridor has interchanges at the same locations as the Green Corridor. The only difference between the two alignments is that the section of the project between Rock Quarry Road and Auburn Knightdale Road has a proposed alignment slightly further to the east in the Mint Corridor option.

Detailed Study Alternative 3 – The Orange Corridor is used for the southern section. The Green, Brown, and Tan Corridors are used for the eastern section of DSA 3. DSA 3 has planned eastern section interchanges with I-40, SR 2700 (White Oak Road), US 70 Business, SR 5204 (Old Baucom Road), SR 2555 (Auburn-Knightdale Road), SR 1007 (Poole Road) and US 64/264. The I-40, Poole Road, and US 64/264 interchanges are proposed to be at the same locations as the Green Corridor. The Brown Corridor's White Oak Road interchange is located slightly to the east of the Green Corridor interchange. The Brown Corridor then takes a more eastern turn to it proposed US 70 Business interchange, which is located near the Wake and Johnston County line. Next, the Tan Corridor alignment begins and heads north to the proposed Old Baucom Road interchange, different from the Rock Quarry Road location found in the Green Corridor. The planned Auburn-Knightdale Road interchange is at the same location in the Tan Corridor as it is in the Green Corridor. From that point, the Tan Corridor merges back into the Green Corridor alignment.

Detailed Study Alternative 4 – DSA 4 is a slight variation of DSA 3. The Orange Corridor is used for the southern section. The Green and Brown Corridors are utilized for the eastern section of DSA 4. The Brown and Tan Corridors have interchanges on the same facilities. The only variations between the Brown and Tan are that the proposed Brown Corridor interchange with Old Baucom Road is slightly to the east of the Tan interchange location and the planned Auburn-Knightdale Road interchange location is slightly more to the east than the Green and Tan Corridor location. After the Auburn-Knightdale Road interchange the Brown Corridor merges back into the Green Corridor alignment.

Detailed Study Alternative 5 – DSA 5 is a combination of DSAs 1-4. The Orange Corridor is used for the southern section. The Green, Teal, and Brown Corridors are combined to create the eastern section of the project. DSA 5 has proposed interchanges with I-40, SR 2700 (White

Oak Road), US 70 Business, SR 5204 (Old Baucom Road), SR 2555 (Auburn-Knightdale Road), SR 1007 (Poole Road), and US 64/264. The planned I-40, White Oak Road, and US 70 Business interchanges are the same as the Green Corridor. The Teal Corridor then aligns to the east and shares the proposed Old Baucom Road and Auburn-Knightdale Road interchanges with the Brown Corridor. This DSA then rejoins the Green Corridor at the Poole Road and US 64/264 interchange locations.

Detailed Study Alternative 6 – This alternative is a combination of the proposed Orange and Red Corridors for the southern section of the project. DSA 6 follows the Orange Corridor through the planned interchanges at NC 55 Bypass, SR 1152 (Holly Springs Road), and SR 1386 (Bells Lake Road). After the proposed Bells Lake Road interchange, the Red Corridor continues eastward crossing SR 1010 (Ten Ten Road) and forming an interchange with US 401 north of SR 1010. The Red Corridor then continues northeast, traveling between Lake Wheeler and Lake Benson, featuring planned interchanges with SR 1006 (Old Stage Road) and NC 50 north of Lake Benson. The planned I-40 interchange location for the Red Corridor is located south of the existing I-40 and US 70 Business interchange (I-40 Exit 306) and north of the SR 2700 (White Oak Road) overpass.

Continuing into the eastern section of the project, the Red Corridor does not have an interchange with US 70 Business, but instead has a proposed interchange at SR 2542 (Rock Quarry Road) that includes an extension of Rock Quarry Road to the south that forms an intersection with US 70 Business. The proposed Rock Quarry Road interchange on the Red Corridor is in the same location as the Rock Quarry Road interchange on the Green Corridor. After the Rock Quarry Road interchange, DSA 6 follows the remainder of the Green Corridor, with future interchanges at SR 2555 (Auburn-Knightdale Road), SR 1007 (Poole Road) and US 64/264.

Detailed Study Alternative 7 – DSA 7 is a slight variation of DSA 6. DSA 7 utilizes the Orange and then the Red Corridor for the southern section, as described in DSA 6. The eastern section alignment includes the Red Corridor, Mint Corridor (see DSA 2 description above), and Green Corridor.

Detailed Study Alternative 8 – This alternative combines the Orange and then the Purple, Blue, and Lilac Corridors for the southern section of the project. The proposed DSA 8 alignment follows the Orange Corridor through the future interchanges at NC 55 Bypass and SR 1152 (Holly Springs Road). After the Holly Springs Road interchange, the Purple Corridor diverges southward from the Orange Corridor. The proposed Purple Corridor has an interchange with SR 1393 (Hilltop Needmore Road). The Purple Corridor alignment then continues southeast to a planned interchange with US 401. DSA 8 continues eastward on the Blue Corridor alignment, with a proposed interchange at SR 1006 (Old Stage Road). The Blue Corridor then merges into the Lilac Corridor alignment just west of the proposed NC 50 interchange. DSA 8 follows the Lilac Corridor alignment to the I-40 and US 70 interchange.

On the eastern section of the project, the Lilac Corridor alignment merges into the Green Corridor prior to the White Oak Road interchange. After the future White Oak Road interchange location, DSA 6 follows the remainder of the Green Corridor alignment, with future interchanges at SR 2542 (Rock Quarry Road), SR 2555 (Auburn-Knightdale Road), SR 1007 (Poole Road) and US 64/264.

Detailed Study Alternative 9 – DSA 9 is a slight variation of DSA 8. DSA 9 utilizes the Orange, Purple, Blue, and Lilac Corridors for the southern section, as described in DSA 8. The eastern section uses the Green and Mint Corridors (see DSA 2 description above).

Detailed Study Alternative 10 – DSA 10 features the Orange, Purple, Blue, and Lilac Corridor alignments (see DSA 9 description above) for the southern section. The eastern section utilizes a combination of the Brown, Tan, and Green Corridors (see DSA 3 description above).

Detailed Study Alternative 11 – DSA 11 features the Orange, Purple, Blue, and Lilac Corridor alignments (see DSA 9 description above) for the southern section. The eastern section proposed alignment features a combination of the Brown, and Green Corridors (see DSA 4 description above).

Detailed Study Alternative 12 – DSA 12 features the Orange, Purple, Blue, and Lilac Corridor alignment (see DSA 9 description above) for the southern section. The Green, Teal, and Brown Corridors are combined to create the eastern section alignment of this project alternative (see DSA 5 description above).

Detailed Study Alternative 13 – This alternative contains the Orange and Lilac Corridor alignments for the southern section of the project. The proposed Lilac Corridor diverges from the Orange Corridor east of the future SR 1006 (Old Stage Road) interchange. The planned Lilac Corridor interchanges with NC 50 and I-40 and US 70 are north of the locations of the proposed NC 50 and I-40 and US 70 interchanges on the Orange Corridor. On the eastern section of the project, the Lilac Corridor alignment merges into the Green Corridor prior to the proposed White Oak Road interchange. After the White Oak Road interchange, DSA 6 follows the remainder of the Green Corridor.

Detailed Study Alternative 14 – DSA 14 is a slight variation of DSA 13. DSA 14 utilizes the Orange and Lilac Corridor alignments for the southern section. The eastern section features the Green and Mint Corridors (see DSA 2 description above).

Detailed Study Alternative 15 – DSA 15 utilizes the Orange and Lilac Corridor alignments (see DSA 13 description above) for the southern section. The eastern section contains a combination of the Brown, Tan, and Green Corridors (see DSA 3 description above).

Detailed Study Alternative 16 – DSA 16 features the Orange and Lilac Corridor alignments (see DSA 13 description above) for the southern section. The eastern section utilizes a combination of the proposed Brown, and Green Corridors (see DSA 4 description above).

Detailed Study Alternative 17 – DSA 17 features the Orange and Lilac Corridor alignments (see DSA 13 description above) for the southern section. The proposed Green, Teal, and Brown Corridors are combined to create the eastern section of this project alternative (see DSA 5 description above).

Table 6, on the following page, summarizes the interchange forms for each DSA along the southern and eastern sections of NC 540.

Table 6. Interchange Forms by Detailed Study Alternative

<table>
<tr><th></th><th></th><th colspan="17">DSA</th></tr>
<tr><th>Interchange</th><th>Interchange #</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>13</th><th>14</th><th>15</th><th>16</th><th>17</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th><th>6</th><th>7</th></tr>
<tr><td>NC 55 BYP & NC 540</td><td>1</td><td colspan="17">6 Ramp ParClo AD</td></tr>
<tr><td>Holly Springs & NC 540</td><td>2</td><td colspan="17">DDI</td></tr>
<tr><td>Bells Lake & NC 540</td><td>3</td><td colspan="10">ParClo AC</td><td colspan="5"></td><td colspan="2">ParClo AC</td></tr>
<tr><td>US 401 & NC 540</td><td>4</td><td colspan="15">6 Ramp ParClo AC</td><td colspan="2">6RParClo BD</td></tr>
<tr><td>Old Stage & NC 540</td><td>5</td><td colspan="15">Diamond</td><td colspan="2">6RParClo AC</td></tr>
<tr><td>NC 50 & NC 540</td><td>6</td><td colspan="5">Half TghtDiam B</td><td colspan="10">ParClo BC</td><td colspan="2">DDI</td></tr>
<tr><td>I-40 & NC 540</td><td>7</td><td colspan="5">Dreamcatcher</td><td colspan="10">4 Level Directional</td><td colspan="2">CloSemiDir D C/D</td></tr>
<tr><td>White Oak & NC 540</td><td>8</td><td colspan="2">ParClo BC</td><td colspan="2">ParClo AD</td><td>Parclo BC</td><td colspan="10">ParClo AD</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>US 70 BUS & NC 540</td><td>9</td><td colspan="2">6RParClo AC</td><td colspan="2">TghtDiam</td><td>6RParClo AC</td><td colspan="2">6RParClo AC</td><td colspan="2">TghtDiam</td><td>6RParClo AC</td><td colspan="2">6RParClo AC</td><td colspan="2">TghtDiam</td><td>6RParClo AC</td></tr>
<tr><td>Rock Quarry / Old Baucom & NC 540</td><td>10</td><td colspan="2">ParClo AD</td><td colspan="3">Tight Diamond</td><td colspan="2">ParClo AD</td><td colspan="3">Tight Diamond</td><td colspan="2">ParClo AD</td><td colspan="3">Tight Diamond</td><td colspan="2">Diamond</td></tr>
<tr><td>Auburn-Knightdale & NC 540</td><td>11</td><td colspan="3">ParClo AD</td><td colspan="2">ParClo BC</td><td colspan="3">ParClo AD</td><td colspan="2">ParClo BC</td><td colspan="3">ParClo AD</td><td colspan="2">ParClo BC</td><td colspan="2">ParClo AD</td></tr>
<tr><td>Poole & NC 540</td><td>12</td><td colspan="17">Half Tight Diamond B</td></tr>
<tr><td>US 64/264 & NC 540</td><td>13</td><td colspan="17">Semidirectional BD</td></tr>
<tr><td>Hilltop-Needmore & NC 540</td><td>20</td><td colspan="10"></td><td colspan="5">ParClo BC</td><td colspan="2"></td></tr>
</table>

Abbreviations:
ParClo AD - Partial Cloverleaf with Loops in Quadrants A & D
DDI - Diverging Diamond Interchange
6R - 6 Ramp
TghtDiam - Tight Diamond Interchange
CloSemiDir D C/D - Cloverleaf with a semi-direct connection in Quadrant D and Collector-Distributor Roads

5. 2012 BASE YEAR / 2035 DESIGN YEAR TRAFFIC VOLUME DEVELOPMENT

NCDOT-approved traffic forecast information from the *Complete 540 - Triangle Expressway Southeast Extension NCDOT STIP Project R-2721, R-2828 & R-2829 Traffic Forecast Technical Memorandum*, prepared by HNTB North Carolina, PC in April 2014 was used as a basis for developing AM and PM peak hour traffic volume data for the 2012 base year and 2035 design year. The daily traffic forecasts for the Complete 540 study area from that document are shown in ***Appendix B***. Daily traffic flows and design data (DHV and D) were entered into the NCDOT Congestion Management Section peak hour breakout spreadsheets for conversion into peak hour volumes at each study area intersection. Truck percentages from the forecast were utilized in the traffic analysis using the assumption of (Duals + TTST / 2) equals peak hour truck percentages.

The peak hour breakout spreadsheet results were converted into individual AM and PM peak hour movements for the proposed DSA interchange forms in a separate conversion spreadsheet developed by HNTB. Both the peak hour breakout spreadsheets and the interchange conversion spreadsheets are found in ***Appendix D***.

Design year (2035) peak hour traffic volumes in the project study area are shown in the freeway segment / intersection LOS result figures for DSA 1, 6 and 8 in **Appendix A**. These figures, described in the following sections, schematically show the Complete 540 freeway system, study area analysis segments, intersections, and laneage for each alternative for the design year.

Traffic flows were balanced between ramp terminals at each interchange, and were balanced (through the FreeVal software data entry) for mainline segments along existing and proposed DSA alignments based on an entry input volume and subsequent peak hour breakout on-ramp/off-ramp volumes. In this manner, the existing freeway and proposed DSA freeway systems were balanced with a different methodology (and results) than if individual interchange mainline volume breakouts were analyzed in individual HCS freeway segment analyses.

6. 2012 BASE YEAR CAPACITY ANALYSIS RESULTS

This section presents capacity analysis results for the 2012 base year AM and PM peak hours for freeway facilities and intersections within the Complete 540 project study area. Detailed segment measures of effectiveness results for the worst-case AM and PM peak hour for DSA's 1, 6 and 8 freeway are presented in **Tables 11** and **12** to provide an overall representation of projected operations for all DSA's.

6.1 2012 Freeway Segment Results

This analysis uses the 2012 base year No-Build and Build peak hour traffic volumes and existing/proposed freeway geometrics to evaluate traffic operations on the Complete 540, NC 540, I-40, US 70, US 64 / US 264 and I-540 uninterrupted flow facilities in the project study area. The analysis determines individual freeway segment and system-wide density and LOS measures of effectiveness for No-Build and Build DSA scenarios. **Figure 3** provides a sheet key for the No-Build freeway segment figures. **Figures 7.1** to **7.5** schematically show 2012 base year No-Build existing laneage and intersection traffic control for roadways in the study area, along with the scheme for freeway segment identification numbers. For 2012 No-Build and Build DSAs, **Tables 7, 8, 9** and **10** provide an overall summary and comparison of LOS results for the worst-case AM and PM peak hour LOS for each facility direction for basic freeway sections, merges, diverges and weaves. ***Appendix E*** contains the detailed HCS 2010 FreeVal output files and corridor summary tables for all DSAs. Individual alternative scenario results are highlighted below.

AM and PM peak hour traffic volumes and existing geometrics were entered into the HCS 2010 FreeVal software module. Since Toll NC 540, Complete 540 and I-540 will form a continuous freeway facility corridor once Complete 540 is constructed, these facility are included in the Complete 540 corridor summary **Tables 7, 11** and **12**.

6.1.1 2012 No-Build Alternative Scenario Results

Most segments along existing freeway facilities perform at an acceptable LOS D or better in the AM and PM peak hours. However, on the I-40 corridor, two (2) eastbound and seven (7) westbound segments are at (LOS E) or exceeding (LOS F) peak hour capacity. **Figures 7.1** to **7.5** provide a schematic representation of the results for the freeway system in the project study area.

6.1.2 2012 Build – DSA 1-5, 13-17 Scenario Results

For Complete 540 DSA operations, all freeway segments are expected to operate at LOS D or better. For the US 70 and US 64 / US 264 corridors, all freeway segments are projected to operate at LOS D or better. For the I-40 corridor, results indicate that corridor operations and segment densities will slightly improve from the No-Build scenario with two (2) I-40 eastbound and five (5) or six (6) I-40 westbound segments near (LOS E) or exceeding (LOS F) peak hour capacity.

6.1.3 2012 Build – DSA 6-7 Scenario Results

For Complete 540 DSA operations, all freeway and collector-distributor segments are expected to operate at LOS D or better. For the US 70 and US 64 / US 264 corridors, all freeway segments are projected to operate at LOS D or better. For the I-40 corridor, results indicate that corridor operations and segment densities will slightly improve from the No-

Build scenario with two (2) I-40 eastbound and five (5) or six (6) I-40 westbound segments at (LOS E) or exceeding (LOS F) peak hour capacity. For the I-40 collector-distributor proposed between US 70 Business and Complete 540, all freeway segments are expected to operate at LOS D or better.

6.1.4 2012 Build – DSA 8-12 Scenario Results

For Complete 540 DSA operations, all freeway segments are expected to operate at LOS D or better. For the US 70 and US 64 / US 264 corridors, all freeway segments are projected to operate at LOS D or better. For the I-40 corridor, results indicate that corridor operations and segment densities will slightly improve from the No-Build scenario with two (2) I-40 eastbound and six (6) I-40 westbound segments at (LOS E) or exceeding (LOS F) peak hour capacity.

**Table 7. 2012 Base Year Complete 540
No-Build & Build DSA Freeway Operations Summary**

Scenario	Complete 540											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
No-Build	5	4	0	0	0	0	5	8	0	0	0	0
DSA 1	50	16	0	0	0	0	33	31	3	0	0	0
DSA 2	50	16	0	0	0	0	33	31	3	0	0	0
DSA 3	43	21	0	0	0	0	31	31	3	0	0	0
DSA 4	48	16	0	0	0	0	31	31	3	0	0	0
DSA 5	55	11	0	0	0	0	36	28	3	0	0	0
DSA 6*	46	8	0	0	0	0	41	15	1	0	0	0
DSA 7*	45	9	0	0	0	0	41	15	1	0	0	0
DSA 8	46	16	0	0	0	0	34	28	3	0	0	0
DSA 9	46	16	0	0	0	0	35	27	3	0	0	0
DSA 10	43	17	0	0	0	0	32	28	3	0	0	0
DSA 11	43	17	0	0	0	0	33	27	3	0	0	0
DSA 12	50	12	0	0	0	0	40	22	3	0	0	0
DSA 13	46	16	0	0	0	0	31	31	3	0	0	0
DSA 14	46	16	0	0	0	0	31	31	3	0	0	0
DSA 15	43	17	0	0	0	0	29	31	3	0	0	0
DSA 16	43	17	0	0	0	0	29	31	3	0	0	0
DSA 17	51	11	0	0	0	0	34	28	3	0	0	0

**DSA 6, 7 includes analysis of collector-distributor segment along Complete 540.*

Scenario	Complete 540 Collector-Distributor											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
DSA 6, 7	N/A	N/A	N/A	N/A	N/A	N/A	7	0	0	0	0	0

Table 8. 2012 Base Year I-40
No-Build & Build DSA Freeway Operations Summary

Scenario	I-40											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
No-Build	0	4	7	2	2	0	0	1	8	1	5	2
DSA 1, 2	2	7	4	4	1	1	3	4	6	3	3	2
DSA 3, 4	2	6	5	4	1	1	3	4	6	2	3	3
DSA 5	2	7	4	4	1	1	3	4	6	3	3	2
DSA 6, 7*	0	6	0	1	0	0	0	6	0	1	0	0
DSA 8, 9	2	5	5	5	1	1	1	6	6	2	3	3
DSA 10, 11	2	5	5	5	1	1	1	6	6	2	3	3
DSA 12	2	5	5	5	1	1	1	6	6	2	3	3
DSA 13, 14	2	6	4	5	1	1	1	6	6	3	3	2
DSA 15, 16	2	5	5	5	1	1	1	6	6	2	3	3
DSA 17	2	6	4	5	1	1	1	6	6	3	3	2

**DSA 6, 7 also contain analysis of collector-distributor segment along I-40.*

Scenario	I-40 Collector-Distributor											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
DSA 6, 7	7	4	0	0	0	0	5	4	0	0	0	0

Table 9. 2012 Base Year US 70
No-Build & Build DSA Freeway Operations Summary

Scenario	US 70											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
No-Build	3	4	0	0	0	0	4	4	0	0	0	0
DSA 1-2	5	6	0	0	0	0	3	7	0	0	0	0
DSA 3-4	6	5	0	0	0	0	3	7	0	0	0	0
DSA 5	5	6	0	0	0	0	3	7	0	0	0	0
DSA 6, 7*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
DSA 8, 9	4	5	0	0	0	0	5	5	0	0	0	0
DSA 10, 11	7	2	0	0	0	0	7	3	0	0	0	0
DSA 12	4	5	0	0	0	0	5	5	0	0	0	0
DSA 13, 14	4	5	0	0	0	0	5	5	0	0	0	0
DSA 15, 16	4	5	0	0	0	0	5	5	0	0	0	0
DSA 17	4	5	0	0	0	0	5	5	0	0	0	0

**DSA 6, 7 not included since proposed design does not impact US 70.*

Table 10. 2012 Base Year US 64
No-Build & Build DSA Freeway Operations Summary

Scenario	US 64											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
No-Build	0	2	6	3	0	0	0	2	6	3	0	0
DSA 1, 2, 13, 14	0	2	10	1	0	0	0	2	10	1	0	0
DSA 3, 4, 15, 16	0	2	10	1	0	0	0	2	10	1	0	0
DSA 5, 17	0	2	10	1	0	0	0	3	9	1	0	0
DSA 6, 7	0	2	10	1	0	0	0	2	10	1	0	0
DSA 8, 9	0	2	10	1	0	0	0	2	10	1	0	0
DSA 10, 11	0	2	10	1	0	0	0	2	10	1	0	0
DSA 12	0	2	10	1	0	0	0	3	9	1	0	0

Table 11. 2012 AM Peak Base Year Freeway Operations Corridor Summary – Complete 540 DSA 1, 6 and 8

Eastern Termini — COMPLETE 540 — Western Termini

2012 Build DSA 8 Eastbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
N/A			
West of NC 55 Bypass	B3	4.1	A
NC 55 Bypass	D4	4.4	A
	B5	3.6	A
	D6	4.4	A
	B7	2.7	A
	M8	4.6	A
	B9	4.4	A
Holly Springs Rd	D10	4.7	A
	B11	3.5	A
	M12	5.9	A
	B13	5.5	A
Hilltop Needmore Rd	D14	5.8	A
	B15	5.0	A
	M16	5.7	A
	B17	5.3	A
US 401	D18	5.7	A
	B19	3.3	A
	M20	3.6	A
	B21	3.4	A
	M22	4.4	A
	B23	4.1	A
Old Stage Rd	D24	4.4	A
	B25	3.3	A
	M26	3.7	A
N/A			
	B27	3.6	A
NC 50	D28	3.8	A
	B29	3.3	A
	M30	4.5	A
	B31	4.3	A
I-40	D32	4.8	A
	B33	1.5	A
	M34	5.0	A
N/A			
	B35	5.0	A
White Oak Rd	D36	5.3	A
	B37	4.8	A
	M38	7.1	A
	B39	6.6	A
US 70 Business	D40	7.0	A
	B41	5.5	A
	M42	6.9	A
	B43	6.6	A
	M44	9.1	A
	B45	8.7	A
Rock Quarry Rd	D46	9.9	A
	B47	8.4	A
	M48	10.3	B
	B49	9.6	A
Auburn-Knightdale Rd	D50	11.1	B
	B51	9.2	A
	M52	10.2	B
	B53	9.6	A
Poole Rd	D54	10.0	B
	B55	9.4	A
	W56	11.3	B
US 64 / US 264	D57	12.9	B
	B58	7.5	A
	D59	15.4	B
	B60	14.7	B
US 64 Business	D61	16.4	B
	B62	10.6	A
	M63	18.9	B
North of US 64 Business	B64	17.5	B
Facility		**6.2**	**A**

2012 Build DSA 6 Eastbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
N/A			
West of NC 55 Bypass	B3	4.0	A
NC 55 Bypass	D4	4.4	A
	B5	2.5	A
	D6	3.1	A
	B7	1.3	A
	M8	3.0	A
	B9	2.9	A
Holly Springs Rd	D10	3.1	A
	B11	2.1	A
	M12	4.1	A
	B13	3.8	A
Bells Lake Rd	D14	4.1	A
	B15	3.2	A
	M16	4.6	A
	B17	4.3	A
US 401	D18	4.6	A
	B19	3.7	A
	D20	4.4	A
	B21	2.3	A
	M22	4.7	A
	B23	4.4	A
Old Stage Rd	D24	4.7	A
	B25	3.0	A
	M26	3.8	A
	B27	3.7	A
	M28	4.5	A
	B29	4.2	A
NC 50	D30	4.5	A
	B31	2.6	A
	M32	5.2	A
	B33	4.9	A
I-40	D34	5.1	A
	B35	2.5	A
	M36	5.0	A
N/A			
	B37	4.9	A
Rock Quarry Rd	D38	5.7	A
	B39	4.8	A
	M40	8.3	A
	B41	7.8	A
Auburn-Knightdale Rd	D42	9.0	A
	B43	7.5	A
	M44	8.5	A
	B45	8.0	A
Poole Rd	D46	8.4	A
	B47	7.8	A
	W48	9.4	A
US 64 / US 264	D49	10.7	B
	B50	6.4	A
	M51	13.4	B
	B52	12.9	B
US 64 Business	D53	14.4	B
	B54	9.0	A
	M55	16.9	B
North of US 64 Business	B56	15.6	B
Facility		**5.6**	**A**

2012 Build DSA 1 Eastbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
N/A			
West of NC 55 Bypass	B3	4.1	A
NC 55 Bypass	D4	4.5	A
	B5	2.8	A
	D6	3.4	A
	B7	1.7	A
	M8	3.4	A
	B9	3.3	A
Holly Springs Rd	D10	3.6	A
	B11	2.4	A
	M12	4.5	A
	B13	4.2	A
Bells Lake Rd	D14	4.4	A
	B15	4.0	A
	M16	6.1	A
	B17	5.7	A
US 401	D18	6.1	A
	B19	4.6	A
	M20	5.2	A
	B21	4.9	A
	M22	6.9	A
	B23	6.5	A
Old Stage Rd	D24	6.9	A
	B25	4.9	A
	M26	5.5	A
N/A			
	B27	5.2	A
NC 50	D28	5.5	A
	B29	4.2	A
	M30	5.3	A
	B31	5.0	A
I-40	D32	5.1	A
	B33	3.7	A
	D34	4.0	A
	B35	1.9	A
	M36	3.9	A
	B37	3.9	A
	M38	5.7	A
	B39	5.6	A
White Oak Rd	D40	5.9	A
	B41	5.2	A
	M42	7.4	A
	B43	7.0	A
US 70 Business	D44	7.4	A
	B45	5.7	A
	M46	7.1	A
	B47	6.8	A
	M48	9.3	A
	B49	8.9	A
Rock Quarry Rd	D50	10.2	B
	B51	8.6	A
	M52	10.3	B
	B53	9.6	A
Auburn-Knightdale Rd	D54	11.1	B
	B55	9.2	A
	M56	10.2	B
	B57	9.6	A
Poole Rd	D58	10.0	B
	B59	9.4	A
	W60	11.2	B
US 64 / US 264	D61	12.9	B
	B62	7.5	A
	M63	15.4	B
	B64	14.8	B
US 64 Business	D65	16.5	B
	B66	10.6	A
	M67	19.1	B
North of US 64 Business	B68	17.7	B
Facility		**6.8**	**A**

2012 Build DSA 1 Westbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of NC 55 Bypass	B135	9.0	A
NC 55 Bypass	M134	9.7	A
	B133	8.0	A
	M132	8.2	A
	B131	5.3	A
	D130	8.6	A
	B129	7.9	A
Holly Springs Rd	M128	8.4	A
	B127	6.5	A
	D126	9.7	A
	B125	9.0	A
Bells Lake Rd	M124	9.7	A
	B123	8.8	A
	D122	12.7	B
	B121	11.7	B
US 401	M120	12.6	B
	B119	11.6	B
	M118	12.3	B
	B117	9.9	A
	D116	12.9	B
	B115	12.1	B
N/A			
Old Stage Rd	M114	13.0	B
	B113	9.7	A
	D112	10.5	B
	B111	10.0	A
NC 50	M110	10.7	B
	B109	8.4	A
	D108	10.6	B
	B107	9.1	A
I-40	M106	9.3	A
	B105	6.9	A
	W104	6.1	A
	B103	3.2	A
	D102	7.4	A
	B101	6.7	A
White Oak Rd	M100	7.1	A
	B99	6.5	A
	D98	9.9	A
	B97	8.4	A
US 70 Business	M96	8.9	A
	B95	7.8	A
	M94	8.2	A
	B93	6.9	A
	D92	11.2	B
	B91	10.3	A
Rock Quarry Rd	M90	11.0	B
	B89	10.0	A
	D88	11.6	B
	B87	11.0	B
Auburn-Knightdale Rd	M86	11.8	B
	B85	10.6	A
	D84	11.5	B
	B83	11.0	B
Poole Rd	M82	11.8	B
	B81	10.8	A
	W80	11.6	B
US 64 / US 264	B79	8.3	A
	D78	13.2	B
	B77	10.8	A
	D76	13.6	B
	B75	12.7	B
US 64 Business	M74	13.6	B
	B73	9.8	A
	D72	15.0	B
	B71	12.5	B
	D70	16.1	B
North of US 64 Business	B69	15.0	B
N/A			
Facility		**9.9**	**A**

2012 Build DSA 6 Westbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of NC 55 Bypass	B113	8.0	A
NC 55 Bypass	M112	8.6	A
	B111	6.8	A
	M110	6.9	A
	B109	3.7	A
	D108	6.9	A
	B107	6.3	A
Holly Springs Rd	M106	6.7	A
	B105	5.1	A
	D104	8.1	A
	B103	7.5	A
Bells Lake Rd	M102	8.0	A
	B101	6.5	A
	D100	8.9	A
	B99	8.3	A
US 401	M98	8.7	A
	B97	5.5	A
	D96	8.9	A
	B95	7.5	A
	D94	8.4	A
	B93	7.9	A
Old Stage Rd	M92	8.6	A
	B91	6.6	A
	M90	6.8	A
	B89	6.3	A
	D88	8.7	A
	B87	8.1	A
NC 50	M86	8.7	A
	B85	6.0	A
	D84	11.2	B
	B83	9.2	A
N/A			
I-40	M82	9.1	A
	B81	5.4	A
	D80	8.6	A
	B79	8.0	A
N/A			
Rock Quarry Rd	M78	8.6	A
	B77	7.7	A
	D76	10.9	B
	B75	10.2	A
Auburn-Knightdale Rd	M74	10.9	B
	B73	9.8	A
	D72	10.9	B
	B71	10.4	A
Poole Rd	M70	11.1	B
	B69	10.2	A
	W68	10.7	B
US 64 / US 264	B67	8.0	A
	D66	12.6	B
	B65	10.5	A
	D64	12.6	B
	B63	11.8	B
US 64 Business	M62	12.7	B
	B61	9.2	A
	D60	14.2	B
	B59	11.9	B
	D58	15.1	B
North of US 64 Business	B57	14.1	B
N/A			
Facility		**8.5**	**A**

2012 Build DSA 8 Westbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of NC 55 Bypass	B129	9.1	A
NC 55 Bypass	M128	9.9	A
	B127	8.1	A
	M126	8.5	A
	B125	7.4	A
	D124	10.7	B
	B123	9.9	A
Holly Springs Rd	M122	10.6	B
	B121	8.5	A
	D120	12.2	B
	B119	11.4	B
Hilltop Needmore Rd	M118	12.3	B
	B117	10.6	A
	D116	11.3	B
	B115	10.8	A
US 401	M114	11.4	B
	B113	10.7	A
	M112	11.3	B
	B111	7.1	A
	D110	8.5	A
	B109	8.0	A
N/A			
Old Stage Rd	M108	8.5	A
	B107	6.6	A
	D106	7.3	A
	B105	6.9	A
NC 50	M104	7.3	A
	B103	6.6	A
	D102	9.5	A
	B101	8.1	A
N/A			
I-40	M100	7.6	A
	B99	2.5	A
	D98	6.8	A
	B97	6.1	A
White Oak Rd	M96	6.4	A
	B95	6.0	A
	D94	9.4	A
	B93	7.9	A
US 70 Business	M92	8.4	A
	B91	7.4	A
	M90	7.8	A
	B89	6.7	A
	D88	10.9	B
	B87	10.1	A
Rock Quarry Rd	M86	10.8	B
	B85	9.8	A
	D84	11.5	B
	B83	10.9	A
Auburn-Knightdale Rd	M82	11.7	B
	B81	10.4	A
	D80	11.4	B
	B79	10.9	A
Poole Rd	M78	11.6	B
	B77	10.6	A
	W76	11.5	B
US 64 / US 264	B75	8.1	A
	D74	13.1	B
	B73	10.8	A
	D72	13.4	B
	B71	12.5	B
US 64 Business	M70	13.5	B
	B69	9.7	A
	D68	14.8	B
	B67	12.4	B
	D66	15.9	B
North of US 64 Business	B65	14.8	B
N/A			
Facility		**9.3**	**A**

Cell Shading – Green = LOS A – D, Orange = LOS E, Red = LOS F; N/A – Analysis not applicable for comparable location or segment.

Table 12. 2012 PM Peak Base Year Build Freeway Operations Corridor Summary – Complete 540 DSA 1, 6 and 8

COMPLETE 540 — Eastern Termini to Western Termini

2012 Build DSA 8 Eastbound PM

Location	Segment ID	Density (pc/mi/ln)	LOS
N/A			
West of NC 55 Bypass	B3	7.6	A
NC 55 Bypass	D4	5.8	A
	B5	6.5	A
	D6	7.7	A
	B7	5.8	A
	M8	8.7	A
	B9	8.3	A
Holly Springs Rd	D10	8.9	A
	B11	6.9	A
	M12	10.5	B
	B13	9.8	A
Hilltop Needmore Rd	D14	10.3	B
	B15	9.2	A
	M16	10.3	B
	B17	9.6	A
US 401	D18	10.5	B
	B19	6.0	A
	M20	6.5	A
	B21	6.2	A
	M22	7.3	A
	B23	6.9	A
Old Stage Rd	D24	7.4	A
	B25	5.5	A
	M26	6.0	A
N/A			
	B27	5.8	A
NC 50	D28	6.1	A
	B29	5.4	A
	M30	7.2	A
	B31	6.9	A
I-40	D32	7.9	A
	B33	1.4	A
	M34	4.9	A
N/A			
	B35	5.0	A
White Oak Rd	D36	5.3	A
	B37	4.8	A
	M38	7.3	A
	B39	6.8	A
US 70 Business	D40	7.2	A
	B41	5.5	A
	M42	7.3	A
	B43	6.9	A
	M44	9.4	A
	B45	9.0	A
Rock Quarry Rd	D46	10.3	B
	B47	8.7	A
	M48	10.5	B
	B49	9.8	A
Auburn-Knightdale Rd	D50	11.3	B
	B51	9.3	A
	M52	10.4	B
	B53	9.7	A
Poole Rd	D54	10.2	B
	B55	9.4	A
	W56	10.3	B
US 64 / US 264	D57	10.8	B
	B58	7.0	A
	D59	12.0	B
	B60	11.5	B
US 64 Business	D61	12.6	B
	B62	8.5	A
	M63	14.8	B
North of US 64 Business	B64	13.7	B
Facility		**7.8**	**A**

2012 Build DSA 6 Eastbound PM

Location	Segment ID	Density (pc/mi/ln)	LOS
N/A			
West of NC 55 Bypass	B3	7.2	A
NC 55 Bypass	D4	8.1	A
	B5	4.1	A
	D6	4.8	A
	B7	2.9	A
	M8	5.7	A
	B9	5.5	A
Holly Springs Rd	D10	5.9	A
	B11	4.2	A
	M12	7.1	A
	B13	6.7	A
Bells Lake Rd	D14	7.1	A
	B15	5.7	A
	M16	8.0	A
	B17	7.5	A
US 401	D18	8.0	A
	B19	6.1	A
	D20	7.1	A
	B21	4.6	A
	M22	7.6	A
	B23	7.1	A
Old Stage Rd	D24	7.7	A
	B25	5.5	A
	M26	7.0	A
	B27	6.7	A
	M28	7.8	A
	B29	7.3	A
NC 50	D30	7.9	A
	B31	5.1	A
	M32	8.9	A
	B33	8.4	A
I-40	D34	8.9	A
	B35	4.5	A
	M36	7.3	A
N/A			
	B37	7.1	A
Rock Quarry Rd	D38	8.2	A
	B39	6.9	A
	M40	9.9	A
	B41	9.3	A
Auburn-Knightdale Rd	D42	10.7	B
	B43	9.0	A
	M44	10.1	B
	B45	9.5	A
Poole Rd	D46	9.9	A
	B47	9.3	A
	W48	9.7	A
US 64 / US 264	D49	10.4	B
	B50	7.1	A
	M51	11.5	B
	B52	11.0	B
US 64 Business	D53	12.0	B
	B54	8.2	A
	M55	14.3	B
North of US 64 Business	B56	13.3	B
Facility		**7.6**	**A**

2012 Build DSA 1 Eastbound PM

Location	Segment ID	Density (pc/mi/ln)	LOS
N/A			
West of NC 55 Bypass	B3	7.5	A
NC 55 Bypass	D4	8.3	A
	B5	4.7	A
	D6	5.6	A
	B7	3.7	A
	M8	6.5	A
	B9	6.3	A
Holly Springs Rd	D10	6.8	A
	B11	4.9	A
	M12	7.9	A
	B13	7.4	A
Bells Lake Rd	D14	7.8	A
	B15	7.2	A
	M16	10.9	B
	B17	10.2	A
US 401	D18	10.9	B
	B19	8.3	A
	M20	9.5	A
	B21	9.0	A
	M22	11.3	B
	B23	10.5	A
Old Stage Rd	D24	11.3	B
	B25	8.1	A
	M26	9.0	A
N/A			
	B27	8.4	A
NC 50	D28	9.0	A
	B29	6.8	A
	M30	8.1	A
	B31	7.6	A
I-40	D32	7.9	A
	B33	5.3	A
	D34	5.9	A
	B35	1.4	A
	M36	3.9	A
	B37	3.9	A
	M38	5.4	A
	B39	5.2	A
White Oak Rd	D40	5.4	A
	B41	4.9	A
	M42	7.3	A
	B43	6.8	A
US 70 Business	D44	7.3	A
	B45	5.3	A
	M46	7.1	A
	B47	6.7	A
	M48	9.3	A
	B49	8.8	A
Rock Quarry Rd	D50	10.1	B
	B51	8.5	A
	M52	10.1	B
	B53	9.5	A
Auburn-Knightdale Rd	D54	10.9	B
	B55	9.1	A
	M56	10.1	B
	B57	9.5	A
Poole Rd	D58	9.9	A
	B59	9.2	A
	W60	10.0	B
US 64 / US 264	D61	10.5	B
	B62	6.7	A
	M63	11.7	B
	B64	11.3	B
US 64 Business	D65	12.4	B
	B66	8.2	A
	M67	14.6	B
North of US 64 Business	B68	13.5	B
Facility		**8.2**	**A**

2012 Build DSA 1 Westbound PM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of NC 55 Bypass	B135	6.3	A
NC 55 Bypass	M134	6.7	A
	B133	5.2	A
	M132	5.4	A
	B131	4.0	A
	D130	6.1	A
	B129	5.6	A
Holly Springs Rd	M128	6.0	A
	B127	4.7	A
	D126	7.0	A
	B125	6.5	A
Bells Lake Rd	M124	6.9	A
	B123	6.3	A
	D122	8.6	A
	B121	8.0	A
US 401	M120	8.5	A
	B119	7.8	A
	M118	8.2	A
	B117	6.9	A
	D116	9.4	A
	B115	8.8	A
N/A			
Old Stage Rd	M114	9.4	A
	B113	7.2	A
	D112	7.8	A
	B111	7.4	A
NC 50	M110	7.9	A
	B109	6.6	A
	D108	8.4	A
	B107	7.2	A
I-40	M106	7.4	A
	B105	5.9	A
	W104	5.1	A
	B103	4.5	A
	D102	8.6	A
	B101	7.9	A
White Oak Rd	M100	8.4	A
	B99	7.6	A
	D98	10.9	B
	B97	9.3	A
US 70 Business	M96	9.9	A
	B95	8.7	A
	M94	9.2	A
	B93	8.0	A
	D92	12.0	B
	B91	11.2	B
Rock Quarry Rd	M90	12.0	B
	B89	10.9	A
	D88	12.5	B
	B87	11.9	B
Auburn-Knightdale Rd	M86	12.8	B
	B85	11.5	B
	D84	12.4	B
	B83	11.9	B
Poole Rd	M82	12.8	B
	B81	11.8	B
	W80	13.7	B
US 64 / US 264	B79	9.9	A
	D78	19.0	B
	B77	15.2	B
	D76	18.0	B
	B75	17.0	B
US 64 Business	M74	18.4	B
	B73	12.9	B
	D72	20.9	C
	B71	17.4	B
	D70	20.9	C
North of US 64 Business	B69	20.2	C
N/A			
Facility		**9.3**	**A**

2012 Build DSA 6 Westbound PM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of NC 55 Bypass	B113	6.5	A
NC 55 Bypass	M112	6.9	A
	B111	5.3	A
	M110	5.5	A
	B109	4.0	A
	D108	5.9	A
	B107	5.5	A
Holly Springs Rd	M106	5.8	A
	B105	4.7	A
	D104	6.9	A
	B103	6.4	A
Bells Lake Rd	M102	6.9	A
	B101	5.8	A
	D100	7.4	A
	B99	7.0	A
US 401	M98	7.3	A
	B97	5.0	A
	D96	8.1	A
	B95	6.9	A
	D94	7.4	A
	B93	7.0	A
Old Stage Rd	M92	7.6	A
	B91	5.8	A
	M90	6.0	A
	B89	5.6	A
	D88	7.3	A
	B87	6.9	A
NC 50	M86	7.3	A
	B85	5.3	A
	D84	9.0	A
	B83	7.5	A
N/A			
I-40	M82	7.5	A
	B81	5.2	A
	D80	8.2	A
	B79	7.6	A
N/A			
Rock Quarry Rd	M78	8.1	A
	B77	7.4	A
	D76	11.3	B
	B75	10.5	A
Auburn-Knightdale Rd	M74	11.2	B
	B73	10.2	A
	D72	11.2	B
	B71	10.7	A
Poole Rd	M70	11.4	B
	B69	10.6	A
	W68	12.1	B
US 64 / US 264	B67	9.1	A
	D66	17.6	B
	B65	14.1	B
	D64	16.3	B
	B63	15.4	B
US 64 Business	M62	16.6	B
	B61	11.7	B
	D60	19.3	B
	B59	16.0	B
	D58	19.3	B
North of US 64 Business	B57	18.4	C
N/A			
Facility		**8.4**	**A**

2012 Build DSA 8 Westbound PM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of NC 55 Bypass	B129	6.4	A
NC 55 Bypass	M128	6.8	A
	B127	5.4	A
	M126	5.7	A
	B125	5.1	A
	D124	7.3	A
	B123	6.8	A
Holly Springs Rd	M122	7.3	A
	B121	5.9	A
	D120	8.5	A
	B119	7.9	A
Hilltop Needmore Rd	M118	8.5	A
	B117	7.4	A
	D116	8.1	A
	B115	7.7	A
US 401	M114	8.1	A
	B113	7.5	A
	M112	7.9	A
	B111	5.6	A
	D110	6.8	A
	B109	6.4	A
N/A			
Old Stage Rd	M108	6.8	A
	B107	5.7	A
	D106	6.2	A
	B105	5.9	A
NC 50	M104	6.3	A
	B103	5.6	A
	D102	7.8	A
	B101	6.7	A
N/A			
I-40	M100	6.6	A
	B99	3.8	A
	D98	8.0	A
	B97	7.3	A
White Oak Rd	M96	7.7	A
	B95	7.2	A
	D94	10.5	B
	B93	8.9	A
US 70 Business	M92	9.5	A
	B91	8.4	A
	M90	8.9	A
	B89	7.8	A
	D88	11.8	B
	B87	11.0	B
Rock Quarry Rd	M86	11.7	B
	B85	10.7	A
	D84	12.6	B
	B83	11.9	B
Auburn-Knightdale Rd	M82	12.8	B
	B81	11.5	B
	D80	12.4	B
	B79	11.9	B
Poole Rd	M78	12.8	B
	B77	11.8	B
	W76	13.7	B
US 64 / US 264	B75	9.8	A
	D74	19.0	B
	B73	15.3	B
	D72	17.9	B
	B71	17.0	B
US 64 Business	M70	18.3	B
	B69	12.9	B
	D68	20.8	C
	B67	17.3	B
	D66	20.9	C
North of US 64 Business	B65	20.1	C
N/A			
Facility		**8.8**	**A**

Cell Shading – Green = LOS A – D, Orange = LOS E, Red = LOS F; N/A – Analysis not applicable for comparable location or segment.

6.2 2012 Base Year Intersection Capacity Analysis Results

The following sections provide descriptions and tabular results for intersection capacity analyses for all project study area intersections. LOS results and additional signalized intersection details for these scenarios are found in the raw Synchro output sheets in ***Appendix F***. The project study area contains six existing (No-Build) and seven Build unsignalized two-way stop-controlled intersections – these capacity analysis output sheets are found in ***Appendix G.*** ***Appendix H*** contains the SIDRA analysis output reports for the one existing (No-Build) single-lane roundabout located within the project study area. A tabular results summary for all alternative scenarios is found in **Table 13** on the following pages.

Summary figures showing traffic volumes, laneage, and overall intersection LOS for the 2012 No-Build (Existing) scenario can be found in **Figures 7.1** to **7.5.** Similar summary figures for the 2012 Build scenarios are not provided in this report; however, the summary figures provided for selected 2035 Build scenarios show where additional 2035 LRTP laneage was added to the 2012 Build design laneage. For all Build DSAs, optimized signal cycle lengths were held constant at locations where the interchange forms were identical, to provide a meaningful comparison between the Build DSAs alternatives. The splits for each phase were re-optimized based on the specific Build DSA traffic forecast volumes.

6.2.1 2012 No-Build Alternative Scenario Results

For the 2012 No-Build alternative AM and PM peak hour scenarios, 11 out of the 16 analyzed intersections operate at adequate levels of service in the AM and PM peak hours. The two ramp terminal intersections at the interchange of NC 540 and NC 55 Bypass were not analyzed because they currently operate under free-flow conditions with the existing geometric configuration. Intersections that experience deficient overall LOS in at least one peak hour include:

- US 401 and Ten Ten Road in both the AM (LOS E) and PM (LOS F) peak hour, due to high vehicular delays for left-turn movements.
- NC 50 and Cleveland School Road / Stevens Oaks Drive in the AM peak hour (LOS E), due to limited capacity for the southbound left-turn movement from NC 50 to Cleveland School Road.
- Poole Road and Hodge Road in the PM peak hour (LOS F), due to limited capacity for the southbound left-turn movement from Hodge Road to Poole Road.
- US 401 and Dwight Rowland Road in the AM peak hour, due to the northbound left-turn movement from Dwight Rowland Road to US 401 operating at LOS E.
- White Oak Road and Raynor Road in the PM peak hour, due to the southbound shared left and right-turn movement on Raynor Road operating at LOS E.

6.2.2 2012 Build – DSA 1-5, 13-17 Scenario Results

For the 2012 Build DSA 1-5, 13-17 AM and PM peak hour scenarios, it was assumed that all existing signalized intersections in the project study area would be re-optimized, to reflect anticipated traffic volume changes that were included in the Complete 540 traffic forecast data. These changes had a positive effect on operations at the NC 50 and Cleveland School Road / Stevens Oaks Drive intersection (DSAs 1-5 only) and the Poole Road and Hodge Road intersection, with AM and PM peak hour LOS improving to LOS C or better. The PM peak hour southbound shared left and right-turn movement LOS at the two-way stop-controlled intersection of White Oak Road and Raynor Road remained at LOS E in the DSA 1-2, 5, 13-14, and 17 scenarios, with a slight increase in delay from the No-Build. No other intersections, including the new ramp terminal intersections added in the Build DSA 1-5 and 13-17 scenarios, would be expected to operate at an overall LOS E or LOS F in the 2012 base year.

6.2.3 2012 Build DSA 6-7 Alternative Scenario Results

In the 2012 Build DSA 6-7 AM and PM peak hour scenarios, the splits for each phase were re-optimized based on the 2012 Build DSA 6-7 traffic forecast volumes. These updates had a positive effect on operations at the Poole Road and Hodge Road intersection, with AM and PM peak hour LOS improving to LOS B or better. In the 2012 Build DSA 6-7 scenarios, the intersection of Vandora Springs Road and Buffaloe Road was converted from a single-lane roundabout in the No-Build to an unsignalized intersection with stop control on Buffaloe Road, due to the widening of Vandora Springs Road and the relocation of this intersection in the Build design.

At US 401 and Ten Ten Road, both the AM and PM LOS improved from LOS E (AM) and F (PM) in the No-Build to LOS D (AM) and LOS E (PM) in the Build DSA 6-7 analysis, with lengthy delays still expected for traffic on the Ten Ten Road approaches. No other intersections, including the new ramp terminal intersections added in the Build DSA 6-7 scenarios, would be expected to operate at an overall LOS E or LOS F in 2012.

6.2.4 2012 Build DSA 8-12 Alternative Scenario Results

In the 2012 Build DSA 8-12 AM and PM peak hour scenarios, the splits for each phase were re-optimized based on the 2012 Build DSA 8-12 traffic forecast volumes. These updates had a positive effect on operations at the Poole Road and Hodge Road intersection and the US 401 and Dwight Rowland Road intersection, with AM and PM peak hour LOS improving to LOS B or better. In the Build DSA 8-12 scenarios, the proposed DSA design severs Dwight Rowland Road into two sections by the construction of NC 540 and vehicles heading north on Dwight Rowland Road are restricted to right turns only at the intersection with NC 401. The proposed alignment requires local traffic to re-route through the existing road network onto US 401 via Meadow Drive south of the proposed Complete 540 alignment. This re-routing reduced existing and future traffic volume estimates along Dwight Rowland Road and increased existing and future volumes on Meadow Drive for DSA 8-12 analyses.

The intersection of US 401 and Meadow Drive was evaluated for conversion from two-way stop control in the No-Build scenario to signalized control in the DSA analyses, due to the worst-case critical movement (northbound shared left/right) operating at LOS F in the 2012 Build DSA 8-12 AM peak hour. Per results from the HCS Peak Hour Signal Warrants Analysis Module (found in ***Appendix I)***, this intersection meets the MUTCD peak hour signal warrant threshold in 2012, and therefore is analyzed as a signalized intersection in the 2012 and 2035 Build DSAs 8-12 scenarios. Based on the Synchro signalized intersection capacity analysis (***Appendix F***), the signalized intersection of US 401 and Meadow Drive is expected to operate at LOS D or better in 2012.

The PM peak hour southbound shared left and right-turn movement LOS at the two-way stop-controlled intersection of White Oak Road and Raynor Road remained at LOS E in the DSA 8-9 and 12 scenarios, with an increase in delay from the No-Build scenario. No other intersections, including the new ramp terminal intersections added in the Build DSA 8-12 scenarios, would be expected to operate at an overall LOS E or LOS F in 2012.

Table 13. 2012 AM & (PM) Peak Hour No-Build Intersection Capacity Analysis Results Summary

				LOS																		DELAY																	
					2012 Build																		2012 Build																
Intersection	Intersection #	2012 NB	2012 B	2012 NB	1	2	3	4	5	13	14	15	16	17	8	9	10	11	12	6	7	2012 NB	1	2	3	4	5	13	14	15	16	17	8	9	10	11	12	6	7
NC 55 BYP & NC 540 EB Ramps	10	UNSIG	SIG	N/A	B (A)										A (A)					B (A)			22.3 (9.4)										22.5 (9.3)					11.6 (6.6)	
NC 55 BYP & NC 540 WB Ramps	11	UNSIG	SIG	N/A	B (B)										B (B)					B (B)			22.3 (9.4)										22.5 (9.3)					12.4 (10.4)	
Holly Springs & NC 540 EB (XOVER) Ramps	20		SIG		B (A)										B (A)					B (A)			22.3 (9.4)										22.5 (9.3)					16.7 (9.2)	
Holly Springs & NC 540 WB (XOVER) Ramps	21		SIG		C (A)										C (A)					B (A)			22.3 (9.4)										22.5 (9.3)					20.0 (9.3)	
Holly Springs & NC 540 EB Off RT Ramps	22		SIG		A (A)										A (A)					A (A)			2.9 (3.0)										1.9 (2.9)					2.6 (2.9)	
Holly Springs & Kildaire Farm	23	SIG	SIG	B (C)	B (C)										C (C)					B (C)		13.8 (26.6)	15.5 (23.2)										22.6 (31.0)					15.0 (24.5)	
Holly Springs & NC 540 EB Off LT Ramps	24		SIG		A (A)										A (A)					A (A)			3.2 (2.7)										3.6 (3.1)					3.0 (2.7)	
Holly Springs & NC 540 WB Off LT Ramps	25		SIG		B (A)										B (A)					B (A)			11.4 (4.2)										10.8 (4.0)					14.7 (5.5)	
Holly Springs & NC 540 WB Off RT Ramps	26		SIG		A (A)										A (A)					A (A)			3.6 (3.1)										4.3 (4.0)					3.7 (3.1)	
Bells Lake & NC 540 EB Ramps	30		SIG		A (A)															A (A)			3.5 (3.6)															5.8 (7.1)	
Bells Lake & NC 540 WB Ramps	31		SIG		B (A)															A (A)			13.0 (10.0)															9.3 (7.7)	
US 401 & NC 540 EB Ramps	40		SIG		B (A)										A (B)					A (A)		N/A	13.8 (6.0)										7.1 (5.6)					5.0 (9.3)	
US 401 & NC 540 WB Ramps	41		SIG		A (A)										A (A)					A (A)		N/A	12.7 (12.3)										13.1 (11.5)					7.1 (6.2)	
US 401 & Donny Brook/McCullers	42	SIG	N/A	C (B)																		28.8 (19.3)																	
US 401 & Donny Brook / Chandler / Wake Tech	43	SIG	SIG	C (B)	C (C)																	21.6 (14.3)	30.2 (27.2)																
US 401 & Ten Ten	44	SIG	SIG	***E (F)***																D ***(E)***			15.1 (9.3)										13.6 (9.8)					45.8 ***(56.8)***	
US 401 & Dwight Rowland	45	UNSIG	UNSIG	***E*** (D)											B (B)							***37.2*** (26.1)											13.9 (12.0)						
US 401 & Meadow	46	UNSIG	SIG	C (B)											B (B)							16.5 (12.7)											14.8 (11.7)						
Old Stage & NC 540 EB Ramps	50		SIG		B (B)										A (B)					A (A)			11.8 (15.3)										8.7 (12.7)					8.4 (8.7)	
Old Stage & NC 540 WB Ramps	51		SIG		B (B)										A (A)					A (A)			15.5 (12.8)										3.4 (4.1)					6.9 (5.0)	
Old Stage & Vandora Springs	52	SIG	SIG	C (C)																A (B)		22.2 (21.7)																7.5 (10.5)	
Old Stage & Norman Blalock	53	UNSIG	UNSIG	B (B)											B (B)							13.0 (12.8)											10.8 (11.0)						
Vandora Springs & Buffaloe	54	1ROUND	UNSIG	A (A)																C (C)		9.0 (9.3)																23.7 (23.4)	
NC 50 & NC 540 EB (XOVER) Ramps	60		SIG		B (B)					A					A (A)					B (B)			10.4 (14.1)					8.4					3.6 (4.8)					16.9 (15.6)	
NC 50 & NC 540 WB (XOVER) Ramps	61		SIG		B (B)					A					B (A)					B (C)			10.6 (10.8)					9.9					12.4 (7.2)					18.4 (22.9)	
NC 50 & NC 540 EB Off RT Ramps	62		SIG																	A (A)																		3.9 (7.7)	
NC 50 & NC 540 EB Off LT Ramps	63		SIG																	A (A)																		5.7 (5.5)	
NC 50 & NC 540 WB Off LT Ramps	64		SIG																	A (A)																		8.9 (8.1)	
NC 50 & NC 540 WB Off RT Ramps	65		SIG																	A (A)																		6.9 (3.1)	
NC 50 & Stevens Oaks/Cleveland	66	SIG	SIG	***E*** (C)	C (B)																	***74.8*** (33.6)	30.8 (17.6)																
NC 50 & Ten Ten	67	SIG	SIG	B (C)						B					B (B)							13.5 (22.2)						13.7					15.3 (17.8)						
White Oak & NC 540 NB Ramps	80		SIG		B (B)		B (B)		B (A)	A (A)		B (B)		A (A)	A (A)		B (B)		A (A)				11.4 (10.2)		13.3 (10.9)		10.4 (8.9)	7.8 (8.0)		13.3 (10.9)		8.9 (8.3)	7.4 (7.8)		13.2 (10.9)		8.2 (7.9)		
White Oak & NC 540 SB Ramps	81		SIG		B (B)		B (B)		B (B)	B (B)		B (B)		B (B)	B (B)		B (B)		B (B)				15.9 (15.6)		13.8 (11.0)		14.4 (13.6)	16.1 (13.5)		13.8 (11.0)		14.1 (11.8)	15.0 (13.1)		12.7 (10.4)		14.9 (13.1)		
White Oak & Raynor	82	UNSIG	UNSIG	C ***(E)***	C ***(E)***				C ***(E)***	C ***(E)***				C ***(E)***	C ***(E)***				C ***(E)***			20.6 ***(37.2)***	24.3 ***(39.5)***				23.9 ***(46.5)***	24.3 ***(39.5)***				23.9 ***(46.5)***	22.9 ***(46.5)***				22.9 ***(46.5)***		
US 70 BUS & NC 540 NB Ramps	90		SIG		A (A)		B (B)		B (B)	A (A)		B (B)		B (B)	A (A)		B (B)		B (A)				8.5 (8.8)		13.2 (15.4)		12.1 (11.5)	8.5 (8.8)		13.2 (15.4)		12.1 (11.5)	7.2 (6.2)		12.6 (14.5)		10.5 (9.7)		
US 70 BUS & NC 540 SB Ramps	91		SIG		B (B)		C (C)		B (B)	B (B)		C (C)		B (B)	B (B)		B (C)		B (B)				12.9 (12.7)		20.2 (20.5)		11.6 (11.8)	12.9 (12.7)		20.2 (20.5)		11.6 (11.8)	13.2 (12.8)		19.4 (20.1)		11.6 (12.0)		
Rock Quarry / Old Baucom & NC 540 NB Ramps	100		SIG		A (A)		A (A)		A (A)	A (A)		A (A)		A (A)	A (A)		A (A)		A (A)	A (A)			4.4 (4.4)		7.5 (9.6)		2.2 (3.2)	4.4 (4.4)		7.5 (9.6)		2.2 (3.2)	3.7 (3.7)		5.7 (6.9)		2.2 (3.2)	3.0 (3.2)	
Rock Quarry / Old Baucom & NC 540 SB Ramps	101		SIG		B (B)		A (A)		B (B)	B (B)		A (A)		B (B)	B (B)		A (A)		B (B)	B (B)			10.8 (10.3)		4.8 (5.2)		15.0 (14.4)	10.8 (10.3)		4.8 (5.2)		15.0 (14.4)	10.8 (10.9)		7.3 (8.3)		15.7 (15.0)	14.9 (14.4)	
Rock Quarry & Auburn-Knightdale	102	SIG	SIG	B (B)	A (A)					A (A)					A (A)					A (B)		14.0 (14.1)	6.7 (7.2)					6.7 (7.2)					6.4 (6.9)					9.1 (10.2)	
Rock Quarry & Old Baucom	103	UNSIG	UNSIG	B (B)	B (B)					B (B)					B (B)					C (C)		11.2 (10.9)	12.3 (13.7)					12.3 (13.7)					13.4 (15.0)					18.4 (18.5)	
Rock Quarry & Rock Quarry Extension	104		UNSIG																	C (D)																		18.5 (30.8)	
Rock Quarry Ext & US 70 BUS	105		SIG																	A (B)																		9.8 (16.2)	
Auburn-Knightdale & NC 540 NB Ramps	110		SIG		A (A)		A (A)	A (A)	A (A)	A (A)		A (A)	A (A)	A (A)	A (A)		A (A)	A (A)	A (A)	A (A)			7.0 (7.6)		3.8 (3.7)	3.5 (3.1)	5.0 (4.9)	7.0 (7.6)		3.8 (3.7)	3.5 (3.1)	5.0 (4.9)	7.5 (8.0)		3.8 (3.6)	3.5 (3.1)	5.0 (5.0)	5.5 (5.8)	
Auburn-Knightdale & NC 540 SB Ramps	111		SIG		A (A)		B (B)	B (B)	B (A)	A (A)		B (B)	B (B)	B (A)	A (A)		B (B)	B (B)	B (A)	A (A)			6.3 (6.1)		12.8 (11.8)	12.0 (11.1)	10.4 (9.6)	6.3 (6.1)		12.8 (11.8)	12.0 (11.1)	10.4 (9.6)	6.3 (6.1)		12.5 (11.6)	11.8 (10.9)	10.2 (9.4)	7.4 (6.8)	
Poole & NC 540 NB Ramps	120		SIG		A (A)		A (A)		A (A)	A (A)		A (A)		A (A)	A (A)		A (A)		A (A)	A (A)			8.8 (7.4)		8.7 (6.6)		9.0 (7.8)	8.8 (7.4)		8.7 (6.6)		9.0 (7.8)	8.6 (6.9)		7.9 (6.2)		8.7 (7.6)	8.6 (6.4)	
Poole & NC 540 SB Ramps	121		SIG		B (B)		B (A)		B (B)	B (B)		B (A)		B (B)	B (B)		B (A)		B (B)	B (A)			12.9 (10.6)		12.1 (9.8)		13.6 (10.4)	12.9 (10.6)		12.1 (9.8)		13.6 (10.4)	13.3 (10.4)		11.7 (9.1)		13.9 (10.5)	10.7 (8.5)	
Poole & Hodge	122	SIG	SIG	D ***(F)***	A (B)										A (B)					A (B)		39.5 ***(80.6)***	7.8 (12.5)										7.8 (12.2)					8.0 (12.4)	
Hilltop-Needmore & NC 540 EB Ramps	200		SIG												A (A)																		7.0 (8.1)						
Hilltop-Needmore & NC 540 WB Ramps	201		SIG												A (A)																		5.4 (3.8)						
Hilltop-Needmore & Old Mills	202	UNSIG	UNSIG	B (B)											B (B)							11.1 (11.1)											14.1 (14.0)						

Delay Measured In Seconds Per Vehicle
BOLD/ITALIC = Intersection/Approach/Movement that has Operational Deficiencies (LOS E or F)

7. 2035 DESIGN YEAR CAPACITY ANALYSIS RESULTS

This section presents future anticipated roadway network changes and capacity analysis results for the 2035 design year AM and PM peak hours for freeway facilities and intersections within the Complete 540 project study area.

7.1 Network Changes Between 2012 Scenarios and 2035 Scenarios

The following sections present the network changes between the 2012 No-Build and 2035 No-Build scenarios and the 2012 Build and 2035 Build scenarios.

7.1.1 No-Build Scenario Changes

Table 4, previously shown in Section 4.1 of this report provided updated 2035 laneage assumptions for the roadways scheduled for improvement in the 2035 LRTP. This updated laneage was applied to the 2012 No-Build roadway network analysis files to create updated 2035 No-Build scenarios. In addition, Old Stage Road from US 401 to Ten Ten Road was considered to be widened to four lanes to be consistent with the scheduled widening of Vandora Springs Road in 2035. In addition, this section of Old Stage Road is included as a four-lane section in the 2040 MTP.

7.1.2 Build DSA Scenario Changes

The updated 2035 LRTP laneage described in **Table 4** was also applied to the 2035 Build DSA scenarios.

<u>Rock Quarry Road Extension</u>
DSA 6 and 7 also include an assumption to widen the new location Rock Quarry Road Extension to a four-lane section to be consistent with the scheduled 2035 LRTP project to widen existing Rock Quarry Road, and since the Extension would provide primary access between the NC 540, Rock Quarry Road and US 70 Business.

<u>R-2635D (Western Wake Freeway and Old Holly Springs-Apex Road Interchange)</u>
Between the base year and the design year, R-2635D, also referred to as Access 540, proposes to convert the existing bridge on Old Holly Springs-Apex Road at Triangle Expressway (Toll NC 540) to a partial cloverleaf interchange and construct auxiliary lanes between US 1 and NC 55 Bypass. The project is currently scheduled to be open to traffic in 2017. R-2635D functional design plans, prepared by HNTB, were reviewed and incorporated into the freeway analysis only. A partial cloverleaf, with loop ramps in the northeast and southeast quadrants, was analyzed in FreeVal by inserting diverge and merge segments into the existing Toll NC 540 freeway network configuration. The 2035 design year No-Build and Build freeway analyses were updated from the 2012 base year to include this interchange adjacent to the Complete 540 western project termini at NC 55 Bypass.

7.2 2035 Freeway Segment Analysis Results

This analysis uses the 2035 design year No-Build and Build peak hour traffic volumes and future planned/proposed freeway geometrics to evaluate traffic operations on the Complete 540, NC 540, I-40, US 70, US 64 / US 264 and I-540 uninterrupted flow facilities in the project study area. Like the 2012 scenario evaluations presented in the previous section, this analysis determines individual freeway segment and system-wide density and LOS measures of effectiveness for No-Build and Build DSA scenarios. **Figures 3, 4, 5** and **6** provide a sheet key for the No-Build and Build DSA 1, 6 and 8 freeway segment figures. **Figures 8.1** to **8.5** schematically show 2035 design year No-Build laneage and intersection traffic control for roadways in the study area, along with the scheme for freeway segment identification numbers. **Figures 9.1** to **9.8, 10.1** to **10.0** and **11.1** to **11.8** schematically show 2035 design year Build laneage, future 2035 LRTP laneage assumptions, volumes, intersection traffic control, freeway segment identification numbers and LOS for DSAs 1, 6 and 8, respectively.

Due to there being 17 DSAs in this project, summary figures are not provided for all DSAs. As a result, DSAs 1, 6, and 8 were selected as being most representative of the corridor variations and operations in the study area. For 2035 No-Build and Build DSAs, **Tables 14, 15, 16** and **17** provide an overall summary and comparison of LOS results for the worst-case AM and PM peak hour LOS for each facility direction for basic freeway sections, merges, diverges and weaves. Detailed segment measures of effectiveness results for the worst-case AM and PM peak hour for DSA's 1, 6 and 8 are presented in **Tables 18** and **19** to provide an overall representation of projected operations for all DSAs. ***Appendix D*** contains the detailed HCS 2010 FreeVal output files and corridor summary tables for all DSAs. Individual alternative scenario results are highlighted below.

AM and PM peak hour traffic volumes and existing geometrics were entered into the HCS 2010 FreeVal software module. Since Toll NC 540, Complete 540 and I-540 will form a continuous freeway facility corridor once Complete 540 is constructed, these facility are included in the Complete 540 corridor summary **Tables 14, 18** and **19**.

7.2.1 2035 No-Build Alternative Scenario Results

Most segments along existing freeway facilities perform at an acceptable LOS D or better in the AM and PM peak hours. However, on the I-40 corridor, one (1) eastbound and one (1) westbound segment are at (LOS E) peak hour capacity. On the US 64 / US 264 corridor, six (6) eastbound and nine (9) westbound segments are at (LOS E) or exceeding (LOS F) peak hour capacity. **Figures 8.1** to **8.5** provide a schematic representation of the results for the freeway system in the project study area.

7.2.2 2035 Build – DSA 1-5, 13-17 Scenario Results

For Complete 540 DSA operations, all freeway segments, except one weaving segment in the westbound PM peak, are expected to operate at LOS D or better. For the US 70 corridor, all freeway segments are projected to operate at LOS D or better. For the I-40 corridor, results indicate that corridor operations and segment densities will slightly improve from the No-Build scenario, with all segments expected to operate at LOS D or better. On the US 64 / US 264 corridor, results indicate very similar operations compared to the No-Build scenario, with seven (7) or eight (8) eastbound and nine (9) westbound segments at (LOS E) or exceeding (LOS F) peak hour capacity. **Figures 9.1** to **9.8** provide a schematic representation of the results for the DSA 1-5 and 13-17 freeway system in the project study area.

7.2.3 2035 Build – DSA 6-7 Scenario Results

For Complete 540 DSA operations, all freeway and collector-distributor segments, except one weaving segment in the westbound PM peak, are expected to operate at LOS D or better. For the US 70 corridor, all freeway segments are projected to operate at LOS D or better. For the I-40 corridor, results indicate that corridor operations and segment densities may slightly improve from the No-Build scenario with all segments, except one westbound segment, expected to operate at LOS D or better. For the I-40 collector-distributor proposed between US 70 Business and Complete 540, all freeway segments are expected to operate at LOS D or better. On the US 64 / US 264 corridor, results indicate similar operations compared to the No-Build with nine (9) eastbound and nine (9) westbound segments at (LOS E) or exceeding (LOS F) peak hour capacity. **Figures 10.1** to **10.8** provide a schematic representation of the results for the DSA 6-7 freeway system in the project study area.

7.2.4 2035 Build – DSA 8-12 Scenario Results

For Complete 540 DSA operations, all freeway segments, except one weaving segment in the westbound PM peak, are expected to operate at LOS D or better. For the US 70 corridor, all freeway segments are projected to operate at LOS D or better. For the I-40 corridor, results indicate that corridor operations and segment densities will slightly improve from the No-Build scenario with all segments expected to operate at LOS D or better. On the US 64 / US 264 corridor, results indicate very similar operations compared to the No-Build with seven (7) or eight (8) eastbound and nine (9) westbound segments at (LOS E) or exceeding (LOS F) peak hour capacity. **Figures 11.1** to **11.8** provide a schematic representation of the results for the DSA 8-12 freeway system in the project study area.

Table 14. 2035 Design Year Complete 540
No-Build & Build Freeway Operations Summary

Scenario	Complete 540											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
No-Build	3	3	5	0	0	0	3	11	1	0	0	0
DSA 1	2	32	33	1	0	0	1	27	39	1	1	0
DSA 2	2	32	33	1	0	0	1	27	39	1	1	0
DSA 3	1	38	26	1	0	0	1	27	37	1	1	0
DSA 4	3	29	33	1	0	0	1	27	37	1	1	0
DSA 5	3	37	27	1	0	0	1	31	35	1	1	0
DSA 6*	0	14	40	2	0	0	0	34	24	0	1	0
DSA 7*	0	15	39	2	0	0	0	34	24	0	1	0
DSA 8	1	31	31	1	0	0	1	32	33	0	1	0
DSA 9	1	31	31	1	0	0	1	32	33	0	1	0
DSA 10	1	28	32	1	0	0	1	30	33	0	1	0
DSA 11	1	28	32	1	0	0	1	30	33	0	1	0
DSA 12	1	34	28	1	0	0	1	36	29	1	0	0
DSA 13	1	29	33	1	0	0	1	25	39	1	1	0
DSA 14	1	29	33	1	0	0	1	26	38	1	1	0
DSA 15	2	23	36	1	0	0	1	25	37	1	1	0
DSA 16	2	24	35	1	0	0	1	25	37	1	1	0
DSA 17	2	33	28	1	0	0	1	31	33	1	1	0

**DSA 6, 7 includes analysis of collector-distributor segment along Complete 540.*

Scenario	Complete 540 Collector-Distributor											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
DSA 6, 7	N/A	N/A	N/A	N/A	N/A	N/A	3	4	0	0	0	0

Table 15. 2035 Design Year I-40 No-Build & Build Freeway Operations Summary

Scenario	I-40											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
No-Build	0	5	8	1	1	0	0	5	10	1	1	0
DSA 1, 2	0	9	8	2	0	0	0	11	9	1	0	0
DSA 3, 4	0	6	11	2	0	0	0	11	9	1	0	0
DSA 5	0	6	11	2	0	0	0	11	9	1	0	0
DSA 6, 7*	0	2	1	4	0	0	0	1	5	0	1	0
DSA 8, 9	0	7	10	2	0	0	0	9	11	1	0	0
DSA 10, 11	0	7	10	2	0	0	0	9	11	1	0	0
DSA 12	0	7	10	2	0	0	0	9	11	1	0	0
DSA 13, 14	0	8	9	2	0	0	0	10	10	1	0	0
DSA 15, 16	0	8	9	2	0	0	0	10	10	1	0	0
DSA 17	0	8	9	2	0	0	0	10	10	1	0	0

**DSA 6, 7 also contain analysis of collector-distributor segment along I-40.*

Scenario	I-40 Collector-Distributor											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
DSA 6, 7	1	5	5	0	0	0	0	2	5	2	0	0

Table 16. 2035 Design Year US 70 No-Build & Build Freeway Operations Summary

Scenario	US 70											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
No-Build	0	5	2	0	0	0	2	3	3	0	0	0
DSA 1-2	4	1	6	0	0	0	2	1	7	0	0	0
DSA 3-4	4	2	5	0	0	0	2	1	7	0	0	0
DSA 5	4	2	5	0	0	0	2	1	7	0	0	0
DSA 6, 7*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
DSA 8, 9	1	3	5	0	0	0	3	2	5	0	0	0
DSA 10, 11	1	4	4	0	0	0	4	1	5	0	0	0
DSA 12	1	4	4	0	0	0	3	2	5	0	0	0
DSA 13, 14	1	4	4	0	0	0	3	2	5	0	0	0
DSA 15, 16	1	4	4	0	0	0	4	1	5	0	0	0
DSA 17	1	4	4	0	0	0	4	1	5	0	0	0

**DSA 6, 7 not included since proposed design does not impact US 70.*

**Table 17. 2035 Design Year US 64
No-Build & Build Freeway Operations Summary**

Scenario	US 64											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
No-Build	0	0	2	3	6	0	0	0	2	0	7	2
DSA 1, 2, 13, 14	0	0	1	4	7	1	0	1	1	2	6	3
DSA 3, 4, 15, 16	0	1	1	4	6	1	0	1	1	2	6	3
DSA 5, 17	0	0	1	4	7	1	0	1	1	2	6	3
DSA 6, 7	0	0	0	4	8	1	0	0	2	2	6	3
DSA 8, 9	0	1	1	4	6	1	0	0	2	2	7	2
DSA 10, 11	0	0	1	4	6	2	0	0	2	2	7	2
DSA 12	0	0	2	4	5	2	0	0	2	2	7	2

Table 18. 2035 AM Peak Design Year Build Freeway Operations Corridor Summary – Complete 540 DSA 1, 6 and 8

2035 Build DSA 8 Eastbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of Old Holly Springs Apex Rd	B1	13.2	B
Old Holly Springs Apex Rd	D2	16.4	B
	B3	8.9	A
	W4	7.7	A
NC 55 Bypass	B5	8.3	A
	D6	9.9	A
	B7	7.3	A
	M8	10.4	B
	B9	9.9	A
Holly Springs Rd	D10	10.5	B
	B11	8.4	A
	M12	14.2	B
	B13	13.2	B
Hilltop Needmore Rd	D14	13.8	B
	B15	12.6	B
	M16	14.4	B
	B17	13.3	B
US 401	D18	14.5	B
	B19	9.1	A
	M20	9.8	A
	B21	9.3	A
	M22	10.7	B
	B23	10	A
Old Stage Rd	D24	10.7	B
	B25	8.1	A
	M26	8.9	A
N/A			
	B27	8.4	A
NC 50	D28	8.8	A
	B29	7.8	A
	M30	10.7	B
	B31	10	A
I-40	D32	11.2	B
	B33	4.6	A
	M34	11.1	B
N/A			
	B35	11.2	B
White Oak Rd	D36	12	B
	B37	10.3	A
	M38	14.1	B
	B39	13.2	B
US 70 Business	D40	14	B
	B41	11	B
	M42	14	B
	B43	13.2	B
	M44	17.1	B
	B45	16	B
Rock Quarry Rd	D46	18.1	B
	B47	15.5	B
	M48	19.1	B
	B49	17.5	B
Auburn-Knightdale Rd	D50	20.1	C
	B51	16.8	B
	M52	19.8	B
	B53	18.2	C
Poole Rd	D54	19	B
	B55	17.4	B
	W56	24.9	C
US 64 / US 264	D57	25.7	C
	B58	15.7	B
	M59	20.1	C
	B60	19.1	C
US 64 Business	D61	20.2	C
	B62	13.3	B
	M63	23.5	C
North of US 64 Business	B64	21.9	C
N/A			
Facility		**12.6**	**B**

2035 Build DSA 6 Eastbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of Old Holly Springs Apex Rd	B1	13.9	B
Old Holly Springs Apex Rd	D2	17.5	B
	B3	8.7	A
	W4	7.7	A
NC 55 Bypass	B5	7.3	A
	D6	8.8	A
	B7	6.3	A
	M8	9.9	A
	B9	9.5	A
Holly Springs Rd	D10	10.2	B
	B11	7.6	A
	M12	12.2	B
	B13	11.4	B
Bells Lake Rd	D14	12.1	B
	B15	9.5	A
	M16	13	B
	B17	12.1	B
US 401	D18	12.8	B
	B19	10.7	A
	D20	12.6	B
	B21	8.1	A
	M22	12.8	B
	B23	12	B
Old Stage Rd	D24	12.8	B
	B25	9.3	A
	M26	12.3	B
	B27	11.6	B
	M28	13.8	B
	B29	12.7	B
NC 50	D30	13.9	B
	B31	8.3	A
	M32	12.1	B
	B33	11.3	B
I-40	D34	11.8	B
	B35	8	A
	M36	14.1	B
N/A			
	B37	13.9	B
Rock Quarry Rd	D38	14.6	B
	B39	13.4	B
	M40	18.4	B
	B41	16.9	B
Auburn-Knightdale Rd	D42	19.4	B
	B43	16	B
	M44	18.9	B
	B45	17.4	B
Poole Rd	D46	18.2	B
	B47	16.3	B
	W48	23.9	C
US 64 / US 264	D49	23.6	C
	B50	15.2	B
	M51	19	C
	B52	18.1	C
US 64 Business	D53	19.1	B
	B54	13	B
	M55	22	C
North of US 64 Business	B56	20.7	C
N/A			
Facility		**13.3**	**B**

2035 Build DSA 1 Eastbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of Old Holly Springs Apex Rd	B1	13.1	B
Old Holly Springs Apex Rd	D2	16.2	B
	B3	8.7	A
	W4	7.7	A
NC 55 Bypass	B5	7.6	A
	D6	9	A
	B7	6.6	A
	M8	9.6	A
	B9	9.2	A
Holly Springs Rd	D10	9.9	A
	B11	7.5	A
	M12	12.3	B
	B13	11.5	B
Bells Lake Rd	D14	12.1	B
	B15	11	B
	M16	14.8	B
	B17	13.7	B
US 401	D18	14.7	B
	B19	11	B
	M20	12.3	B
	B21	11.5	B
	M22	15.5	B
	B23	14.4	B
Old Stage Rd	D24	15.4	B
	B25	11.2	B
	M26	12.5	B
N/A			
	B27	11.6	B
NC 50	D28	12.4	B
	B29	9.8	A
	M30	11.7	B
	B31	11	B
I-40	D32	11.3	B
	B33	9.1	A
	D34	9.9	A
	B35	5.6	A
	M36	9.6	A
	B37	9.4	A
	M38	12.9	B
	B39	12.4	B
White Oak Rd	D40	13.1	B
	B41	11.2	B
	M42	15.3	B
	B43	14.2	B
US 70 Business	D44	15.1	B
	B45	11.7	B
	M46	14.9	B
	B47	14	B
	M48	18	B
	B49	16.8	B
Rock Quarry Rd	D50	19	B
	B51	16.3	B
	M52	19.6	B
	B53	18	C
Auburn-Knightdale Rd	D54	20.6	C
	B55	17.3	B
	M56	20.4	C
	B57	18.7	C
Poole Rd	D58	19.5	B
	B59	18	C
	W60	25.6	C
US 64 / US 264	D61	26.1	C
	B62	16.5	B
	M63	21.5	C
	B64	20.5	C
US 64 Business	D65	21.5	C
	B66	14.1	B
	M67	24.6	C
North of US 64 Business	B68	23.1	C
N/A			
Facility		**14**	**B**

Eastern Termini — COMPLETE 540 — Western Termini

2035 Build DSA 1 Westbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of Old Holly Springs Apex Rd	B137	24.2	C
Old Holly Springs Apex Rd	M136	25.5	C
	B135	16.1	B
	W134	14.4	B
NC 55 Bypass	B133	16.0	B
	M132	16.9	B
	B131	12.8	B
	D130	18.0	B
	B129	16.7	B
Holly Springs Rd	M128	18.1	B
	B127	13.9	B
	D126	20.8	C
	B125	19.3	C
Bells Lake Rd	M124	21.1	C
	B123	18.7	C
	D122	24.8	C
	B121	23.8	C
US 401	M120	25.6	C
	B119	22.4	C
	M118	24.2	C
	B117	18.8	C
	D116	24.2	C
	B115	23.2	C
N/A			
Old Stage Rd	M114	25.2	C
	B113	18.0	C
	D112	19.5	B
	B111	18.7	C
NC 50	M110	20.3	C
	B109	15.3	B
	D108	18.9	B
	B107	16.4	B
I-40	M106	17.0	B
	B105	13.1	B
	W104	12.8	B
	B103	5.6	A
	D102	13.3	B
	B101	12.0	B
White Oak Rd	M100	12.8	B
	B99	10.9	A
	D98	16.6	B
	B97	14.0	B
US 70 Business	M96	15.2	B
	B95	13.1	B
	M94	13.9	B
	B93	11.2	B
	D92	18.1	B
	B91	16.7	B
Rock Quarry Rd	M90	18.1	B
	B89	16.0	B
	D88	18.9	B
	B87	17.9	B
Auburn-Knightdale Rd	M86	19.5	B
	B85	17.1	B
	D84	19.6	B
	B83	18.7	C
Poole Rd	M82	20.3	C
	B81	17.5	B
	W80	21.4	C
US 64 / US 264	B79	13.1	B
	D78	14.7	B
	B77	12.6	B
	D76	14.7	B
	B75	14.3	B
US 64 Business	M74	15.2	B
	B73	10.2	A
	D72	15.1	B
	B71	13.2	B
	D70	16.6	B
North of US 64 Business	B69	16.0	B
Facility		**17.3**	**B**

2035 Build DSA 6 Westbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of Old Holly Springs Apex Rd	B115	20.8	C
Old Holly Springs Apex Rd	M114	22.4	C
	B113	12.5	B
	W112	11.2	B
NC 55 Bypass	B111	12.3	B
	M110	12.8	B
	B109	8.6	A
	D108	14.8	B
	B107	13.5	B
Holly Springs Rd	M106	14.5	B
	B105	10.5	A
	D104	17.1	B
	B103	15.6	B
Bells Lake Rd	M102	17.0	B
	B101	13.2	B
	D100	18.0	B
	B99	16.8	B
US 401	M98	17.9	B
	B97	11.3	B
	D96	17.5	B
	B95	14.8	B
	D94	16.3	B
	B93	15.5	B
Old Stage Rd	M92	16.9	B
	B91	12.9	B
	M90	13.8	B
	B89	12.4	B
	D88	19.4	B
	B87	17.8	B
NC 50	M86	19.4	B
	B85	11.9	B
	D84	18.0	B
	B83	16.4	B
N/A			
I-40	M82	16.7	B
	B81	10.7	A
	D80	19.2	B
	B79	17.4	B
N/A			
Rock Quarry Rd	M78	18.9	B
	B77	16.3	B
	D76	20.2	C
	B75	19.1	C
Auburn-Knightdale Rd	M74	20.9	C
	B73	18.0	C
	D72	20.5	C
	B71	19.6	C
Poole Rd	M70	21.4	C
	B69	17.9	B
	W68	22.1	C
US 64 / US 264	B67	13.5	B
	D66	14.1	B
	B65	12.3	B
	D64	14.3	B
	B63	14.0	B
US 64 Business	M62	14.8	B
	B61	10.5	A
	D60	15.1	B
	B59	13.3	B
	D58	16.3	B
North of US 64 Business	B57	15.8	B
Facility		**15.7**	**B**

2035 Build DSA 8 Westbound AM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of Old Holly Springs Apex Rd	B131	23.0	C
Old Holly Springs Apex Rd	M130	24.4	C
	B129	15.2	B
	W128	13.7	B
NC 55 Bypass	B127	15.1	B
	M126	16.0	B
	B125	13.1	B
	D124	18.1	B
	B123	16.9	B
Holly Springs Rd	M122	18.3	B
	B121	14.4	B
	D120	23.4	C
	B119	21.6	C
Hilltop Needmore Rd	M118	23.5	C
	B117	20.7	C
	D116	22.6	C
	B115	21.9	C
US 401	M114	23.8	C
	B113	20.0	C
	M112	21.6	C
	B111	15.4	B
	D110	17.3	B
	B109	16.5	B
N/A			
Old Stage Rd	M108	17.9	B
	B107	13.6	B
	D106	14.6	B
	B105	13.9	B
NC 50	M104	15.1	B
	B103	13.0	B
	D102	18.6	B
	B101	15.5	B
N/A			
I-40	M100	15.0	B
	B99	4.6	A
	D98	12.6	B
	B97	11.2	B
White Oak Rd	M96	12.0	B
	B95	10.4	A
	D94	15.7	B
	B93	13.4	B
US 70 Business	M92	14.4	B
	B91	12.6	B
	M90	13.4	B
	B89	10.8	A
	D88	17.6	B
	B87	16.2	B
Rock Quarry Rd	M86	17.5	B
	B85	15.6	B
	D84	18.9	B
	B83	17.8	B
Auburn-Knightdale Rd	M82	19.4	B
	B81	17.0	B
	D80	19.5	B
	B79	18.6	C
Poole Rd	M78	20.2	C
	B77	17.3	B
	W76	21.2	C
US 64 / US 264	B75	12.9	B
	D74	14.1	B
	B73	12.2	B
	D72	14.2	B
	B71	13.8	B
US 64 Business	M70	14.7	B
	B69	9.9	A
	D68	14.7	B
	B67	12.9	B
	D66	16.3	B
North of US 64 Business	B65	15.7	B
Facility		**16.1**	**B**

Cell Shading – Green = LOS A – D, Orange = LOS E, Red = LOS F; N/A – Analysis not applicable for comparable location or segment.

Table 19. 2035 PM Peak Design Year Build Freeway Operations Corridor Summary – Complete 540 DSA 1, 6 and 8

2035 Build DSA 8 Eastbound PM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of Old Holly Springs Apex Rd	B1	25.9	C
Old Holly Springs Apex Rd	D2	29.1	D
	B3	17.4	B
	W4	15.8	B
NC 55 Bypass	B5	15.8	B
	D6	18.4	B
	B7	15.2	B
	M8	20.4	C
	B9	19	C
Holly Springs Rd	D10	20.1	C
	B11	16.4	B
	M12	26.2	C
	B13	24.1	C
Hilltop Needmore Rd	D14	24.5	C
	B15	23.1	C
	M16	26.4	C
	B17	24.5	C
US 401	D18	25.7	C
	B19	17.5	B
	M20	19.2	B
	B21	17.9	B
	M22	20.2	C
	B23	18.6	C
Old Stage Rd	D24	19.7	B
	B25	15.6	B
	M26	17.4	B
N/A			
	B27	16	B
NC 50	D28	16.8	B
	B29	15	B
	M30	19.2	B
	B31	17.6	B
I-40	D32	20.5	C
	B33	6.5	A
	M34	13.2	B
N/A			
	B35	13.2	B
White Oak Rd	D36	14.1	B
	B37	12.2	B
	M38	16.4	B
	B39	15.3	B
US 70 Business	D40	16.2	B
	B41	12.6	B
	M42	16.4	B
	B43	15.4	B
	M44	19.5	B
	B45	18.2	C
Rock Quarry Rd	D46	20.6	C
	B47	17.6	B
	M48	21.6	C
	B49	19.8	C
Auburn-Knightdale Rd	D50	22.6	C
	B51	19	C
	M52	22.4	C
	B53	20.6	C
Poole Rd	D54	21.5	C
	B55	19.1	C
	W56	22.6	C
US 64 / US 264	D57	22	C
	B58	14.8	B
	M59	15.9	B
	B60	15.2	B
US 64 Business	D61	16.1	B
	B62	11.1	B
	M63	18.3	B
North of US 64 Business	B64	17.1	B
N/A			
Facility		**18**	**C**

2035 Build DSA 6 Eastbound PM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of Old Holly Springs Apex Rd	B1	27.5	D
Old Holly Springs Apex Rd	D2	30.7	D
	B3	17.3	B
	W4	16.1	B
NC 55 Bypass	B5	14.1	B
	D6	16.4	B
	B7	13.4	B
	M8	19.6	B
	B9	18.4	C
Holly Springs Rd	D10	19.6	B
	B11	15.3	B
	M12	22.6	C
	B13	20.7	C
Bells Lake Rd	D14	21.7	C
	B15	18.1	C
	M16	24	C
	B17	22	C
US 401	D18	23.1	C
	B19	18.6	C
	D20	21.4	C
	B21	16.1	B
	M22	22.4	C
	B23	20.6	C
Old Stage Rd	D24	21.8	C
	B25	17.2	B
	M26	23.3	C
	B27	21.5	C
	M28	25	C
	B29	23.1	C
NC 50	D30	24.5	C
	B31	16.6	B
	M32	23.2	C
	B33	21.4	C
I-40	D34	22.6	C
	B35	15.4	B
	M36	23.3	C
N/A			
	B37	22.6	C
Rock Quarry Rd	D38	23.3	C
	B39	21.3	C
	M40	26.6	C
	B41	24.7	C
Auburn-Knightdale Rd	D42	27.2	C
	B43	23.3	C
	M44	27.1	C
	B45	25.3	C
Poole Rd	D46	25.6	C
	B47	23	C
	W48	26.9	C
US 64 / US 264	D49	24.9	C
	B50	18.2	C
	M51	18.3	C
	B52	17.5	B
US 64 Business	D53	18.2	B
	B54	13.7	B
	M55	20.7	C
North of US 64 Business	B56	19.6	C
N/A			
Facility		**20.8**	**C**

2035 Build DSA 1 Eastbound PM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of Old Holly Springs Apex Rd	B1	25.5	C
Old Holly Springs Apex Rd	D2	28.8	D
	B3	17.1	B
	W4	16	B
NC 55 Bypass	B5	14.4	B
	D6	16.8	B
	B7	13.8	B
	M8	18.8	B
	B9	17.6	B
Holly Springs Rd	D10	18.8	B
	B11	14.8	B
	M12	22.1	C
	B13	20.3	C
Bells Lake Rd	D14	21	C
	B15	19.6	C
	M16	27	C
	B17	25	C
US 401	D18	25.8	C
	B19	19.8	C
	M20	22.6	C
	B21	20.9	C
	M22	26.2	C
	B23	24.4	C
Old Stage Rd	D24	25.4	C
	B25	19	C
	M26	21.5	C
N/A			
	B27	19.6	C
NC 50	D28	20.9	C
	B29	16.1	B
	M30	18.9	B
	B31	17.4	B
I-40	D32	18.2	B
	B33	14.1	B
	D34	15.9	B
	B35	6.1	A
	M36	10.8	B
	B37	10.6	A
	M38	13.4	B
	B39	12.9	B
White Oak Rd	D40	13.4	B
	B41	11.7	B
	M42	16	B
	B43	14.9	B
US 70 Business	D44	15.9	B
	B45	12	B
	M46	15.7	B
	B47	14.8	B
	M48	18.9	B
	B49	17.6	B
Rock Quarry Rd	D50	19.9	B
	B51	17	B
	M52	20.5	C
	B53	18.8	C
Auburn-Knightdale Rd	D54	21.4	C
	B55	18	C
	M56	21.3	C
	B57	19.6	C
Poole Rd	D58	20.4	C
	B59	18.1	C
	W60	21.6	C
US 64 / US 264	D61	20.7	C
	B62	13.9	B
	M63	16	B
	B64	14.9	B
US 64 Business	D65	15.9	B
	B66	10.7	A
	M67	17.8	B
North of US 64 Business	B68	16.6	B
N/A			
Facility		**18.3**	**C**

COMPLETE 540 — Eastern Termini / Western Termini

2035 Build DSA 1 Westbound PM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of Old Holly Springs Apex Rd	B137	15.6	B
Old Holly Springs Apex Rd	M136	16.6	B
	B135	11.2	B
	W134	8.7	A
NC 55 Bypass	B133	10.7	A
	M132	11.1	B
	B131	9.3	A
	D130	13.3	B
	B129	12.1	B
Holly Springs Rd	M128	12.7	B
	B127	10.3	A
	D126	15.8	B
	B125	14.2	B
Bells Lake Rd	M124	15.3	B
	B123	13.8	B
	D122	17.9	B
	B121	16.4	B
US 401	M120	17.8	B
	B119	15.5	B
	M118	16.5	B
	B117	13.8	B
	D116	18.7	B
	B115	17.0	B
N/A			
Old Stage Rd	M114	18.2	B
	B113	13.8	B
	D112	15.4	B
	B111	14.3	B
NC 50	M110	15.3	B
	B109	12.6	B
	D108	15.4	B
	B107	13.7	B
I-40	M106	14.1	B
	B105	11.8	B
	W104	13.7	B
	B103	8.9	A
	D102	17.0	B
	B101	15.0	B
White Oak Rd	M100	16.1	B
	B99	13.8	B
	D98	19.2	B
	B97	16.8	B
US 70 Business	M96	18.2	B
	B95	15.8	B
	M94	16.8	B
	B93	14.4	B
	D92	21.3	C
	B91	19.3	C
Rock Quarry Rd	M90	21.0	C
	B89	18.8	C
	D88	22.1	C
	B87	20.6	C
Auburn-Knightdale Rd	M86	22.5	C
	B85	19.8	C
	D84	22.8	C
	B83	21.4	C
Poole Rd	M82	23.3	C
	B81	20.8	C
	W80	36.9	E
US 64 / US 264	B79	19.4	C
	D78	24.0	C
	B77	20.9	C
	D76	22.8	C
	B75	23.1	C
US 64 Business	M74	23.8	C
	B73	16.2	B
	D72	24.2	C
	B71	22.1	C
	D70	25.3	C
North of US 64 Business	B69	26.0	D
Facility		**16.9**	**B**

2035 Build DSA 6 Westbound PM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of Old Holly Springs Apex Rd	B115	18.8	C
Old Holly Springs Apex Rd	M114	19.9	B
	B113	13.0	B
	W112	10.2	B
NC 55 Bypass	B111	12.5	B
	M110	13.1	B
	B109	11.1	B
	D108	15.6	B
	B107	14.2	B
Holly Springs Rd	M106	15.1	B
	B105	12.3	B
	D104	17.8	B
	B103	16.1	B
Bells Lake Rd	M102	17.3	B
	B101	14.2	B
	D100	18.2	B
	B99	16.7	B
US 401	M98	17.5	B
	B97	12.9	B
	D96	18.8	B
	B95	16.4	B
	D94	17.7	B
	B93	16.6	B
Old Stage Rd	M92	17.8	B
	B91	14.4	B
	M90	15.5	B
	B89	14.0	B
	D88	19.2	B
	B87	17.5	B
NC 50	M86	18.7	B
	B85	13.0	B
	D84	17.5	B
	B83	16.1	B
N/A			
I-40	M82	16.5	B
	B81	12.7	B
	D80	20.8	C
	B79	18.6	C
N/A			
Rock Quarry Rd	M78	20.2	C
	B77	18.1	C
	D76	23.5	C
	B75	21.8	C
Auburn-Knightdale Rd	M74	23.7	C
	B73	20.7	C
	D72	23.5	C
	B71	22.2	C
Poole Rd	M70	24.1	C
	B69	21.1	C
	W68	36.6	E
US 64 / US 264	B67	20.2	C
	D66	22.8	C
	B65	20.2	C
	D64	22.3	C
	B63	22.4	C
US 64 Business	M62	23.1	C
	B61	16.5	B
	D60	24.0	C
	B59	22.1	C
	D58	24.8	C
North of US 64 Business	B57	25.5	C
Facility		**18.1**	**C**

2035 Build DSA 8 Westbound PM

Location	Segment ID	Density (pc/mi/ln)	LOS
West of Old Holly Springs Apex Rd	B131	16.4	B
Old Holly Springs Apex Rd	M130	17.4	B
	B129	11.9	B
	W128	9.6	A
NC 55 Bypass	B127	11.2	B
	M126	11.8	B
	B125	10.5	A
	D124	14.5	B
	B123	13.2	B
Holly Springs Rd	M122	14.1	B
	B121	11.6	B
	D120	18.4	B
	B119	16.5	B
Hilltop Needmore Rd	M118	17.9	B
	B117	15.9	B
	D116	17.7	B
	B115	16.5	B
US 401	M114	17.8	B
	B113	14.8	B
	M112	15.6	B
	B111	12.3	B
	D110	14.3	B
	B109	13.3	B
N/A			
Old Stage Rd	M108	14.1	B
	B107	11.4	B
	D106	12.4	B
	B105	11.6	B
NC 50	M104	12.4	B
	B103	11.0	B
	D102	15.2	B
	B101	13.3	B
N/A			
I-40	M100	13.0	B
	B99	7.7	A
	D98	16.4	B
	B97	14.3	B
White Oak Rd	M96	15.3	B
	B95	13.5	B
	D94	18.6	B
	B93	16.3	B
US 70 Business	M92	17.6	B
	B91	15.6	B
	M90	16.5	B
	B89	14.1	B
	D88	21.0	C
	B87	19.0	C
Rock Quarry Rd	M86	20.7	C
	B85	18.5	C
	D84	22.2	C
	B83	20.7	C
Auburn-Knightdale Rd	M82	22.5	C
	B81	19.9	C
	D80	22.7	C
	B79	21.3	C
Poole Rd	M78	23.2	C
	B77	20.7	C
	W76	36.3	E
US 64 / US 264	B75	19.1	C
	D74	22.9	C
	B73	20.0	C
	D72	22.1	C
	B71	22.1	C
US 64 Business	M70	22.9	C
	B69	15.7	B
	D68	23.7	C
	B67	21.5	C
	D66	24.7	C
North of US 64 Business	B65	25.2	C
Facility		**16.1**	**B**

Cell Shading – Green = LOS A – D, Orange = LOS E, Red = LOS F; N/A – Analysis not applicable for comparable location or segment.

7.3 2035 Design Year Intersection Capacity Analysis Results

The following sections provide descriptions and tabular results for intersection capacity analyses for all project study area intersections. LOS results and additional signalized intersection details for these scenarios are found in the raw Synchro output sheets in ***Appendix F***. In the 2035 design year, the project study area is expected to contain five No-Build and four Build DSA unsignalized two-way stop-controlled intersections – these capacity analysis output sheets are found in ***Appendix G. Appendix H*** contains the SIDRA analysis output reports for the two-lane roundabout currently located at Vandora Springs Road and Buffaloe Road and analyzed in the 2035 No-Build scenario. The anticipated changes to the study area at-grade intersections between the 2012 and 2035 analysis years are listed below:

- <u>Intersection control changes between 2012 and 2035 No-Build scenarios</u>
  - Ramp terminal intersections at the interchange of NC 540 and NC 55 Bypass converted from unsignalized to signalized control.
  - Single-lane roundabout at Vandora Springs Road and Buffaloe Road converted to two-lane roundabout with 2035 LRTP widening of Vandora Springs Road.
  - White Oak Road was analyzed as a two-lane and four-lane section in 2012 and 2035, respectively, per the LRTP. This intersection is expected to operate at LOS F in the 2035 No-Build scenario as an unsignalized intersection. Per HCS Peak Hour Signal Warrants Analysis module results in ***Appendix I***, this intersection meets the MUTCD peak hour signal warrant threshold in 2035, and therefore was analyzed as a signalized intersection in the 2035 No-Build scenarios.
- <u>Intersection control changes between 2012 and 2035 Build DSA scenarios</u>
  - At the future proposed intersection of Rock Quarry Road and Rock Quarry Road Extension, the worst case critical movement (westbound left-turn) is expected to operate at a LOS F by 2035 in the PM peak hour. Per the HCS Peak Hour Signal Warrants Analysis module results in ***Appendix I***, this intersection meets the MUTCD peak hour signal warrant threshold in 2035, and therefore was analyzed as a signalized intersection in the 2035 Build DSAs 6-7 scenarios. This intersection may operate acceptably as an unsignalized intersection in the interim years prior to 2035, so consideration should be given to operating this intersection as unsignalized if constructed and monitor it for future signalization. Based on the capacity analysis results, the intersection of Rock Quarry Road and Rock Quarry Road Extension is expected to operate at LOS B as a signalized intersection in 2035.
  - In the 2035 Build DSA 6-7 scenarios, the intersection of Vandora Springs Road and Buffaloe Road was converted from a two-lane roundabout in the No-Build scenario to a signalized intersection, due to the relocation of this intersection in the Build design. Preliminary design files indicated that this intersection would become a three-legged, unsignalized, T-intersection in the Build DSAs 6-7 scenarios, and it was analyzed with these assumptions. Based on the analysis results, the unsignalized intersection of Vandora Springs Road and Buffaloe Road is expected to operate at a LOS F in 2035. Per the HCS Peak Hour Signal Warrants Analysis module results in ***Appendix I***, this intersection meets the MUTCD peak hour signal warrant threshold with 2035 traffic volume projections, and therefore was analyzed as a signalized intersection in the 2035 Build DSAs 6-7 scenarios.

- o The White Oak Road and Raynor Road intersection was assume to be converted from two-way stop control to signalized control between the 2012 and 2035 analysis years. This intersection is expected to operate at a LOS F in the 2035 Build DSA scenarios as an unsignalized intersection. Per the HCS Peak Hour Signal Warrants Analysis module results in ***Appendix I***, this intersection meets the MUTCD peak hour signal warrant threshold in 2035, and therefore was analyzed as a signalized intersection in the 2035 Build DSA scenarios. This intersection may operate acceptably as an unsignalized intersection in the interim years prior to 2035. Consideration should be given to operating this intersection as unsignalized and monitor it for future signalization.

A tabular results summary for all 2035 design year alternative scenarios is found in **Table 20**.

For all Build DSAs, optimized signal cycle lengths were held constant at locations where the interchange forms were identical, to provide a meaningful comparison between the Build DSAs alternatives. The splits for each phase were re-optimized based on the specific Build DSA traffic forecast volumes.

7.3.1 2035 No-Build Alternative Scenario Results

For the 2035 No-Build alternative AM and PM peak hour scenarios, 7 out of the 16 analyzed intersections are projected to operate at adequate levels of service in the AM and PM peak hours. Re-optimization of all signal timings was employed in the 2035 No-Build alternative analyses. Specific intersections that experience deficient overall LOS in at least one peak hour include:

- US 401 and Ten Ten Road operates at overall intersection LOS F in both the AM and PM peak hours, due to high vehicular delays for left-turn and through movements.
- US 401 and Dwight Rowland Road operates at LOS F in both the AM and PM peak hours, due to the westbound left-turn movement from US 401 to Dwight Rowland Road operating at LOS F.
- Poole Road and Hodge Road operates at overall intersection LOS F in both the AM and PM peak hours, due to high delays for left-turn and through movements.
- US 401 and Donny Brook Road / McCullers Road operates at LOS F in the AM and LOS E in the PM peak hour, due to high delays for left-turn and US 401 through movements.
- The existing intersection of Vandora Springs Road and Buffaloe Road is currently a single-lane roundabout that operates at LOS A in the 2012 No-Build scenario. Vandora Springs Road was analyzed as a four-lane section in 2035 per the LRTP, while Buffaloe Road remained a two-lane section. Based on the analysis, the two-lane roundabout intersection is expected to operate as LOS F in the 2035 No-Build AM peak hour due to high delays for the Buffaloe Road approach.
- Old Stage Road and Vandora Springs Road operates at LOS E in the AM peak hour, due to the northbound Old Stage through movement and southbound Old Stage left-turn movement being over capacity.
- Old Stage Road and Norman Blalock Road is projected to experience LOS E in the AM peak hour, due to the eastbound shared left/through/right movement on Norman Blalock Road operating at LOS E.

- US 401 and Wake Tech Drive / Chandler Ridge Circle operates at LOS E in the AM peak hour, due to limited capacity for the US 401 northbound through movement and the movements entering and exiting the Wake Tech campus.
- Rock Quarry Road and Auburn-Knightdale Road operates at LOS E in the AM peak hour, because of high delays for left-turn movements from Rock Quarry Road and insufficient capacity for the northbound through movement on Auburn-Knightdale Road.

Traffic volumes, laneage, and overall intersection LOS results are also found in **Figures 8.1** to **8.5** for the study area intersections in the 2035 No-Build alternative scenario.

7.3.2 2035 Build – DSA 1-5, 13-17 Scenario Results

For the 2035 Build DSA 1-5, 13-17 AM and PM peak hour scenarios, it was assumed that all existing signalized intersections in the project study area would be re-optimized, to reflect anticipated traffic volume changes that were included in the Complete 540 traffic forecast data. These volume changes had a positive effect on operations at the Rock Quarry Road and Auburn-Knightdale Road intersection (DSAs 1-2 and 13-14 only), with AM and PM peak hour LOS improving to LOS B versus LOS E in the AM peak in the 2035 No-Build scenario. The updated traffic volumes also slightly improved operations at Poole Road and Hodge Road, but the intersection still experiences LOS E in the AM peak hour. Operations at the intersection of re-routed Donny Brook Road/Chandler Ridge Circle/Wake Tech Drive and US 401 deteriorated from LOS E in the AM and LOS D in the PM in the No-Build to LOS F in both the AM and PM peak hours. The addition of the eastbound Donny Brook Road traffic to the eastbound Chandler Ridge Circle traffic in the Build DSA 1-5 and 13-17 scenarios resulted in increased delay at this intersection. No other intersections, including the ramp terminal intersections added in the Build DSA 1-5 and 13-17 scenarios, would be expected to operate at an overall LOS E or LOS F in the 2035 design year.

Traffic volumes, laneage, and overall intersection LOS results are shown in **Figures 9.1 to 9.8** for the study area intersections in the 2035 Build DSA 1 scenario.

7.3.3 2035 Build – DSA 6-7 Scenario Results

In the 2035 Build DSA 6-7 AM and PM peak hour scenarios, the splits for each phase were re-optimized based on the 2035 Build DSA 6-7 traffic forecast volumes. These updates slightly improved operations at Poole Road and Hodge Road, but the intersection still experiences LOS E in the AM peak hour.

In the 2035 Build DSA 6-7 scenarios the intersection of Vandora Springs Road and Buffaloe Road was converted from a two-lane roundabout in the No-Build to a signalized intersection due to the relocation of this intersection in the Build. This intersection may operate acceptably as an unsignalized intersection in the interim years prior to 2035. However, consideration should be given to operating this intersection as unsignalized and monitoring for future signalization. Based on the analysis, the intersection of Vandora Springs Road and Buffaloe Road is expected to operate at LOS B as a signalized intersection in 2035.

At US 401 and Ten Ten Road, the overall intersection LOS in the AM and PM peak hours remained at LOS F as compared to the No-Build, with high delays persisting at the Ten Ten Road approaches. Old Stage Road and Vandora Springs Road also continued to operate at LOS E in the AM peak in the Build DSA 6-7 scenarios. Operations for the stop-controlled westbound left-turn movement from Old Baucom Road to Rock Quarry Road deteriorated from LOS C in the No-Build to LOS E in the Build DSA 6-7 scenarios during the PM peak hour. No other intersections, including the ramp terminal intersections added in the Build DSA 6-7 scenarios, would be expected to operate at an overall LOS E or LOS F in 2035.

Traffic volumes, laneage, and overall intersection LOS results are shown in **Figures 10.1** to **10.8** for the study area intersections in the 2035 Build DSA 6 scenario.

7.3.4 2035 Build – DSA 8-12 Scenario Results

In the 2035 Build DSA 8-12 AM and PM peak hour scenarios, the splits for each phase were re-optimized based on the 2035 Build DSA 8-12 traffic forecast volumes. These updates slightly improved operations at Poole Road and Hodge Road, but the intersection still experiences LOS E in the AM peak hour.

These updates had a positive effect on operations at the US 401 and Dwight Rowland Road intersection, with AM and PM peak hour LOS improving to LOS C or better. The intersection of US 401 and Meadow Drive was converted from two-way stop control in the 2035 No-Build to signalized control in the 2035 Build due to the 2035 Build volumes satisfying the peak hour signal warrant. These volume changes also had a positive effect on operations at the Rock Quarry Road and Auburn-Knightdale Road intersection (DSAs 8-9 only), with AM and PM peak hour LOS improving to LOS B versus LOS E in the AM peak in the 2035 No-Build scenario. AM peak operations for the eastbound shared left/through/right movement at Old Stage Road and Norman Blalock Road also improved from LOS E in the No-Build to LOS B in the Build. No other intersections, including the ramp terminal intersections added in the Build DSA 8-12 scenarios, would be expected to operate at an overall LOS E or LOS F in 2035.

Traffic volumes, laneage, and overall intersection LOS results are shown in **Figures 11.1** to **11.8** for the study area intersections in the 2035 Build DSA 8 scenario.

Table 20. 2035 AM & (PM) Peak Hour No-Build Intersection Capacity Analysis Results Summary

				LOS																	
					2035 Build																
Intersection	**Intersection #**	**2035 NB**	**2035 B**	**2035 NB**	**1**	**2**	**3**	**4**	**5**	**13**	**14**	**15**	**16**	**17**	**8**	**9**	**10**	**11**	**12**	**6**	**7**
NC 55 BYP & NC 540 EB Ramps	10	UNSIG	SIG	N/A	D (A)										D (A)					D (A)	
NC 55 BYP & NC 540 WB Ramps	11	UNSIG	SIG	N/A	C (C)										D (D)					D (D)	
Holly Springs & NC 540 EB (XOVER) Ramps	20		SIG		C (C)										C (C)					D (C)	
Holly Springs & NC 540 WB (XOVER) Ramps	21		SIG		C (C)										C (C)					C (C)	
Holly Springs & NC 540 EB Off RT Ramps	22		SIG		A (B)										A (A)					A (B)	
Holly Springs & Kildaire Farm	23	SIG	SIG	C (D)	C (C)										C (D)					C (D)	
Holly Springs & NC 540 EB Off LT Ramps	24		SIG		A (A)										A (A)					A (A)	
Holly Springs & NC 540 WB Off LT Ramps	25		SIG		B (B)										B (B)					A (B)	
Holly Springs & NC 540 WB Off RT Ramps	26		SIG		A (A)										B (A)					A (A)	
Bells Lake & NC 540 EB Ramps	30		SIG		A (B)															C (D)	
Bells Lake & NC 540 WB Ramps	31		SIG		B (B)															C (B)	
US 401 & NC 540 EB Ramps	40		SIG		D (D)										B (B)					B (C)	
US 401 & NC 540 WB Ramps	41		SIG		C (C)										A (A)					C (B)	
US 401 & Donny Brook/McCullers	42	SIG	N/A	***F (E)***																	
US 401 & Donny Brook / Chandler / Wake	43	SIG	SIG	***E*** (D)	***F (F)***																
US 401 & Ten Ten	44	SIG	SIG	***F (F)***																***F (F)***	
US 401 & Dwight Rowland	45	UNSIG	UNSIG	***F (F)***											C (B)						
US 401 & Meadow	46	UNSIG	SIG	C (B)											D (B)						
Old Stage & NC 540 EB Ramps	50		SIG		B (B)										B (C)					B (B)	
Old Stage & NC 540 WB Ramps	51		SIG		C (B)										B (B)					C (D)	
Old Stage & Vandora Springs	52	SIG	SIG	***E*** (D)																***E*** (D)	
Old Stage & Norman Blalock	53	UNSIG	UNSIG	***E*** (D)											B (B)						
Vandora Springs & Buffaloe	54	2ROUND	SIG	***F*** (D)																B (B)	
NC 50 & NC 540 EB (XOVER) Ramps	60		SIG		B (C)					B (C)					B (B)					C (C)	
NC 50 & NC 540 WB (XOVER) Ramps	61		SIG		A (B)					B (B)					B (B)					D (D)	
NC 50 & NC 540 EB Off RT Ramps	62		SIG																	A (B)	
NC 50 & NC 540 EB Off LT Ramps	63		SIG																	B (B)	
NC 50 & NC 540 WB Off LT Ramps	64		SIG																	B (B)	
NC 50 & NC 540 WB Off RT Ramps	65		SIG																	B (A)	
NC 50 & Stevens Oaks/Cleveland	66	SIG	SIG	C (B)	C (B)																
NC 50 & Ten Ten	67	SIG	SIG	B (B)						B (B)					B (C)						
White Oak & NC 540 NB Ramps	80		SIG		B (B)		B (B)		B (B)	B (A)		B (B)		B (B)	A (B)		B (B)		A (B)		
White Oak & NC 540 SB Ramps	81		SIG		B (B)		B (B)		B (B)	B (B)		B (B)		B (B)	B (B)		B (B)		B (B)		
White Oak & Raynor	82	SIG	SIG	C (C)	A (B)				A (B)	A (B)				A (B)	A (B)				A (B)		
US 70 BUS & NC 540 NB Ramps	90		SIG		B (C)		C (C)		C (C)	B (C)		C (C)		C (C)	B (C)		C (C)		C (C)		
US 70 BUS & NC 540 SB Ramps	91		SIG		D (D)		C (C)		D (D)	D (D)		C (C)		D (D)	D (D)		C (C)		D (D)		
Rock Quarry / Old Baucom & NC 540 NB	100		SIG		B (B)		A (A)		A (A)	B (B)		A (A)		A (A)	B (B)		A (A)		A (A)	B (B)	
Rock Quarry / Old Baucom & NC 540 SB	101		SIG		B (B)		A (A)		B (B)	B (B)		A (A)		B (B)	B (B)		B (A)		B (B)	C (C)	
Rock Quarry & Auburn-Knightdale	102	SIG	SIG	***E*** (D)	B (B)					B (B)					B (B)					B (B)	
Rock Quarry & Old Baucom	103	UNSIG	UNSIG	C (C)	C (D)					C (D)					C (D)					D ***(E)***	
Rock Quarry & Rock Quarry Extension	104		SIG																	B (B)	
Rock Quarry Ext & US 70 BUS	105		SIG																	C (D)	
Auburn-Knightdale & NC 540 NB Ramps	110		SIG		B (B)		B (B)	A (A)	A (A)	B (B)		B (B)	A (A)	A (A)	B (B)		B (B)	A (A)	A (A)	B (B)	
Auburn-Knightdale & NC 540 SB Ramps	111		SIG		B (B)		B (B)	B (B)	B (B)	B (B)		B (B)	B (B)	B (B)	B (B)		B (B)	B (B)	B (B)	B (B)	
Poole & NC 540 NB Ramps	120		SIG		C (C)		C (B)		C (C)	C (C)		C (B)		C (C)	C (C)		C (B)		C (C)	C (C)	
Poole & NC 540 SB Ramps	121		SIG		B (B)		B (B)		B (B)	B (B)		B (B)		B (B)	B (B)		B (B)		B (B)	B (B)	
Poole & Hodge	122	SIG	SIG	***F (F)***	***E*** (D)										***E*** (D)					***E*** (D)	
Hilltop-Needmore & NC 540 EB Ramps	200		SIG												A (A)						
Hilltop-Needmore & NC 540 WB Ramps	201		SIG												A (A)						
Hilltop-Needmore & Old Mills	202	UNSIG	UNSIG	B (B)											C (C)						

		DELAY																	
			2035 Build																
Intersection	**Intersection #**	**2035 NB**	**1**	**2**	**3**	**4**	**5**	**13**	**14**	**15**	**16**	**17**	**8**	**9**	**10**	**11**	**12**	**6**	**7**
NC 55 BYP & NC 540 EB Ramps	10	N/A	46.5 (7.0)										41.5 (7.0)					55.0 (9.4)	
NC 55 BYP & NC 540 WB Ramps	11	N/A	28.4 (27.3)										48.7 (44.4)					46.7 (46.4)	
Holly Springs & NC 540 EB (XOVER) Ramps	20		25.7 (28.3)										21.2 (20.7)					35.0 (30.4)	
Holly Springs & NC 540 WB (XOVER) Ramps	21		20.3 (25.4)										20.3 (26.3)					21.1 (26.8)	
Holly Springs & NC 540 EB Off RT Ramps	22		7.1 (13.0)										2.4 (6.0)					8.0 (15.0)	
Holly Springs & Kildaire Farm	23	29.3 (41.8)	29.0 (30.9)										31.1 (44.7)					26.4 (42.4)	
Holly Springs & NC 540 EB Off LT Ramps	24		1.7 (2.1)										1.8 (2.3)					2.5 (2.3)	
Holly Springs & NC 540 WB Off LT Ramps	25		11.3 (14.9)										11.4 (12.8)					9.8 (14.8)	
Holly Springs & NC 540 WB Off RT Ramps	26		8.3 (4.2)										13.9 (6.5)					7.1 (3.3)	
Bells Lake & NC 540 EB Ramps	30		9.1 (10.7)															20.2 (36.6)	
Bells Lake & NC 540 WB Ramps	31		16.9 (11.9)															23.0 (18.0)	
US 401 & NC 540 EB Ramps	40		46.8 (54.9)										14.5 (17.4)					11.1 (29.8)	
US 401 & NC 540 WB Ramps	41		24.1 (24.8)										6.6 (9.3)					24.3 (10.9)	
US 401 & Donny Brook/McCullers	42	***124.2 (63.1)***																	
US 401 & Donny Brook / Chandler / Wake	43	***71.8*** (39.7)	***221.9 (153.3)***																
US 401 & Ten Ten	44	***138.0 (145.3)***																***160.3 (145.4)***	
US 401 & Dwight Rowland	45	***428.8 (108.0)***											24.8 (13.8)						
US 401 & Meadow	46	17.4 (13.3)											46.8 (19.1)						
Old Stage & NC 540 EB Ramps	50		16.5 (18.6)										16.7 (20.7)					17.9 (19.7)	
Old Stage & NC 540 WB Ramps	51		23.8 (19.6)										15.6 (14.7)					31.4 (35.9)	
Old Stage & Vandora Springs	52	***59.8*** (41.6)																***69.5*** (39.7)	
Old Stage & Norman Blalock	53	***39.0*** (28.5)											13.5 (13.7)						
Vandora Springs & Buffaloe	54	***51.7*** (28.5)																16.3 (14.2)	
NC 50 & NC 540 EB (XOVER) Ramps	60		16.8 (30.7)					10.8 (22.8)					10.7 (16.0)					34.9 (22.7)	
NC 50 & NC 540 WB (XOVER) Ramps	61		9.4 (12.3)					10.8 (13.5)					15.2 (15.4)					45.1 (36.4)	
NC 50 & NC 540 EB Off RT Ramps	62																	9.2 (18.9)	
NC 50 & NC 540 EB Off LT Ramps	63																	17.7 (10.7)	
NC 50 & NC 540 WB Off LT Ramps	64																	10.9 (14.5)	
NC 50 & NC 540 WB Off RT Ramps	65																	17.1 (3.2)	
NC 50 & Stevens Oaks/Cleveland	66	25.8 (19.8)	29.2 (15.7)																
NC 50 & Ten Ten	67	13.3 (16.3)						14.5 (16.8)					18.0 (21.1)						
White Oak & NC 540 NB Ramps	80		14.8 (13.2)		15.8 (12.1)		13.5 (12.2)	10.7 (9.6)		15.8 (12.1)		10.8 (10.1)	9.6 (10.8)		15.1 (12.1)		9.6 (10.0)		
White Oak & NC 540 SB Ramps	81		14.4 (15.1)		18.0 (16.4)		13.0 (12.4)	17.6 (13.4)		18.0 (16.4)		16.0 (13.2)	16.2 (12.5)		16.7 (15.7)		14.4 (11.8)		
White Oak & Raynor	82	24.2 (26.1)	8.4 (15.3)				9.5 (16.7)	8.2 (15.9)				8.6 (15.9)	7.9 (15.7)				8.2 (16.1)		
US 70 BUS & NC 540 NB Ramps	90		18.3 (24.5)		25.1 (29.9)		21.9 (27.6)	18.3 (24.5)		25.1 (29.9)		21.9 (27.6)	18.5 (24.5)		25.9 (30.9)		21.6 (27.9)		
US 70 BUS & NC 540 SB Ramps	91		36.3 (37.8)		28.1 (30.6)		45.5 (40.3)	36.3 (37.8)		28.1 (30.6)		45.5 (40.3)	35.9 (40.2)		28.7 (31.7)		45.9 (21.1)		
Rock Quarry / Old Baucom & NC 540 NB	100		13.2 (12.3)		5.3 (5.4)		3.2 (5.4)	13.2 (12.3)		5.3 (5.4)		3.2 (5.4)	14.5 (12.9)		4.9 (5.3)		3.2 (6.3)	10.6 (12.7)	
Rock Quarry / Old Baucom & NC 540 SB	101		12.5 (12.2)		7.3 (7.4)		14.5 (15.5)	12.5 (12.2)		7.3 (7.4)		14.5 (15.5)	13.8 (13.5)		10.3 (9.8)		15.4 (16.6)	20.8 (24.0)	
Rock Quarry & Auburn-Knightdale	102	***57.0*** (43.6)	16.8 (16.2)					16.8 (16.2)					16.0 (16.1)					14.6 (16.4)	
Rock Quarry & Old Baucom	103	24.1 (22.5)	18.2 (28.4)					18.2 (28.4)					17.4 (26.1)					27.2 ***(44.6)***	
Rock Quarry & Rock Quarry Extension	104																	17.8 (15.3)	
Rock Quarry Ext & US 70 BUS	105																	26.9 (47.6)	
Auburn-Knightdale & NC 540 NB Ramps	110		17.1 (17.2)		14.0 (13.0)	4.0 (3.6)	4.0 (3.9)	17.1 (17.2)		14.0 (13.0)	4.0 (3.6)	4.0 (3.9)	17.5 (17.6)		14.2 (13.2)	3.9 (3.6)	4.1 (3.9)	19.0 (19.3)	
Auburn-Knightdale & NC 540 SB Ramps	111		13.9 (13.8)		18.9 (19.2)	15.3 (15.5)	12.9 (12.8)	13.9 (13.8)		18.9 (19.2)	15.3 (15.5)	12.9 (12.8)	13.8 (13.7)		18.6 (19.0)	15.4 (15.5)	12.7 (12.5)	13.4 (13.4)	
Poole & NC 540 NB Ramps	120		24.6 (20.6)		22.3 (19.6)		24.8 (20.7)	24.6 (20.6)		22.3 (19.6)		24.8 (20.7)	24.4 (20.8)		22.6 (19.9)		24.3 (21.1)	26.2 (24.9)	
Poole & NC 540 SB Ramps	121		15.4 (18.4)		15.8 (17.2)		15.5 (18.3)	15.4 (18.4)		15.8 (17.2)		15.5 (18.3)	15.5 (18.3)		15.8 (17.3)		16.5 (18.1)	14.9 (18.0)	
Poole & Hodge	122	***242.5 (125.9)***	***67.7*** (40.8)										***68.5*** (41.3)					***68.3*** (42.6)	
Hilltop-Needmore & NC 540 EB Ramps	200												6.6 (7.9)						
Hilltop-Needmore & NC 540 WB Ramps	201												9.1 (6.4)						
Hilltop-Needmore & Old Mills	202	12.4 (12.6)											20.4 (22.6)						

Delay Measured In Seconds Per Vehicle
BOLD/ITALIC = Intersection/Approach/Movement that has Operational Deficiencies (LOS E or F)

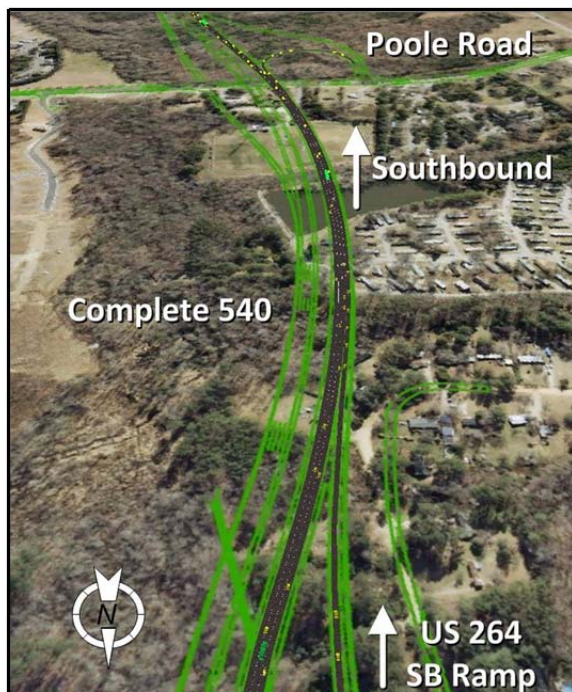
8. Microsimulation Operations Analysis

Initial 2035 PM peak hour HCS-FreeVal results at the northern/eastern project termini for the southbound Complete 540 weaving segment from US 64/US 264 to Poole Road produced densities that correspond to LOS D or E for Build DSAs 1-17. No other Complete 540 freeway segments resulted in LOS E or F in the 2035 design year. To further investigate and assess expected freeway system performance in this area, a 2035 PM peak hour traffic microsimulation model was created for DSA 3, 4, 15 and 16 (which represents the scenario with the highest expected traffic volumes and traffic density). DSA's 3, 4, 15 and 16 share the same facility design in this vicinity, the same projected traffic volumes, and the same FreeVal operational results. The VISSIM microsimulation software tool (Version 5.40) was used for this analysis.

Per HCM 2010 Chapter 6 and Exhibit 6-1, the use of a microsimulation tool (VISSIM) was used to supplement the HCS-FreeVal deterministic procedures and analysis results to help make a more informed decision for the weaving segment between US 64/US 264 and Poole Road. Per Exhibit 6-1, the following traffic phenomenon (ramp merging, merging during congested conditions, generation of vehicles, effect of oversaturation and residual queue at the end of the analysis period) are all present in this weaving segment and are treated differently in deterministic versus microsimulation analysis. The goal of this supplement microsimulation analysis is to better inform project-related design decisions given the HCM/FreeVal weaving segment speeds and densities are just over the LOS E threshold or at LOS D for all DSA's.

8.1 2035 Design Year DSA 3, 4, 15 and 16 VISSIM Model

The microsimulation model for the section of southbound Complete 540 between the US 64 / US 264 interchange and the future Poole Road interchange were developed to include the southbound US 64 / US 264 on-ramp, Complete 540 mainline, and Poole Road loop off-ramp segments only.



The Build DSA model laneage configuration matches the functional Complete 540 design developed by Lochner. The design includes a six-lane facility (three lanes each direction), which includes a fourth southbound auxiliary lane on Complete 540 that adds at the US 64 / 264 on-ramp and drops 1,850 feet downstream at the Poole Road loop off-ramp. The following image details the analysis boundaries, laneage, geometrics, and volumes used in the VISSIM analysis of 2035 PM Build DSA model.

8.2 Measures of Effectiveness and Calibration

Since Complete 540 is a future new location freeway facility, the 2035 Design Year Build PM peak hour model was developed and calibrated to match the current Complete 540 design and criteria. MOEs for volume throughput, weaving segment density and weaving segment speed were computed for freeway operations only. No ramp terminal intersection MOEs or arterial corridor MOEs were developed for this model.

The following "calibration" was completed by coding and adjusting the model to reproduce real-world traffic conditions reasonably well to produce realistic results based on a review of similar adjacent facilities, Complete 540 roadway design criteria, and forecast volume throughputs. The following information was collected for the 2040 microsimulation model development. This information was taken from previous work by HNTB, NCDOT or others.

- Demand Data (from Complete 540 traffic forecast volumes – balanced between interchange ramp terminal intersections and adjusted to provide 15 minute peak traffic flows that would emulate a 0.90 peak hour factor)
- Vehicle Mix (from Complete 540 traffic forecast and FreeVal output estimates for Complete 540 mainline and from traffic turning movement count data for US 64/US 264 and Poole Road)
- Geometric Data (number lanes, configuration, speed, design criteria, etc. based on preliminary functional designs)

Additional travel speed data was collected to confirm a 70 mph free-flow speed (plus 5 mph posted per design criteria) is reasonable to analyze for Complete 540.

- Toll NC 540 free flow travel speeds (from NCTA MVD data) See ***Appendix E***.
- I-540 free flow travel speeds (from INRIX data). See ***Appendix E***.

HNTB coordinated with NCDOT staff in the project scoping process to verify the following basic calibration approach as presented below.

- The future year model was calibrated based on 2040 Design Year PM peak period operations for a single peak hour. Calibration was based upon peak hour traffic forecast volumes balanced between interchange ramp terminal intersections along Complete 540 from future US 64/US 264 on-ramp to future Poole Road off-ramp.
- HNTB calibrated the model based upon a review of existing Toll NC 540 and I-540 travel speeds adjacent to Complete 540, design speed criteria, and volume throughput compared to mainline forecast volumes in the weaving segment.
- Calibration targets were to have 20 run MOE averages with different random seeds for the PM peak period. Models were "seeded" for a 15 minute interval prior to actual peak hour operations and MOE data collection.

The following drive behavior parameters adjustments were made to the default VISSIM parameters during the calibration process:

- I-540/Complete 540 vehicle speed distributions taken from default VISSIM profiles for normalized speed curves for 100 kilometers/hour for cars and 90 kilometers/hour for trucks, resulting in freeway speeds in the 65 mph range.
- System Interchange on-ramp speeds coded as 80 kilometers/hour for both cars and trucks, which equates to an approximate 55 mph range of values. The on-ramp traffic speeds were maintained through the weave area for this traffic mix.

- Loop ramp speeds to Poole Road coded for 50 kilometers/hour distribution curve (equating to a 30-35 mph range entering the ramp).
- Model network extended 2,800 feet upstream of weave area along I-540. Initial traffic entry link limited to outer two lanes only to prevent three lane shifts for downweaving vehicles. Through traffic (not exiting at Poole Road) allowed to enter the inner passing lane immediately downstream of the initial entry link.
- Look-back distance for Poole Road exiting traffic set to 3,500 feet to allow adequate distance for lane changing in upstream traffic lanes.
- Wiedemann 99 driver behavior model employed for all freeway links with advanced merging and cooperative lane-changing options activated.
- Safety distance factor (0.60) and waiting time before diffusion (60 seconds) left at default values. These parameters caused some traffic in higher density situations to nearly come to a complete stop before weaving maneuvers, which may be more realistic as densities increase to near capacity situations in the lanes where weaving occurs just prior to the Poole Road exit. A comparison of resulting densities for these outer freeway lanes and the FreeVal data produces reasonable validation of the FreeVal results in comparison with the VISSIM MOE data.

8.3 2035 Design Year DSA 3, 4, 15 and 16 Analysis Results

The following section highlights 2035 Design Year DSA 3, 4, 15, 16 analysis results for the Complete 540 southbound freeway weaving section between the existing US 64 / US 264 interchange and the future Poole Road interchange. 20 run averaged VISSIM MOE output was tabulated to determine the microsimulation operations analysis results. To assess the validity of the FreeVal results for the Complete 540 southbound segment immediately downstream of the US 64 / US 264 system interchange, VISSIM runs for the Build DSA design concept were compiled and results compared in **Table 21** to FreeVal analysis results.

Table 21. 2035 VISSIM Measures of Effectiveness PM Peak Results

Segment Performance	Complete 540 DSA 3, 4, 15, 16 Southbound Weaving Segment	
	HCS Freeval	VISSIM
Volume [veh/hour]	5,404	5,354
Density [veh/mile]	***34.00***[2]	25.58[1]
Speed [mph]	47.0	53.6

BOLD/ITALIC – Segment Density Exceeds LOS D Thresholds
1 - HCM and VISSIM density and level of service (LOS) results are not directly comparable due to differences in analysis and calculation methods. VISSIM density reported in average density (veh/mi/ln) since VISSIM does not report in (pc/mi/ln).
2 - HCS results in (veh/mi/ln) for comparison only. Corresponding (pc/mi/ln) is 38.30 and LOS E.

As shown in **Table 21**, the worst-case 2035 Build DSA 3, 4, 15, 16 VISSIM analysis provides operational results that compare to an HCM level of service D or better for the Complete 540 southbound freeway weaving section between the existing US 64 / US 264 interchange and the future Poole Road interchange. Initial FreeVal results for this segment predicted 2035 PM peak hour LOS E for the weaving section. Since FreeVal methodologies are not set up to evaluate this area to the same level of detail as microscopic analysis, a microsimulation model was

developed to test the weaving segment in greater detail and more realistically evaluate this area with demands nearing capacity and higher turbulence. Based on the VISSIM microsimulation results, no peak hour operational issues are expected with any of the design study alternatives for this segment and no revisions to the existing DSA designs are recommended.
The difference between HCS-FreeVal and VISSIM results is due primarily to oversaturation and residual queues per HCS-FreeVal combined with VISSIM's ability to provide more detailed simulation of ramp merging, generation of vehicles lane choice and processing of residual queues.

For example, in reviewing the time period densities for the DSA in question, the first two periods (with V/C < 1.0) match the HCM 2010 Equation 12-22 density calculation = (volume in weaving segment / number lanes) / average speed of all vehicles. In the third period, V/C > 1.0 and density does not match the basic formula and increases substantially due to "queuing" with residual effects in Time Period 4. This shows FreeVal results are heavily impacted by the V/C > 1.0, congestion, queuing and oversaturation. Therefore, the use of a supplemental microsimulation tool was considered to gain a better understanding of the traffic operations and make a more informed decision. ***Appendix J*** contains the VISSIM output results.

9. CONCLUSIONS AND RECOMMENDATIONS

The Complete 540 study area traffic capacity analysis was completed to evaluate base year (2012) and design year (2035) peak hour traffic operations for 17 Complete 540 Detailed Study Alternatives and surrounding freeway facilities and nearby intersections within the traffic analysis study area. The capacity analysis report incorporates the ongoing coordination efforts between project planning, design and analysis study teams to produce DSAs that provide sufficient capacity, efficient operations, and acceptable future levels of service. The recommended freeway, arterial, interchange and intersection geometrics and intersection control for Complete 540 DSAs 1, 6 and 8 are presented in **Figures 9.1** to **9.8, 10.1** to **10.8** and **11.1** to **11.8**, respectively. Recommended and analyzed geometrics for all DSAs are included in the detailed capacity analysis outputs from HCS FreeVal, Synchro and HCS unsignalized intersections in ***Appendices E, F*** and ***G***, respectively.

Based on the 2012 base year capacity analysis, the majority of No-Build and Build DSA freeway and intersection facilities are projected to operate at acceptable LOS D or better, with few operational issues.

Based on the 2035 design year capacity analysis, the following conclusions and recommendations are presented for study area facilities and intersections:

Complete 540 Corridors

All Complete 540 DSA freeway segments, interchange design configurations, and interchange ramp terminal intersections are projected to operate at LOS D or better in the 2035 design year, based on the current functional designs for a Complete 540 six-lane, toll facility. Of the 115 to 137 freeway segments analyzed, depending on the DSA, only one weaving segment between US 64 / US 264 and Poole Road in the westbound PM peak experiences projected operational deficiencies, as shown in **Table 22**. To further and more accurately evaluate this weaving segment, supplemental VISSIM microsimulation analyses were prepared and show acceptable weaving segment operations of a comparable LOS D or better for the simulation runs, as shown in **Table 23**.

Of the 29 to 36 study area intersections analyzed at interchange ramp terminals or adjacent Y-lines, depending on the DSA, only 1 to 4 intersections are projected to experience operational deficiencies, depending on specific DSA as shown in **Table 24**. None of the intersections potentially experiencing operational deficiencies are interchange ramp terminal intersections directly impacting Complete 540 mainline freeway operations. The intersections projected to operate at LOS E or F either include unsignalized, minor Y-line intersections or signalized Y-line intersections that incorporate reasonably feasible improvements to optimize intersection operations. Overall, all seventeen (17) DSAs operate with nearly identical freeway and intersection measures of effectiveness and levels of service, even though each DSA includes different volumes, corridor alignments, interchange configurations, interchange access points and impacts to crossing freeway and arterial facilities.

NC 540 Corridor

Based on the 2035 design year Build DSA analysis results, the existing section of NC 540 from US 1 to NC 55 Bypass is projected to operate at acceptable LOS D or better for all DSAs with construction of Complete 540 and the Old Holly Springs-Apex Road interchange (R-2635D).

I-540 Corridor

The existing section of I-540 from US 64 / US 264 to US 64 Business is projected to operate at acceptable LOS D or better for all DSAs with construction of Complete 540 and I-540 planned widening to an 8-lane facility.

I-40 Corridor

I-40 from US 70 Business to NC 42 is projected to operate at acceptable LOS D or better for all DSAs, with construction of Complete 540 and I-40 planned widening to an 8-lane facility. DSAs 1-5 and 8-17 propose a five-leg system interchange with I-40 and US 70 and provide acceptable interchange spacing between US 70 and NC 42. DSAs 6 and 7 connect with I-40 as a four-leg system interchange further to the north and do not provide desirable interchange spacing between the I-40 and US 70 Business interchange. Therefore, DSA 6 and 7 propose collector-distributors on I-40 through the US 70 Business and Complete 540 system interchanges. DSA 6 and 7 also do not provide direct interchange access at US 70 Business due to undesirable interchange spacing from I-40. Rocky Quarry Road Extension is proposed to provide direct access from Complete 540 at the Rock Quarry Road interchange to US 70 Business. The potential impacts of Complete 540 on I-40, US 70, US Business and the system interchange operations should be re-evaluated at the appropriate time for an interchange access request study

US 70 Corridor

The existing section of US 70 from I-40 to NC 42 is projected to operate at acceptable LOS D or better for all DSAs with construction of Complete 540.

US 64 / US 264 Corridor

Capacity analysis results indicate that US 64 / 264 is operating near or over capacity with operational deficiencies in the 2035 design year AM and PM peak hours with or without construction of Complete 540. Based on the 2035 design year No-Build DSA analysis results, US 64 / US 264 from Hodge Road to Smithfield Road is projected to operate at LOS E or F for 6 of 11 eastbound segments and 9 of 11 westbound segments as a six-lane freeway facility. In all Build DSAs, similar facility volumes and operational results are projected. Construction of Complete 540 proposes modifying the existing directional system interchange with US 64 / US 264 and I-540 by connecting the forth leg and constructing a flyover and a loop ramp. The system interchange was planned, designed and constructed to accommodate the future completion and connection of the 540 loop. This interchange modification would add one eastbound and one westbound freeway merge on US 64 / US 264. The potential impacts of Complete 540 on US 64 / US 264, I-540 and the system interchange operations should be re-evaluated at the appropriate time for an interchange access request study.

Table 22. 2035 Design Year No-Build & Build Freeway Operations Summary

Scenario	Complete 540											
	Eastbound						Westbound					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
No-Build	3	3	5	0	0	0	3	11	1	0	0	0
DSA 1	2	32	33	1	0	0	1	27	39	1	1	0
DSA 2	2	32	33	1	0	0	1	27	39	1	1	0
DSA 3	1	38	26	1	0	0	1	27	37	1	1	0
DSA 4	3	29	33	1	0	0	1	27	37	1	1	0
DSA 5	3	37	27	1	0	0	1	31	35	1	1	0
DSA 6*	0	14	40	2	0	0	0	34	24	0	1	0
DSA 7*	0	15	39	2	0	0	0	34	24	0	1	0
DSA 8	1	31	31	1	0	0	1	32	33	0	1	0
DSA 9	1	31	31	1	0	0	1	32	33	0	1	0
DSA 10	1	28	32	1	0	0	1	30	33	0	1	0
DSA 11	1	28	32	1	0	0	1	30	33	0	1	0
DSA 12	1	34	28	1	0	0	1	36	29	1	0	0
DSA 13	1	29	33	1	0	0	1	25	39	1	1	0
DSA 14	1	29	33	1	0	0	1	26	38	1	1	0
DSA 15	2	23	36	1	0	0	1	25	37	1	1	0
DSA 16	2	24	35	1	0	0	1	25	37	1	1	0
DSA 17	2	33	28	1	0	0	1	31	33	1	1	0

**DSA 6, 7 includes analysis of collector-distributor segment along Complete 540.*

Table 23. 2035 VISSIM Measures of Effectiveness PM Peak Results

Segment Performance	Complete 540 DSA 3, 4, 15, 16 Southbound Weaving Segment	
	HCS Freeval	VISSIM
Volume [veh/hour]	5,404	5,354
Density [veh/mile]	***34.00***[2]	25.58[1]
Speed [mph]	47.0	53.6

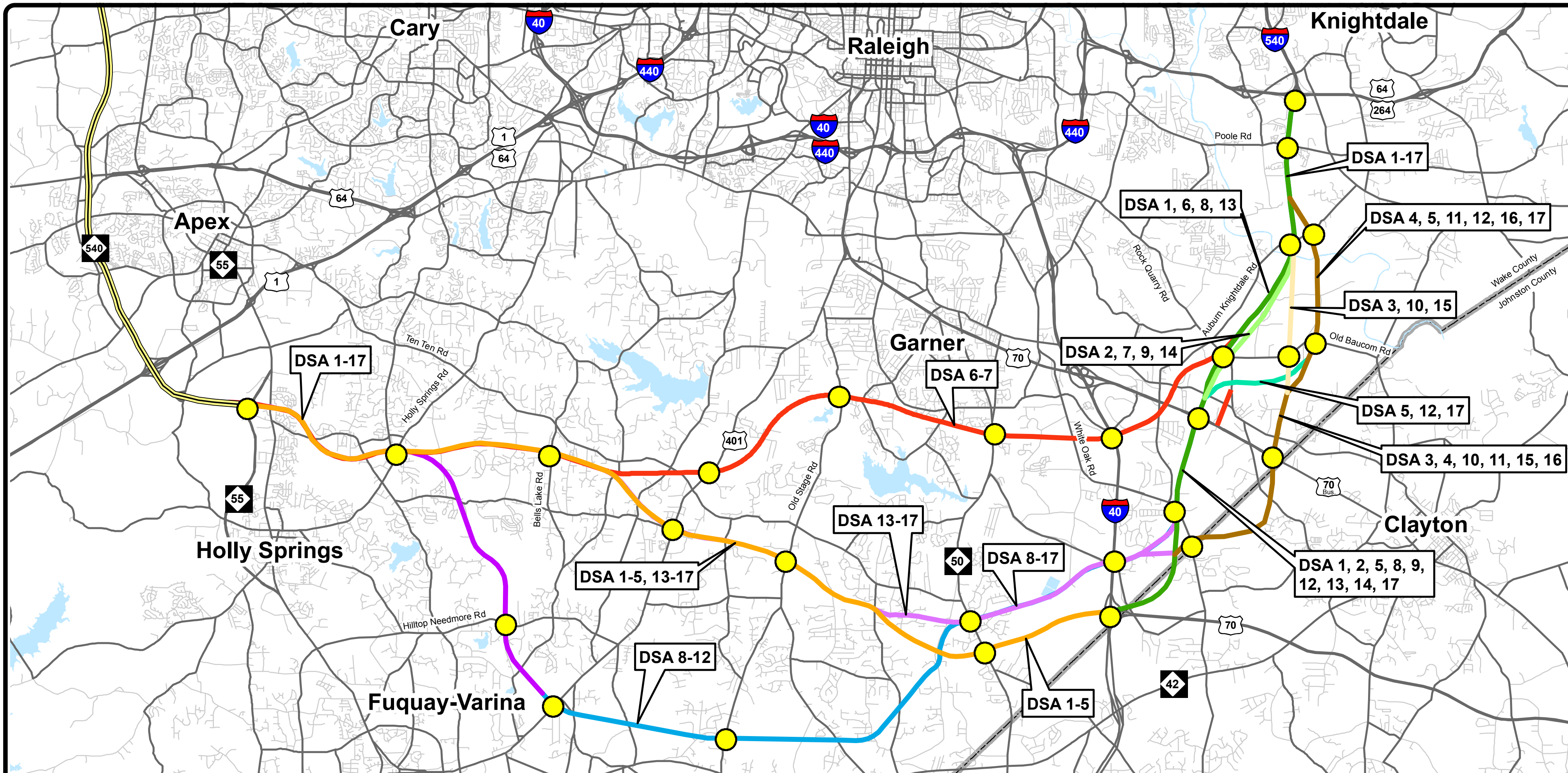
BOLD/ITALIC – Segment Density Exceeds LOS D Thresholds
1 - VISSIM density reported in average density (veh/mi/ln).
2 - HCS density reported in (veh/mi/ln) for comparison. Corresponding (pc/mi/ln) is 38.30 and LOS E.

Table 24. 2012 & 2035 No-Build & Build Intersection Capacity Analysis Summary

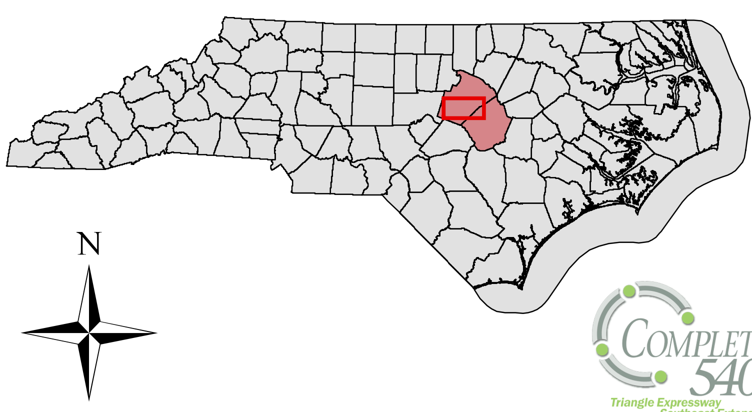
Scenario	Number of Intersections Operating at Given LOS in at Least One AM or PM Peak Hour*											
	2012 Base Year						2035 Design Year					
	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F
No-Build	1	4	6	0	***3***	***2***	0	2	4	1	***4***	***5***
DSA 1	11	17	4	0	***1***	***0***	2	15	10	4	***1***	***1***
DSA 2	11	17	4	0	***1***	***0***	2	15	10	4	***1***	***1***
DSA 3	9	15	5	0	***0***	***0***	4	11	11	2	***1***	***1***
DSA 4	9	15	5	0	***0***	***0***	5	10	11	2	***1***	***1***
DSA 5	8	18	4	0	***1***	***0***	4	12	10	3	***1***	***1***
DSA 6	17	12	4	1	***1***	***0***	2	15	6	8	***3***	***1***
DSA 7	17	12	4	1	***1***	***0***	2	15	6	8	***3***	***1***
DSA 8	16	17	2	0	***1***	***0***	5	16	8	6	***1***	***0***
DSA 9	16	17	2	0	***1***	***0***	5	16	8	6	***1***	***0***
DSA 10	13	17	3	0	***0***	***0***	6	13	9	4	***1***	***0***
DSA 11	13	17	3	0	***0***	***0***	7	12	9	4	***1***	***0***
DSA 12	14	17	2	0	***1***	***0***	7	13	8	5	***1***	***0***
DSA 13	14	15	3	0	***1***	***0***	2	16	9	4	***1***	***0***
DSA 14	14	15	3	0	***1***	***0***	2	16	9	4	***1***	***0***
DSA 15	11	15	4	0	***0***	***0***	4	12	10	2	***1***	***0***
DSA 16	11	15	4	0	***0***	***0***	5	11	10	2	***1***	***0***
DSA 17	11	15	3	0	***1***	***0***	4	13	9	3	***1***	***0***

*-For signalized intersections, overall intersection LOS. For unsignalized intersections, worst-case critical movement.

Appendix A – Figures



Detailed Study Alternative Corridors



Legend

- Interchanges
- Triangle Expressway
- Major Roads
- Counties

DSA Corridors

- Orange
- Green
- Mint
- Brown
- Tan
- Teal
- Lilac
- Red
- Blue
- Purple

STIP: R-2721, R-2828, R-2829

WBS: 37673.1.TA2, 35516.1.TA1, 35517.1.TA1

COUNTY: Wake/Johnston

DIVISION: 5/4

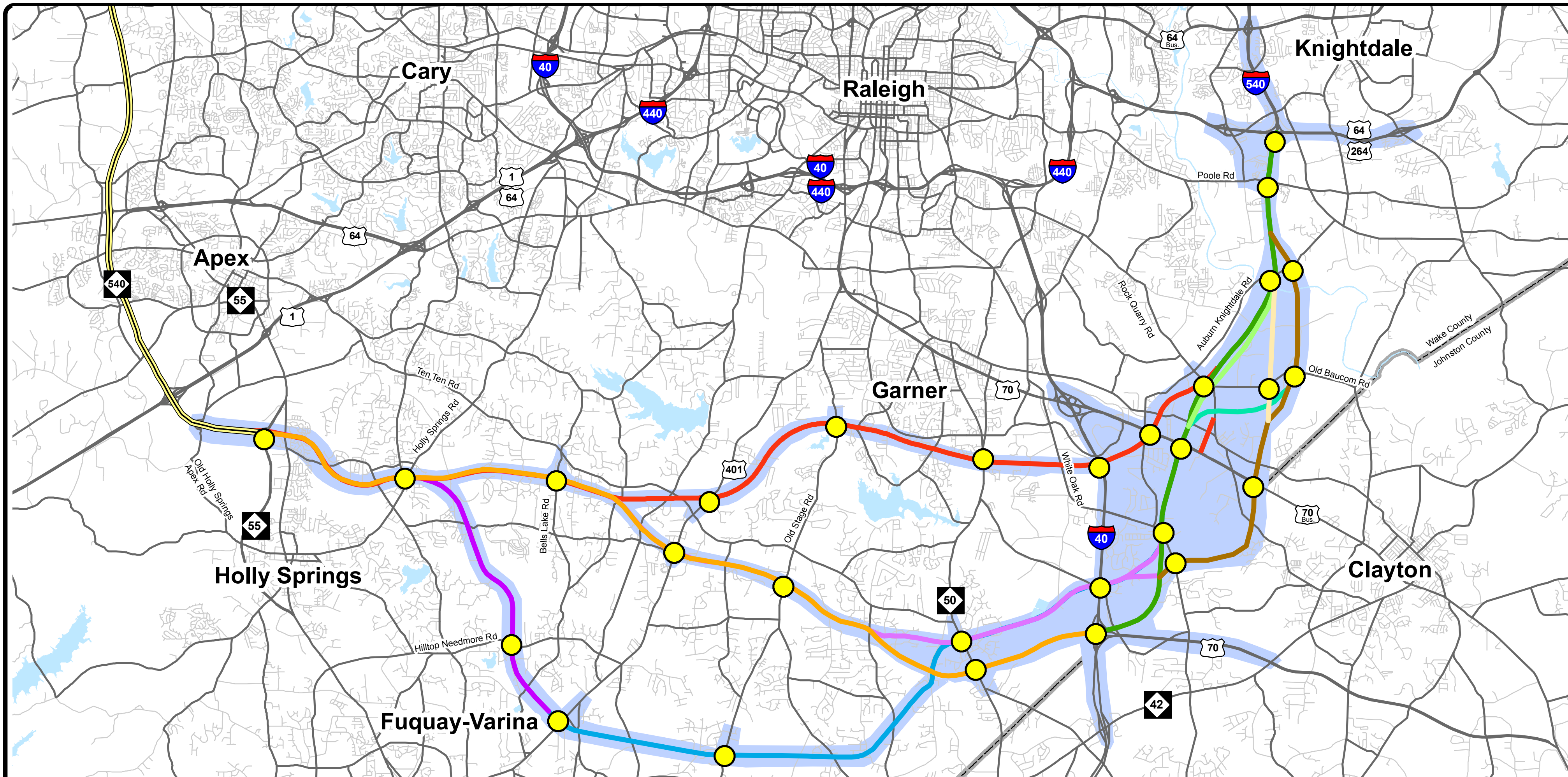
DATE: February 2015

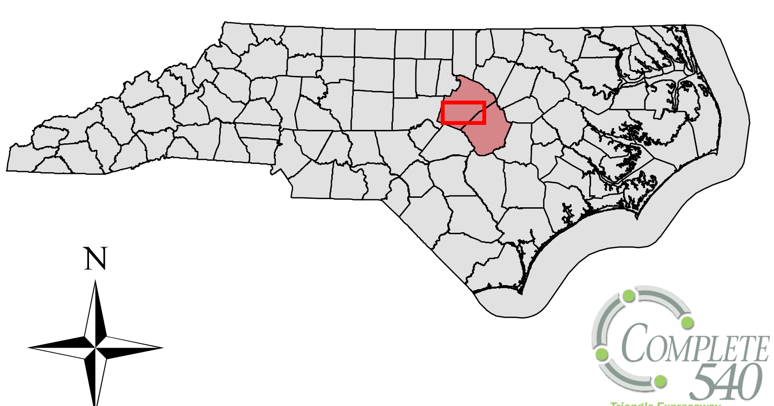
PREPARED BY: HNTB North Carolina, P.C.
343 E. Six Forks Rd, Suite 200
Raleigh, NC 27609

LOCATION: NC 55 Bypass (Holly Springs) to US 64 Bypass (Knightdale)

PROJECT: Complete 540
Triangle Expressway
Southeast Extension

Figure 1





Traffic Analysis Study Area

Legend

- Triangle Expressway
- Major Roads
- Study Area
- Counties
- Interchanges

DSA Corridors

- Orange
- Green
- Mint
- Brown
- Tan
- Teal
- Lilac
- Red
- Blue
- Purple

COMPLETE 540
Triangle Expressway Southeast Extension

STIP: R-2721, R-2828, R-2829

WBS: 37673.1.TA2, 35516.1.TA1, 35517.1.TA1

COUNTY: Wake/Johnston

DIVISION: 5/4

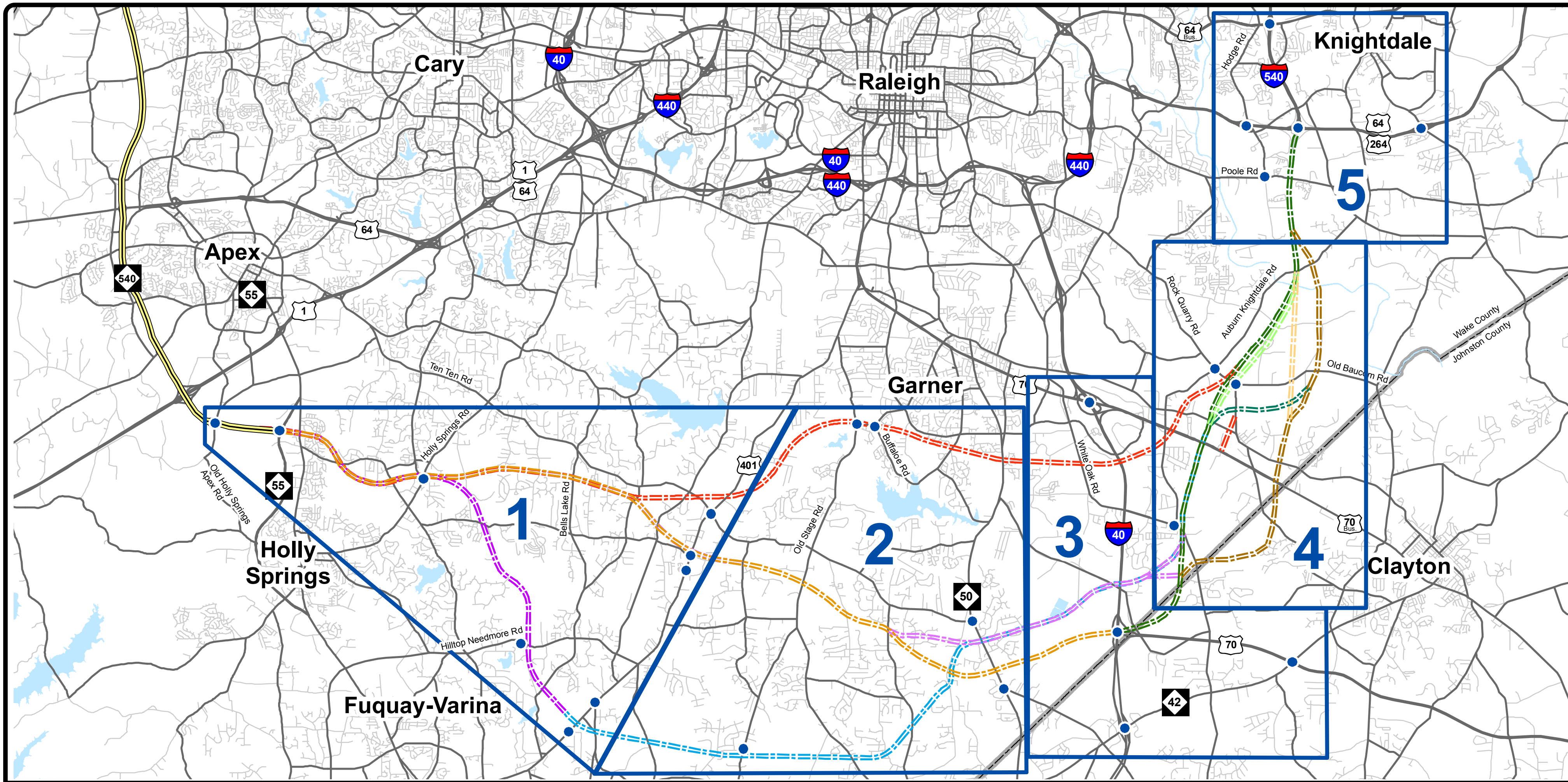
DATE: February 2015

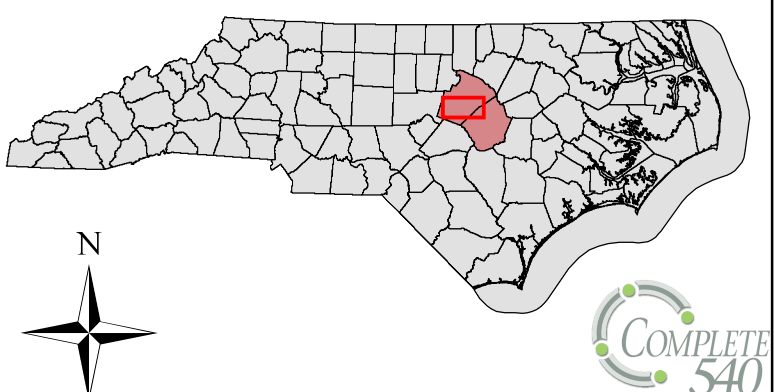
PREPARED BY: HNTB North Carolina, P.C.
343 E. Six Forks Rd, Suite 200
Raleigh, NC 27609

LOCATION: NC 55 Bypass (Holly Springs) to US 64 Bypass (Knightdale)

PROJECT: Complete 540
Triangle Expressway
Southeast Extension

Figure 2





No Build Traffic Analysis Figures Sheet Key

Legend

- Analyzed Intersection/Interchange
- Triangle Expressway
- Major Roads
- Counties

DSA Corridors

- Orange
- Green
- Mint
- Brown
- Tan
- Teal
- Lilac
- Red
- Blue
- Purple

STIP: R-2721, R-2828, R-2829

WBS: 37673.1.TA2, 35516.1.TA1, 35517.1.TA1

COUNTY: Wake/Johnston

DIVISION: 5/4

DATE: February 2015

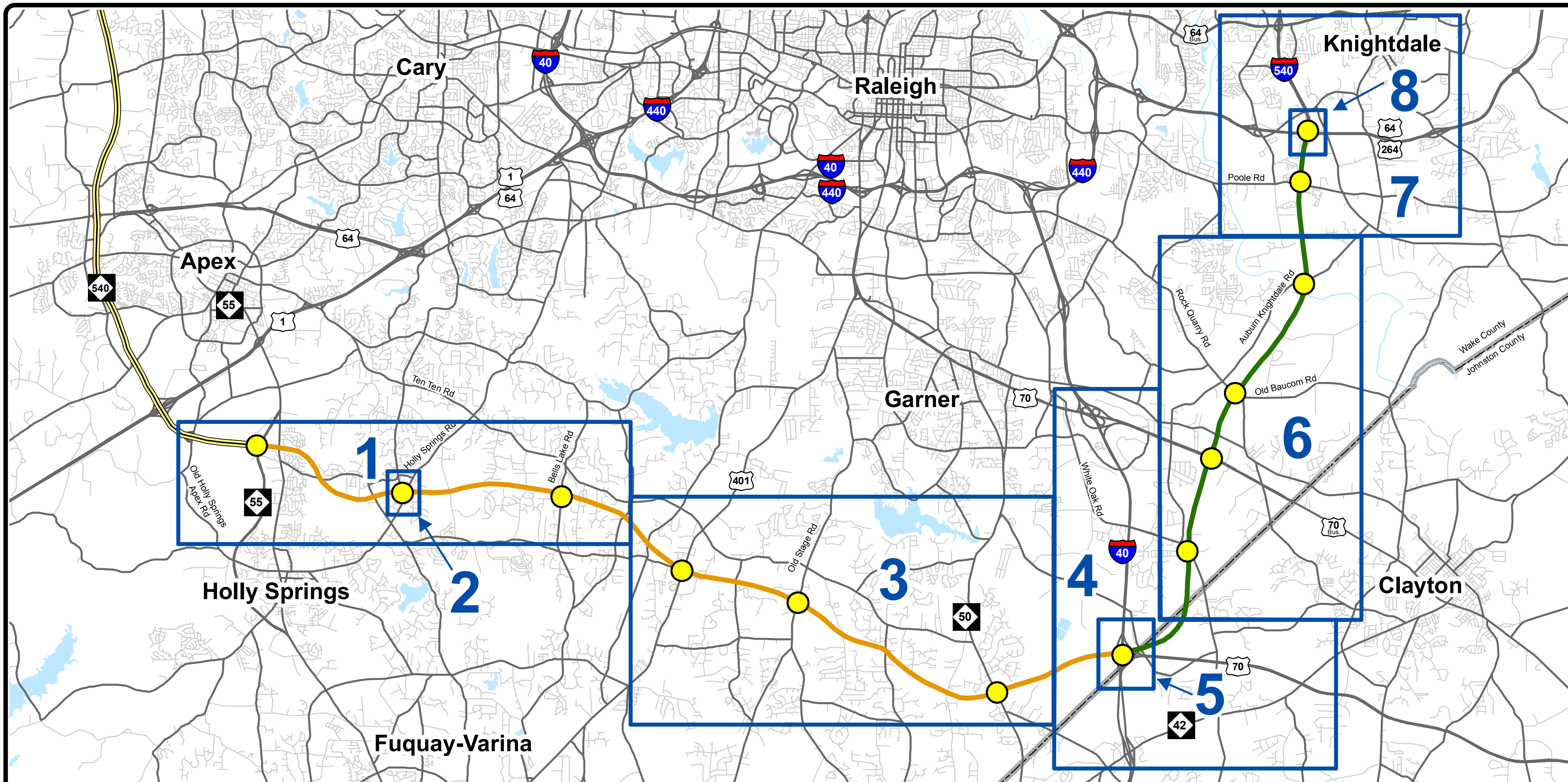
PREPARED BY: HNTB North Carolina, P.C.
343 E. Six Forks Rd, Suite 200
Raleigh, NC 27609

LOCATION: NC 55 Bypass (Holly Springs) to US 64 Bypass (Knightdale)

PROJECT: Complete 540
Triangle Expressway
Southeast Extension

Figure 3

Complete 540
Triangle Expressway Southeast Extension



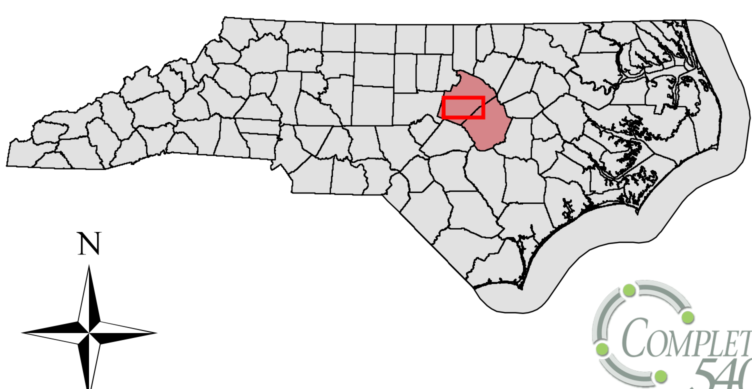
DSA 1 Traffic Analysis Figures Sheet Key

Legend

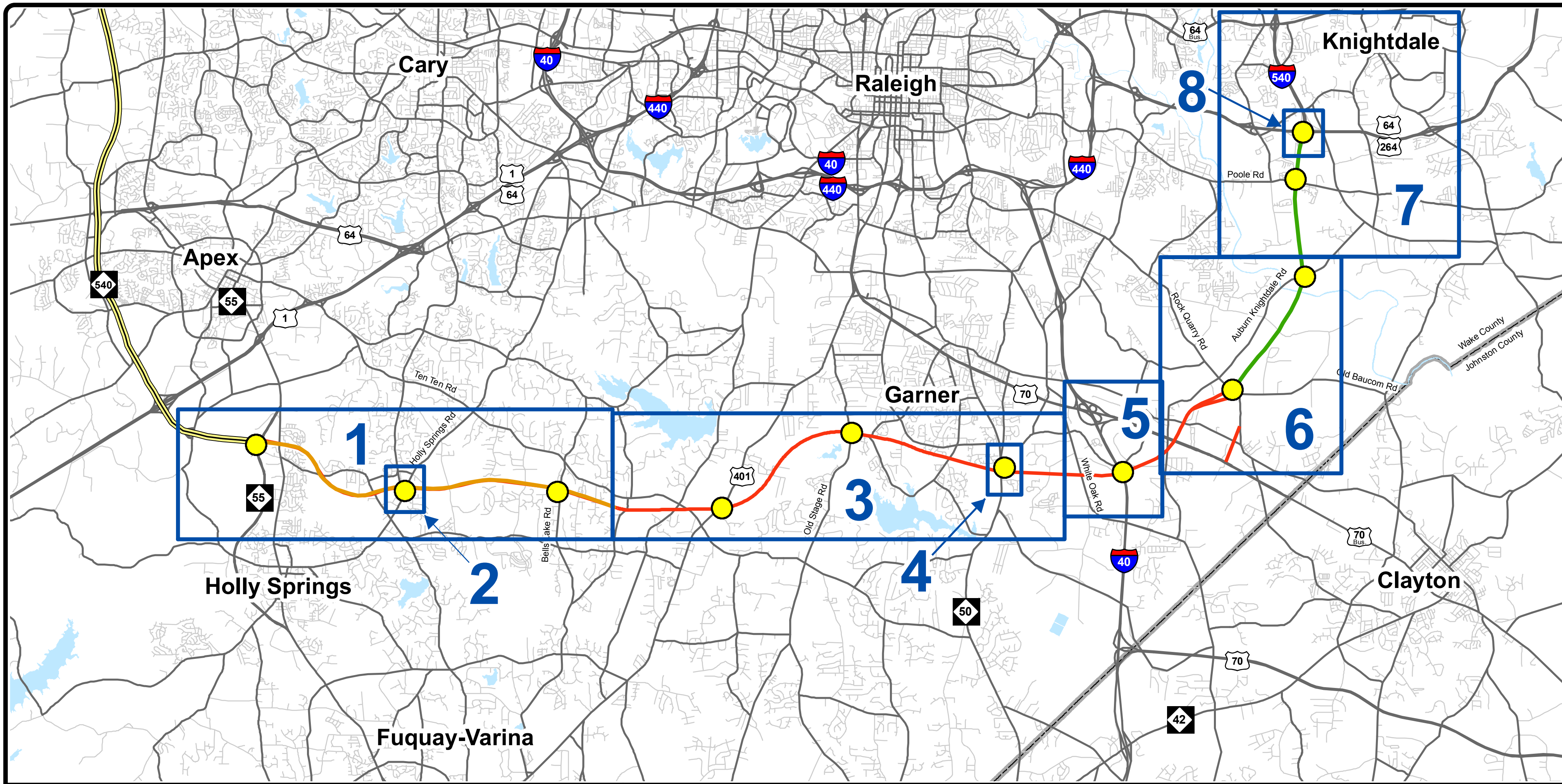
- Interchanges
- Triangle Expressway
- Major Roads
- Counties

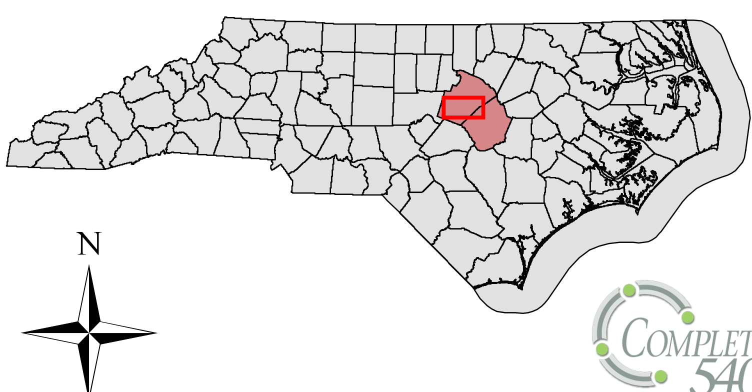
DSA Corridors

- Orange
- Green



STIP: R-2721, R-2828, R-2829	**WBS:** 37673.1.TA2, 35516.1.TA1, 35517.1.TA1
COUNTY: Wake/Johnston	**DIVISION:** 5/4
DATE: February 2015	
PREPARED BY: HNTB North Carolina, P.C. 343 E. Six Forks Rd, Suite 200 Raleigh, NC 27609	
LOCATION: NC 55 Bypass (Holly Springs) to US 64 Bypass (Knightdale)	
PROJECT: Complete 540 Triangle Expressway Southeast Extension	**Figure 4**





DSA 6 Traffic Analysis Figures Sheet Key

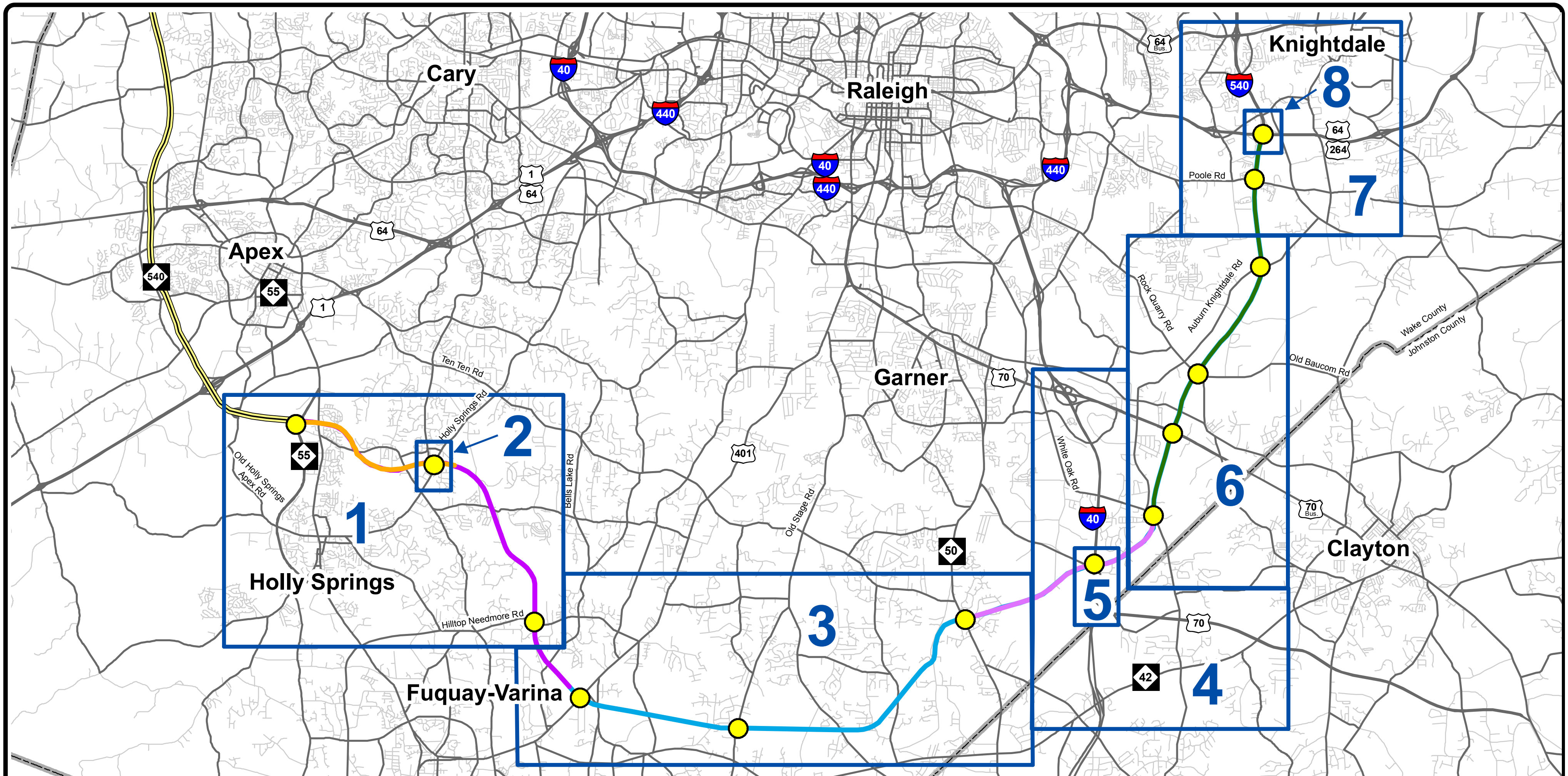
Legend

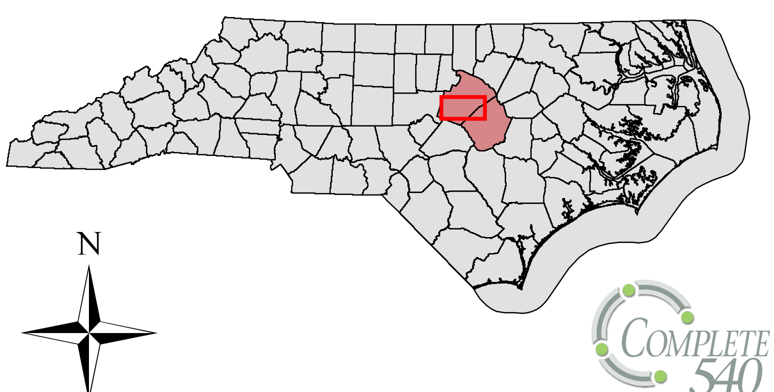
- Interchanges
- Triangle Expressway
- Major Roads
- Counties

DSA Corridors

- Orange Corridor
- Red Corridor
- Green Corridor

STIP: R-2721, R-2828, R-2829		**WBS:** 37673.1.TA2, 35516.1.TA1, 35517.1.TA1	
COUNTY: Wake/Johnston		**DIVISION:** 5/4	
DATE: February 2015			
PREPARED BY:	HNTB North Carolina, P.C. 343 E. Six Forks Rd, Suite 200 Raleigh, NC 27609		
LOCATION:	NC 55 Bypass (Holly Springs) to US 64 Bypass (Knightdale)		
PROJECT:	Complete 540 Triangle Expressway Southeast Extension		**Figure 5**





DSA 8 Traffic Analysis Figures Sheet Key

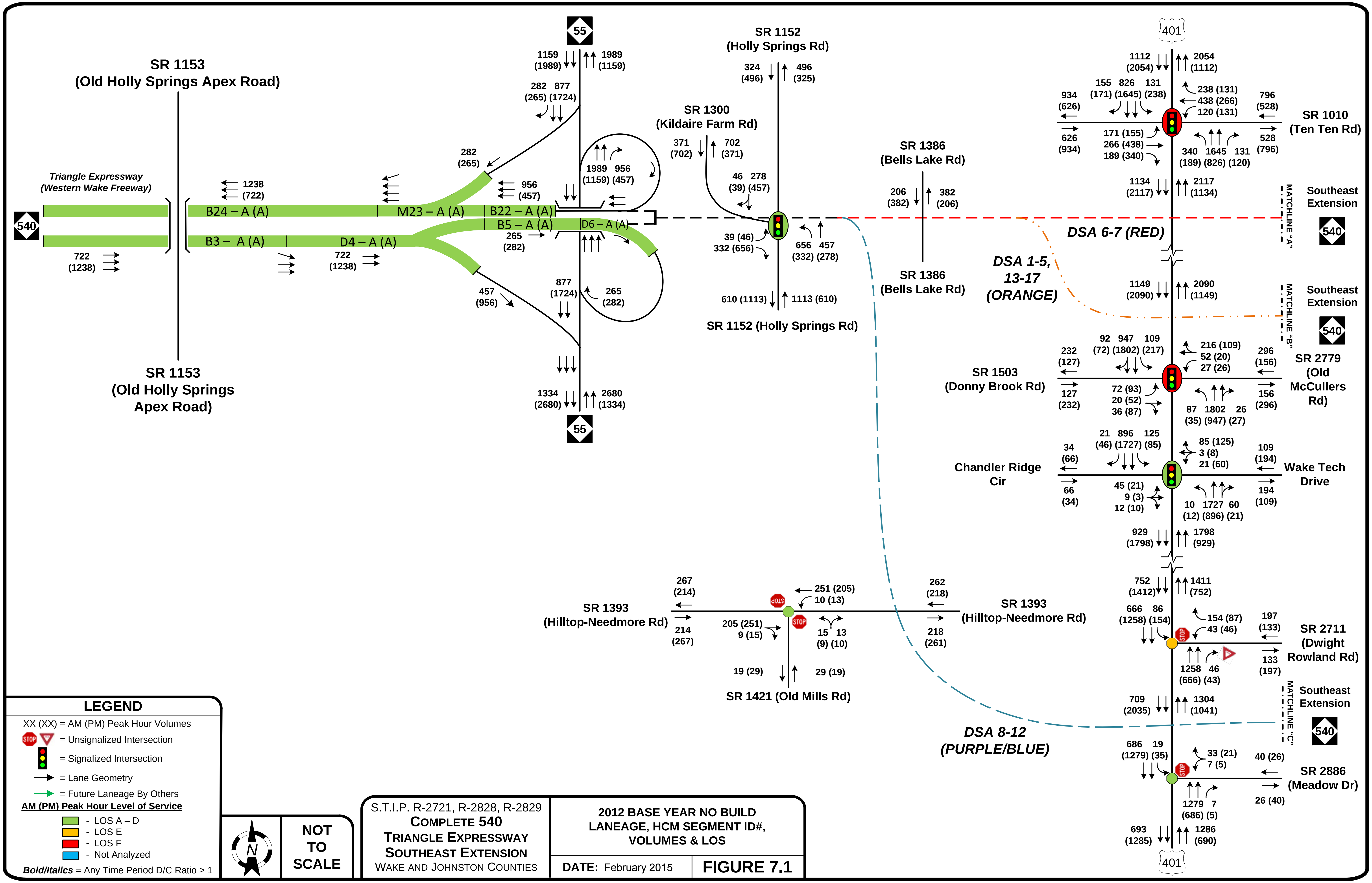
Legend

- Interchanges
- Triangle Expressway
- Major Roads
- Counties

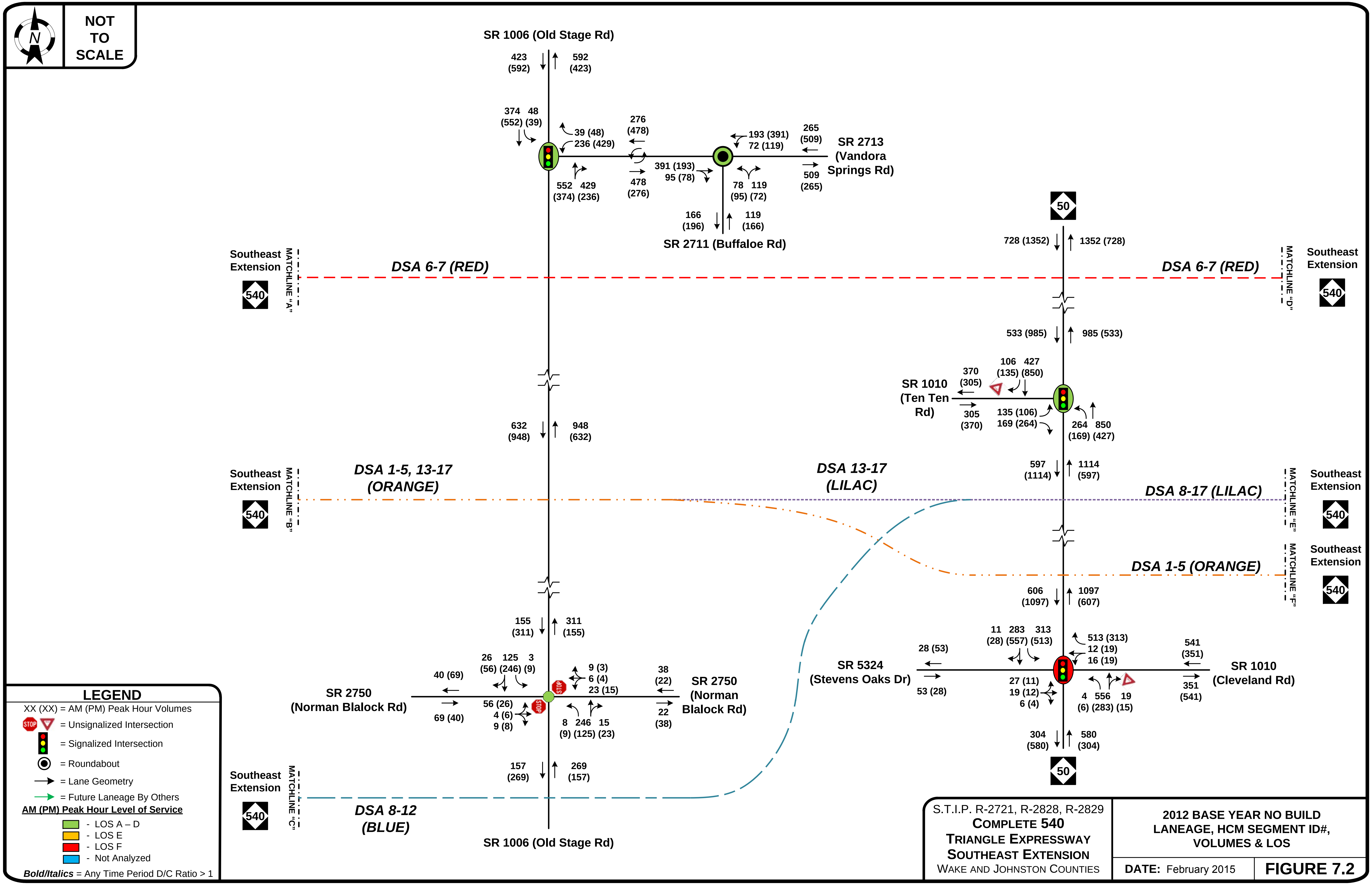
DSA Corridors

- Orange Corridor
- Blue Corridor
- Purple Corridor
- Lilac Corridor
- Green Corridor

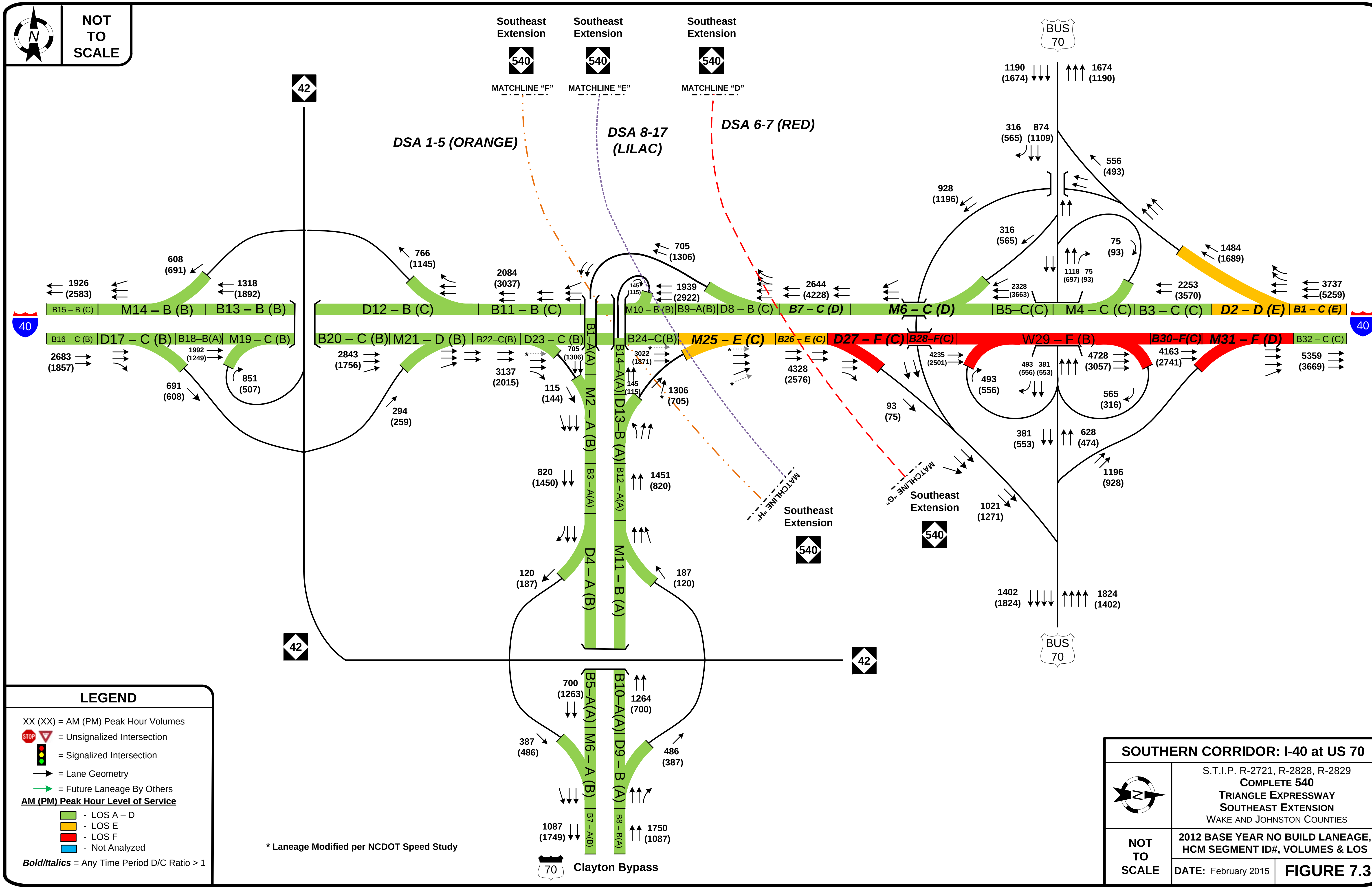
STIP: R-2721, R-2828, R-2829	**WBS:** 37673.1.TA2, 35516.1.TA1, 35517.1.TA1
COUNTY: Wake/Johnston	**DIVISION:** 5/4
DATE: February 2015	
PREPARED BY: HNTB North Carolina, P.C. 343 E. Six Forks Rd, Suite 200 Raleigh, NC 27609	
LOCATION: NC 55 Bypass (Holly Springs) to US 64 Bypass (Knightdale)	
PROJECT: Complete 540 Triangle Expressway Southeast Extension	**Figure** 6



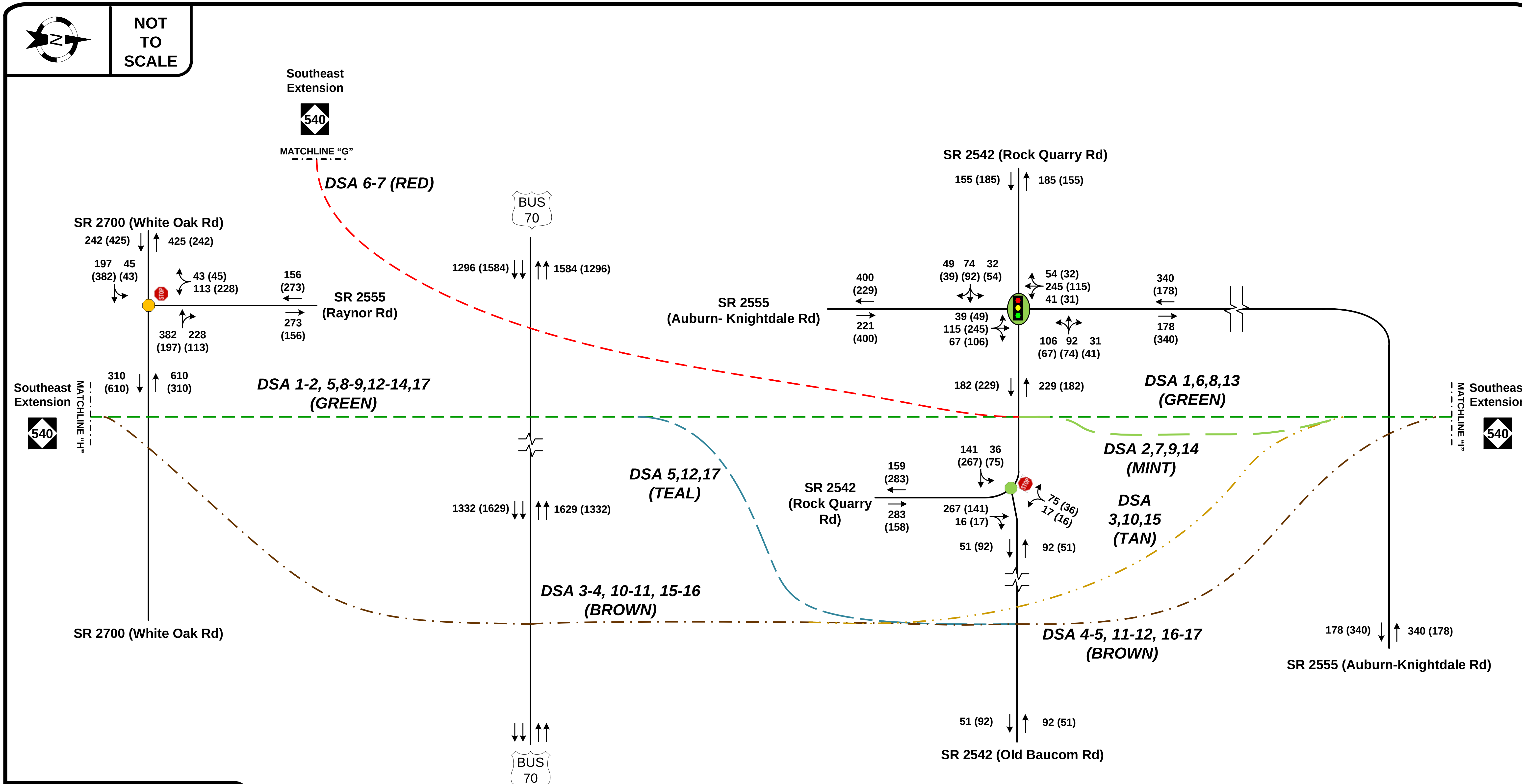
SR 1153
(Old Holly Springs Apex Road)
Triangle Expressway
(Western Wake Freeway)
540
B24 – A (A)
M23 – A (A)
B22 – A (A)
B5 – A (A)
D6 – A (A)
B3 – A (A)
D4 – A (A)
SR 1153
(Old Holly Springs
Apex Road)
55
SR 1152
(Holly Springs Rd)
SR 1300
(Kildaire Farm Rd)
SR 1152 (Holly Springs Rd)
SR 1386
(Bells Lake Rd)
DSA 6-7 (RED)
DSA 1-5,
13-17
(ORANGE)
DSA 8-12
(PURPLE/BLUE)
401
SR 1010
(Ten Ten Rd)
Southeast
Extension
MATCHLINE "A"
MATCHLINE "B"
MATCHLINE "C"
SR 1503
(Donny Brook Rd)
SR 2779
(Old
McCullers
Rd)
Chandler Ridge
Cir
Wake Tech
Drive
SR 1393
(Hilltop-Needmore Rd)
SR 1421 (Old Mills Rd)
SR 2711
(Dwight
Rowland Rd)
SR 2886
(Meadow Dr)
LEGEND
XX (XX) = AM (PM) Peak Hour Volumes
= Unsignalized Intersection
= Signalized Intersection
= Lane Geometry
= Future Laneage By Others
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed
Bold/Italics = Any Time Period D/C Ratio > 1
N
NOT TO SCALE
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES
2012 BASE YEAR NO BUILD
LANEAGE, HCM SEGMENT ID#,
VOLUMES & LOS
DATE: February 2015
FIGURE 7.1



NOT TO SCALE
N
SR 1006 (Old Stage Rd)
423 (592)
592 (423)
374 48 (552) (39)
39 (48)
236 (429)
552 429 (374) (236)
276 (478)
478 (276)
391 (193)
95 (78)
193 (391)
72 (119)
265 (509)
509 (265)
78 119 (95) (72)
166 (196)
119 (166)
SR 2713 (Vandora Springs Rd)
SR 2711 (Buffalo Rd)
50
728 (1352)
1352 (728)
Southeast Extension
MATCHLINE "A"
540
DSA 6-7 (RED)
DSA 6-7 (RED)
MATCHLINE "D"
533 (985)
985 (533)
370 (305)
106 427 (135) (850)
SR 1010 (Ten Ten Rd)
305 (370)
135 (106)
169 (264)
264 850 (169) (427)
632 (948)
948 (632)
597 (1114)
1114 (597)
MATCHLINE "B"
DSA 1-5, 13-17 (ORANGE)
DSA 13-17 (LILAC)
DSA 8-17 (LILAC)
MATCHLINE "E"
DSA 1-5 (ORANGE)
MATCHLINE "F"
606 (1097)
1097 (607)
155 (311)
311 (155)
26 125 3 (56) (246) (9)
9 (3)
6 (4)
23 (15)
38 (22)
40 (69)
SR 2750 (Norman Blalock Rd)
56 (26)
4 (6)
9 (8)
69 (40)
8 246 15 (9) (125) (23)
22 (38)
11 283 313 (28) (557) (513)
513 (313)
12 (19)
16 (19)
541 (351)
28 (53)
SR 5324 (Stevens Oaks Dr)
53 (28)
27 (11)
19 (12)
6 (4)
4 556 19 (6) (283) (15)
351 (541)
SR 1010 (Cleveland Rd)
304 (580)
580 (304)
157 (269)
269 (157)
MATCHLINE "C"
DSA 8-12 (BLUE)
SR 1006 (Old Stage Rd)
LEGEND
XX (XX) = AM (PM) Peak Hour Volumes
= Unsignalized Intersection
= Signalized Intersection
= Roundabout
= Lane Geometry
= Future Laneage By Others
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed
Bold/Italics = Any Time Period D/C Ratio > 1
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES
2012 BASE YEAR NO BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS
DATE: February 2015
FIGURE 7.2



NOT TO SCALE
Southeast Extension
540
MATCHLINE "F"
MATCHLINE "E"
MATCHLINE "D"
MATCHLINE "H"
MATCHLINE "G"
DSA 1-5 (ORANGE)
DSA 8-17 (LILAC)
DSA 6-7 (RED)
BUS 70
42
40
B15 – B (C)
M14 – B (B)
B13 – B (B)
D12 – B (C)
B11 – B (C)
M10 – B (B)
B9–A(B)
D8 – B (C)
B7 – C (D)
M6 – C (D)
B5–C(C)
M4 – C (C)
B3 – C (C)
D2 – D (E)
B1 – C (E)
B16 – C (B)
D17 – C (B)
B18–B(A)
M19 – C (B)
B20 – C (B)
M21 – D (B)
B22–C(B)
D23 – C (B)
B24–C(B)
M25 – E (C)
B26 – E (C)
D27 – F (C)
B28–F(C)
W29 – F (B)
B30–F(C)
M31 – F (D)
B32 – C (C)
B1–A(A)
M2 – A (B)
B3 – A(A)
D4 – A (B)
B14–A(A)
D13–B (A)
B12 – A(A)
M11 – B (A)
B5–A(A)
M6 – A (B)
B7 – A(B)
B10–A(A)
D9 – B (A)
B8 – B(A)
70
Clayton Bypass
* Laneage Modified per NCDOT Speed Study
LEGEND
XX (XX) = AM (PM) Peak Hour Volumes
= Unsignalized Intersection
= Signalized Intersection
= Lane Geometry
= Future Laneage By Others
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed
Bold/Italics = Any Time Period D/C Ratio > 1
SOUTHERN CORRIDOR: I-40 at US 70
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES
NOT TO SCALE
2012 BASE YEAR NO BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS
DATE: February 2015
FIGURE 7.3



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

= Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

= Future Laneage By Others

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

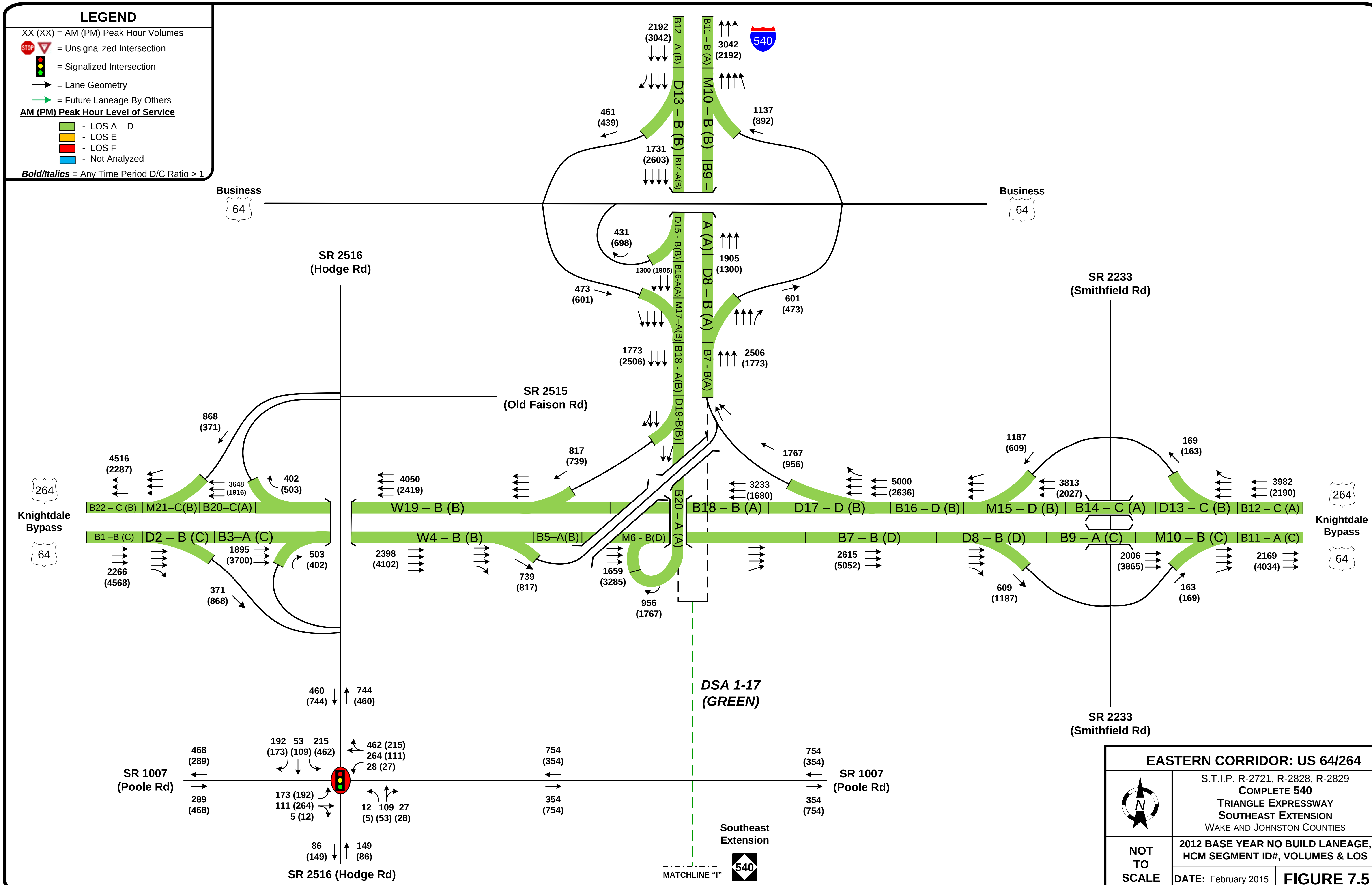
Bold/Italics = Any Time Period D/C Ratio > 1

S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

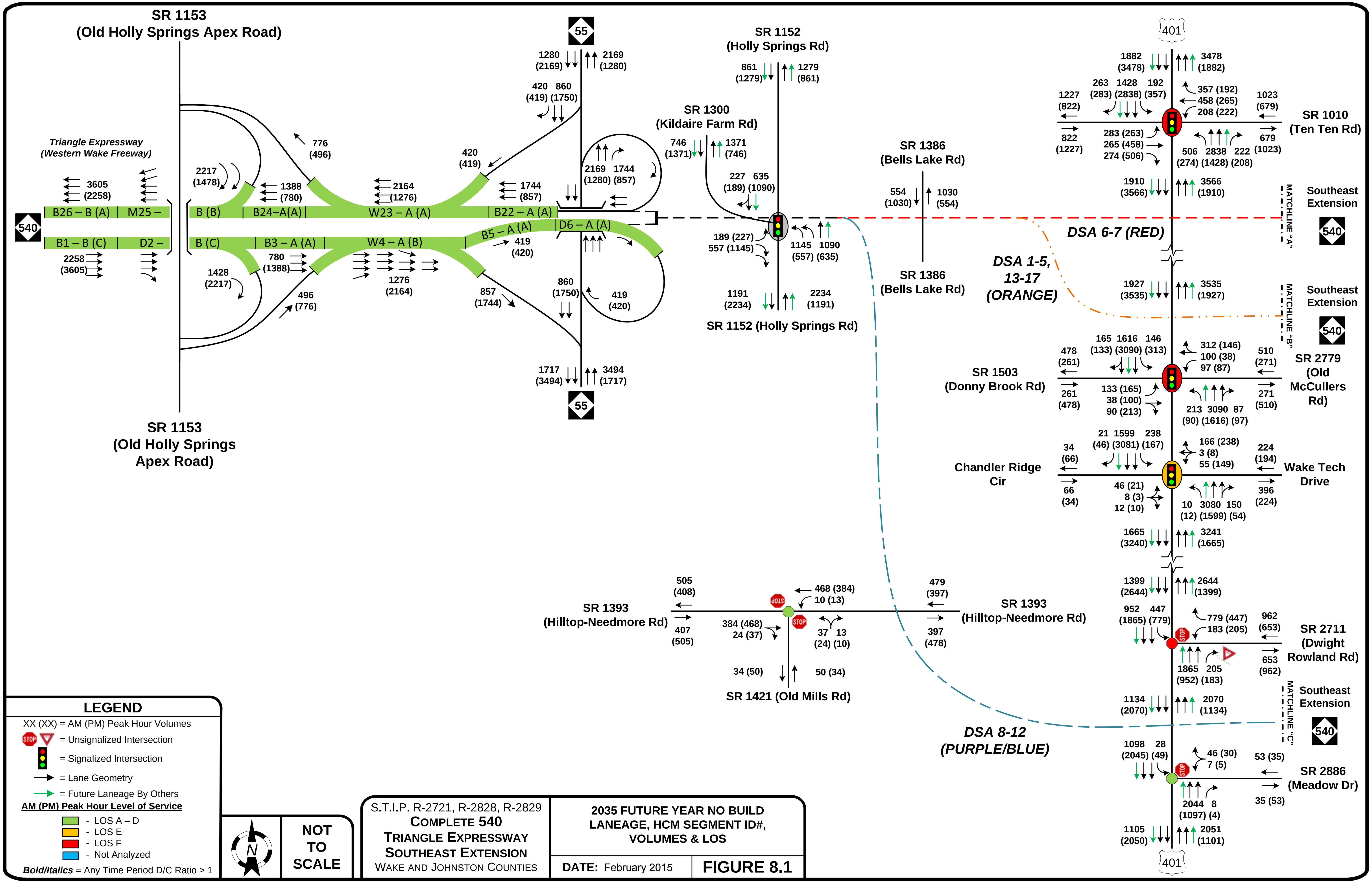
2012 BASE YEAR NO BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

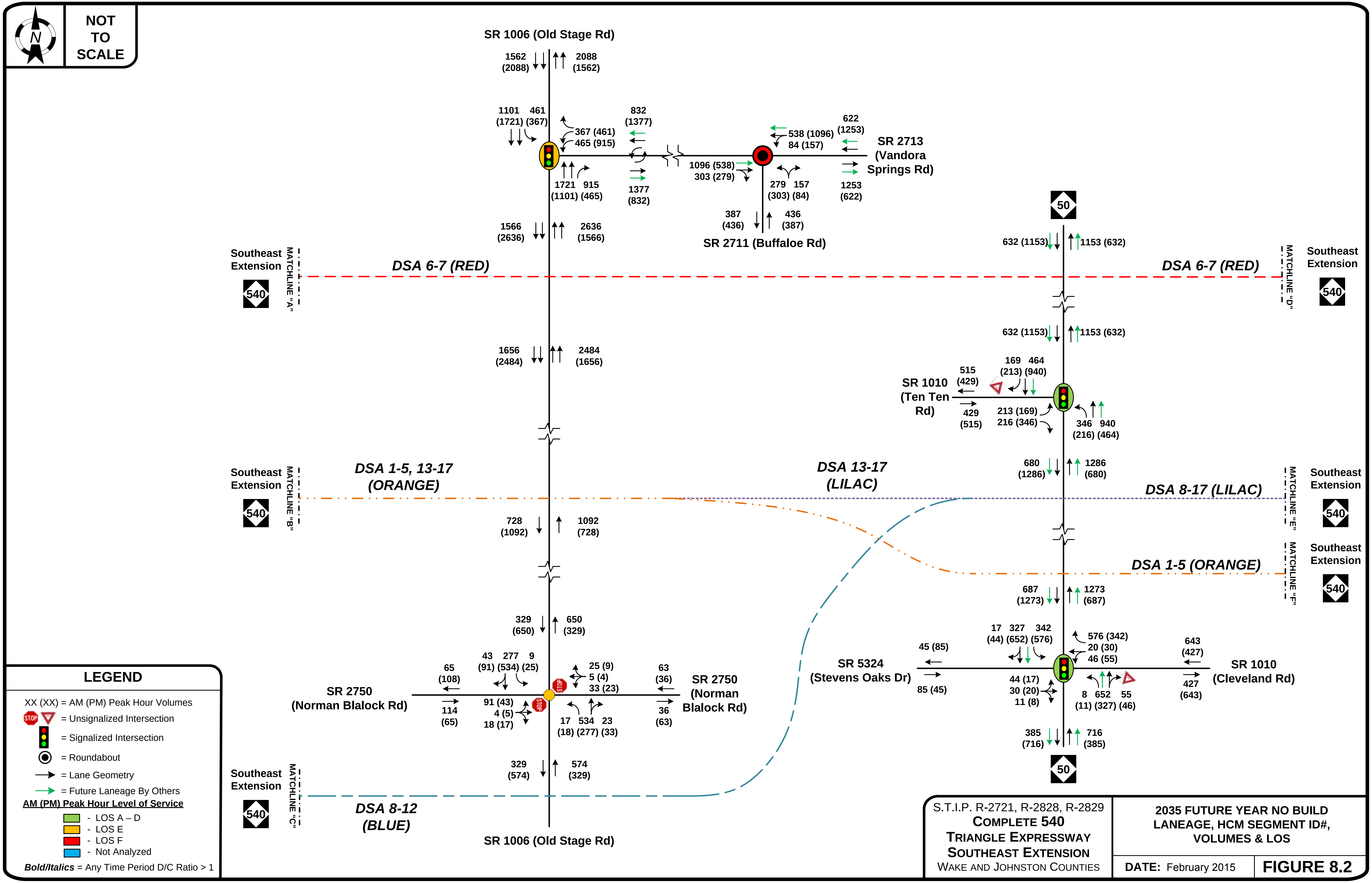
DATE: February 2015

FIGURE 7.4

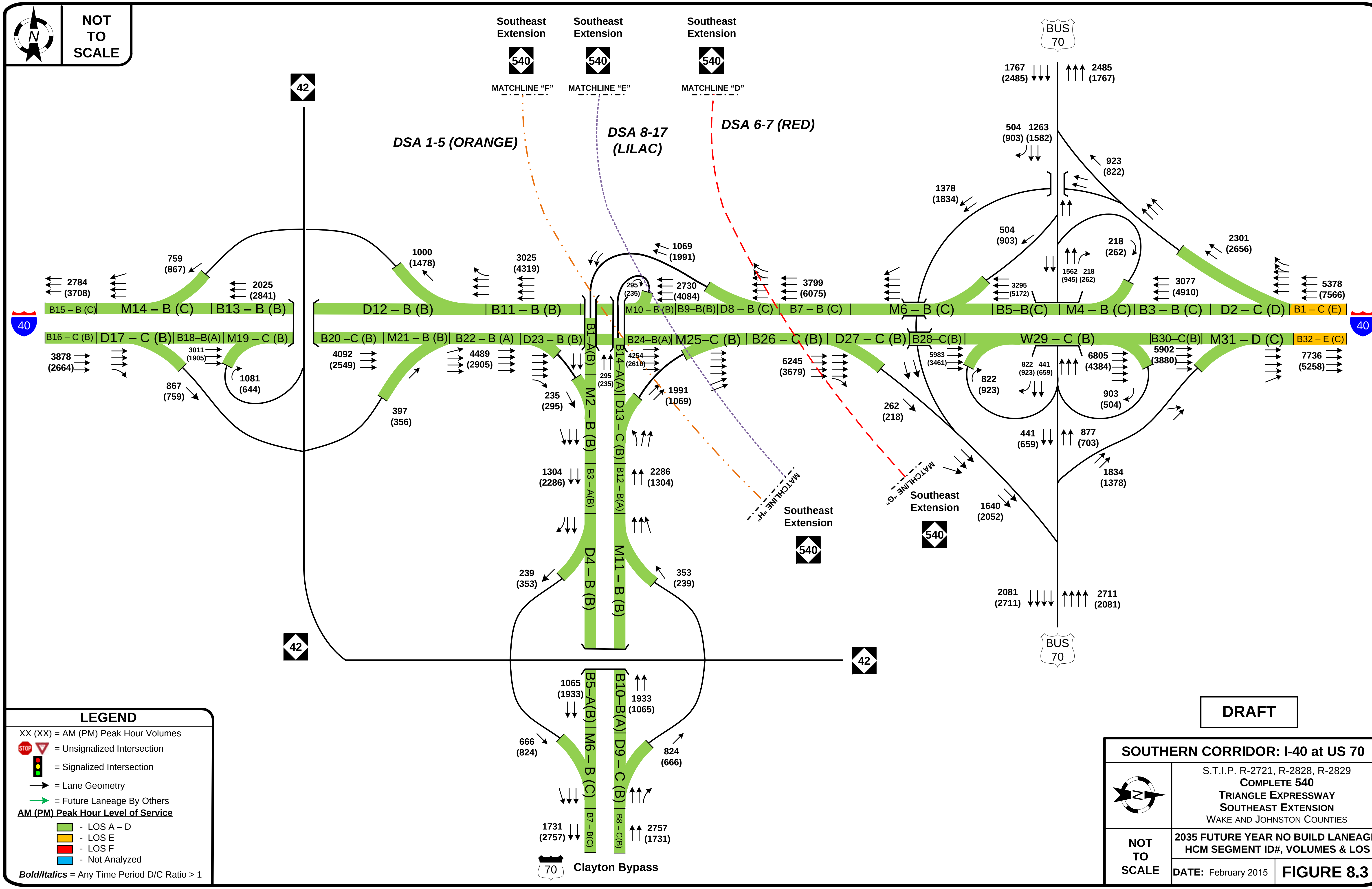


LEGEND
XX (XX) = AM (PM) Peak Hour Volumes
= Unsignalized Intersection
= Signalized Intersection
= Lane Geometry
= Future Laneage By Others
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed
Bold/Italics = Any Time Period D/C Ratio > 1
540
Business 64
SR 2516 (Hodge Rd)
SR 2515 (Old Faison Rd)
SR 2233 (Smithfield Rd)
264 Knightdale Bypass 64
SR 1007 (Poole Rd)
SR 2516 (Hodge Rd)
DSA 1-17 (GREEN)
Southeast Extension
MATCHLINE "I"
B12 – A (B)
D13 – B (B)
B14-A(B)
B11 – B (A)
M10 – B (B)
B9 –
D15 - B(B)
B16-A(A)
M17–A(B)
B18 - A(B)
D19-B(B)
B20 – A (A)
A (A)
D8 – B (A)
B7 - B(A)
B22 – C (B)
M21–C(B)
B20–C(A)
W19 – B (B)
B18 – B (A)
D17 – D (B)
B16 – D (B)
M15 – D (B)
B14 – C (A)
D13 – C (B)
B12 – C (A)
B1 –B (C)
D2 – B (C)
B3–A (C)
W4 – B (B)
B5–A(B)
M6 - B(D)
B7 – B (D)
D8 – B (D)
B9 – A (C)
M10 – B (C)
B11 – A (C)
2192 (3042)
3042 (2192)
461 (439)
1137 (892)
1731 (2603)
431 (698)
1905 (1300)
1300 (1905)
473 (601)
601 (473)
1773 (2506)
2506 (1773)
868 (371)
817 (739)
1767 (956)
1187 (609)
169 (163)
4516 (2287)
3648 (1916)
402 (503)
4050 (2419)
3233 (1680)
5000 (2636)
3813 (2027)
3982 (2190)
1895 (3700)
503 (402)
2398 (4102)
2266 (4568)
371 (868)
739 (817)
1659 (3285)
956 (1767)
2615 (5052)
609 (1187)
2006 (3865)
163 (169)
2169 (4034)
460 (744)
744 (460)
468 (289)
289 (468)
192 (173)
53 (109)
215 (462)
462 (215)
264 (111)
28 (27)
173 (192)
111 (264)
5 (12)
12 (5)
109 (53)
27 (28)
754 (354)
354 (754)
86 (149)
149 (86)
EASTERN CORRIDOR: US 64/264
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES
NOT TO SCALE
2012 BASE YEAR NO BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS
DATE: February 2015
FIGURE 7.5

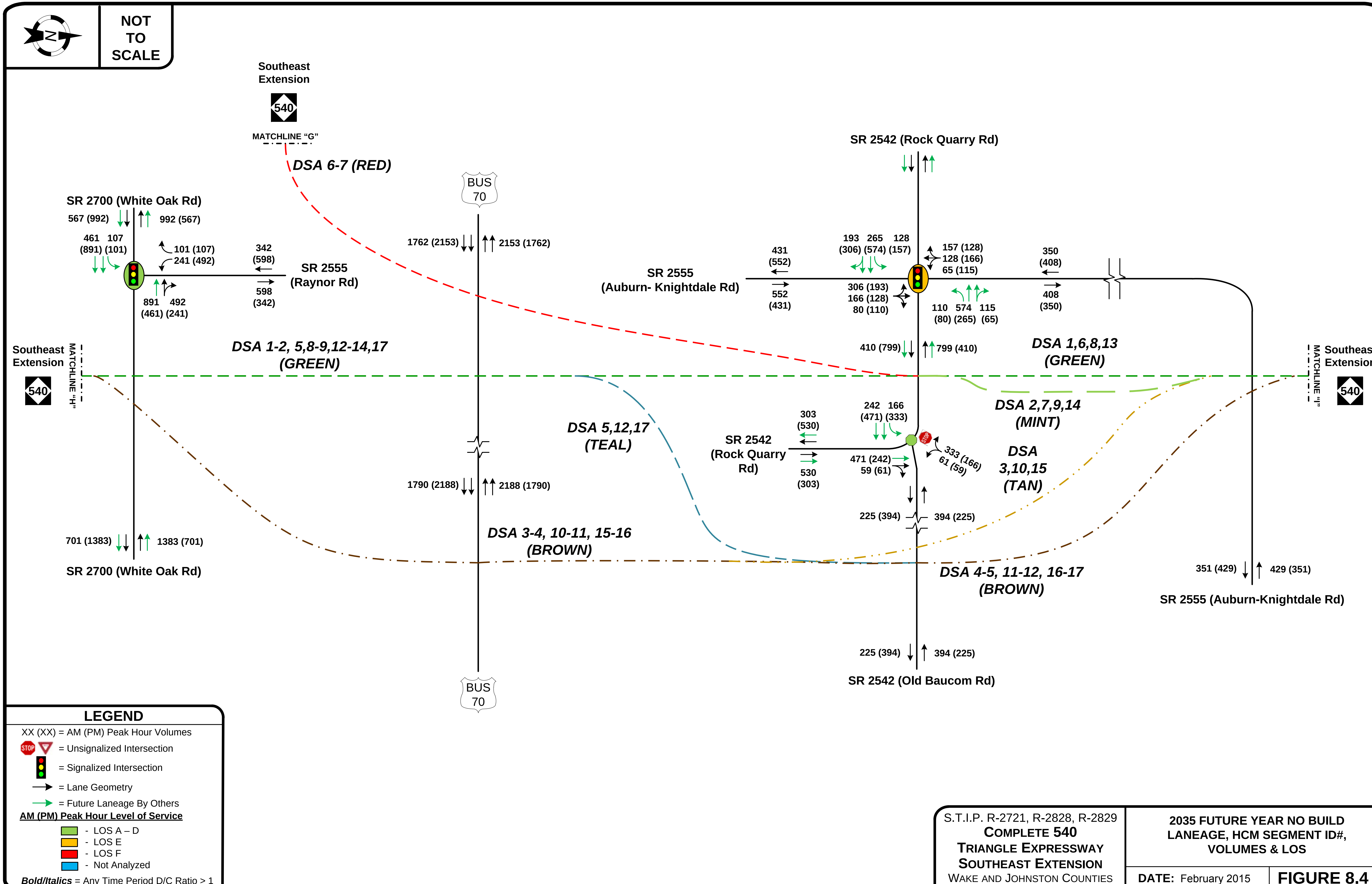

SR 1153
(Old Holly Springs Apex Road)
Triangle Expressway
(Western Wake Freeway)
540
B26 – B (A)
M25 –
B1 – B (C)
D2 –
B (B)
B24–A(A)
W23 – A (A)
B22 – A (A)
B (C)
B3 – A (A)
W4 – A (B)
B5 – A (A)
D6 – A (A)
55
SR 1153
(Old Holly Springs
Apex Road)
SR 1152
(Holly Springs Rd)
SR 1300
(Kildaire Farm Rd)
SR 1152 (Holly Springs Rd)
SR 1386
(Bells Lake Rd)
SR 1386
(Bells Lake Rd)
401
SR 1010
(Ten Ten Rd)
Southeast
Extension
MATCHLINE "A"
DSA 6-7 (RED)
DSA 1-5,
13-17
(ORANGE)
MATCHLINE "B"
SR 1503
(Donny Brook Rd)
SR 2779
(Old
McCullers
Rd)
Chandler Ridge
Cir
Wake Tech
Drive
SR 1393
(Hilltop-Needmore Rd)
SR 1393
(Hilltop-Needmore Rd)
SR 1421 (Old Mills Rd)
SR 2711
(Dwight
Rowland Rd)
MATCHLINE "C"
DSA 8-12
(PURPLE/BLUE)
SR 2886
(Meadow Dr)
LEGEND
XX (XX) = AM (PM) Peak Hour Volumes
= Unsignalized Intersection
= Signalized Intersection
= Lane Geometry
= Future Laneage By Others
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed
Bold/Italics = Any Time Period D/C Ratio > 1
N
NOT
TO
SCALE
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES
2035 FUTURE YEAR NO BUILD
LANEAGE, HCM SEGMENT ID#,
VOLUMES & LOS
DATE: February 2015
FIGURE 8.1



NOT TO SCALE
N
SR 1006 (Old Stage Rd)
1562 (2088)
2088 (1562)
1101 (1721)
461 (367)
367 (461)
465 (915)
832 (1377)
1721 (1101)
915 (465)
1377 (832)
1566 (2636)
2636 (1566)
538 (1096)
84 (157)
622 (1253)
SR 2713 (Vandora Springs Rd)
1096 (538)
303 (279)
279 (303)
157 (84)
1253 (622)
387 (436)
436 (387)
SR 2711 (Buffaloe Rd)
50
632 (1153)
1153 (632)
Southeast Extension
540
MATCHLINE "A"
DSA 6-7 (RED)
MATCHLINE "D"
1656 (2484)
2484 (1656)
515 (429)
169 (213)
464 (940)
SR 1010 (Ten Ten Rd)
429 (515)
213 (169)
216 (346)
346 (216)
940 (464)
MATCHLINE "B"
DSA 1-5, 13-17 (ORANGE)
DSA 13-17 (LILAC)
680 (1286)
1286 (680)
DSA 8-17 (LILAC)
MATCHLINE "E"
728 (1092)
1092 (728)
MATCHLINE "F"
DSA 1-5 (ORANGE)
687 (1273)
1273 (687)
329 (650)
650 (329)
17 (44)
327 (652)
342 (576)
576 (342)
20 (30)
46 (55)
45 (85)
643 (427)
SR 5324 (Stevens Oaks Dr)
SR 1010 (Cleveland Rd)
85 (45)
44 (17)
30 (20)
11 (8)
8 (11)
652 (327)
55 (46)
427 (643)
385 (716)
716 (385)
43 (91)
277 (534)
9 (25)
65 (108)
25 (9)
5 (4)
33 (23)
63 (36)
SR 2750 (Norman Blalock Rd)
SR 2750 (Norman Blalock Rd)
114 (65)
91 (43)
4 (5)
18 (17)
17 (18)
534 (277)
23 (33)
36 (63)
329 (574)
574 (329)
MATCHLINE "C"
DSA 8-12 (BLUE)
SR 1006 (Old Stage Rd)
LEGEND
XX (XX) = AM (PM) Peak Hour Volumes
STOP = Unsignalized Intersection
= Signalized Intersection
= Roundabout
= Lane Geometry
= Future Laneage By Others
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed
Bold/Italics = Any Time Period D/C Ratio > 1
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES
2035 FUTURE YEAR NO BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS
DATE: February 2015
FIGURE 8.2



NOT TO SCALE
Southeast Extension
540
MATCHLINE "F"
MATCHLINE "E"
MATCHLINE "D"
BUS 70
DSA 1-5 (ORANGE)
DSA 8-17 (LILAC)
DSA 6-7 (RED)
42
40
B15 – B (C)
M14 – B (C)
B13 – B (B)
D12 – B (B)
B11 – B (B)
M10 – B (B)
B9–B(B)
D8 – B (C)
B7 – B (C)
M6 – B (C)
B5–B(C)
M4 – B (C)
B3 – B (C)
D2 – C (D)
B1 – C (E)
B16 – C (B)
D17 – C (B)
B18–B(A)
M19 – C (B)
B20 – C (B)
M21 – B (B)
B22 – B (A)
D23 – B (B)
B24–B(A)
M25–C (B)
B26 – C (B)
D27 – C (B)
B28–C(B)
W29 – C (B)
B30–C(B)
M31 – D (C)
B32 – E (C)
B1 – A(B)
M2 – B (B)
B3 – A(B)
D4 – B (B)
B5–A(B)
M6 – B (C)
B7 – B(C)
B14 – A(A)
D13 – C (B)
B12 – B(A)
M11 – B (B)
B10–B(A)
D9 – C (B)
B8 – C(B)
MATCHLINE "H"
MATCHLINE "G"
70
Clayton Bypass
DRAFT
LEGEND
XX (XX) = AM (PM) Peak Hour Volumes
= Unsignalized Intersection
= Signalized Intersection
= Lane Geometry
= Future Laneage By Others
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed
Bold/Italics = Any Time Period D/C Ratio > 1
SOUTHERN CORRIDOR: I-40 at US 70
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES
NOT TO SCALE
2035 FUTURE YEAR NO BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS
DATE: February 2015
FIGURE 8.3

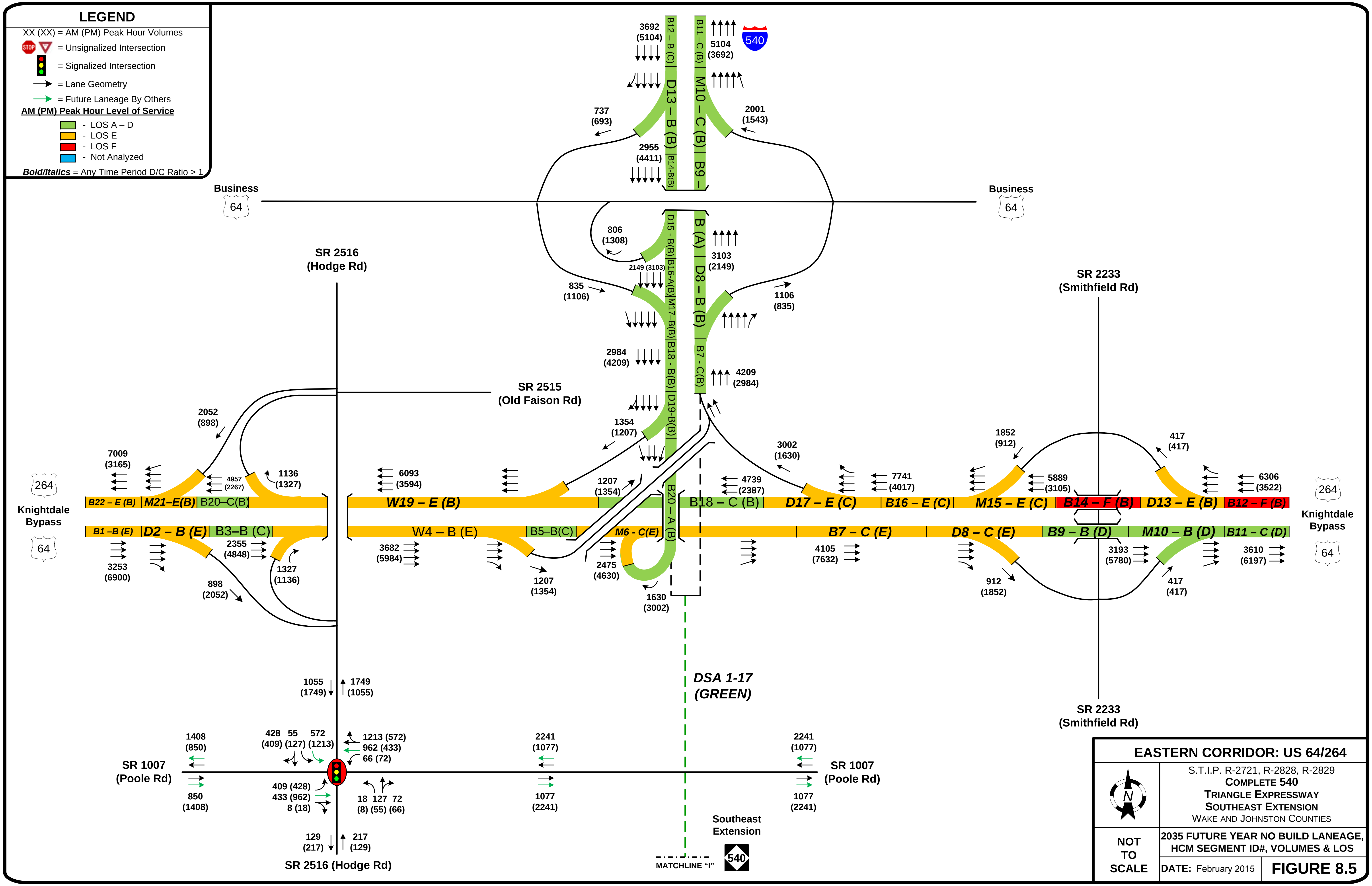


S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

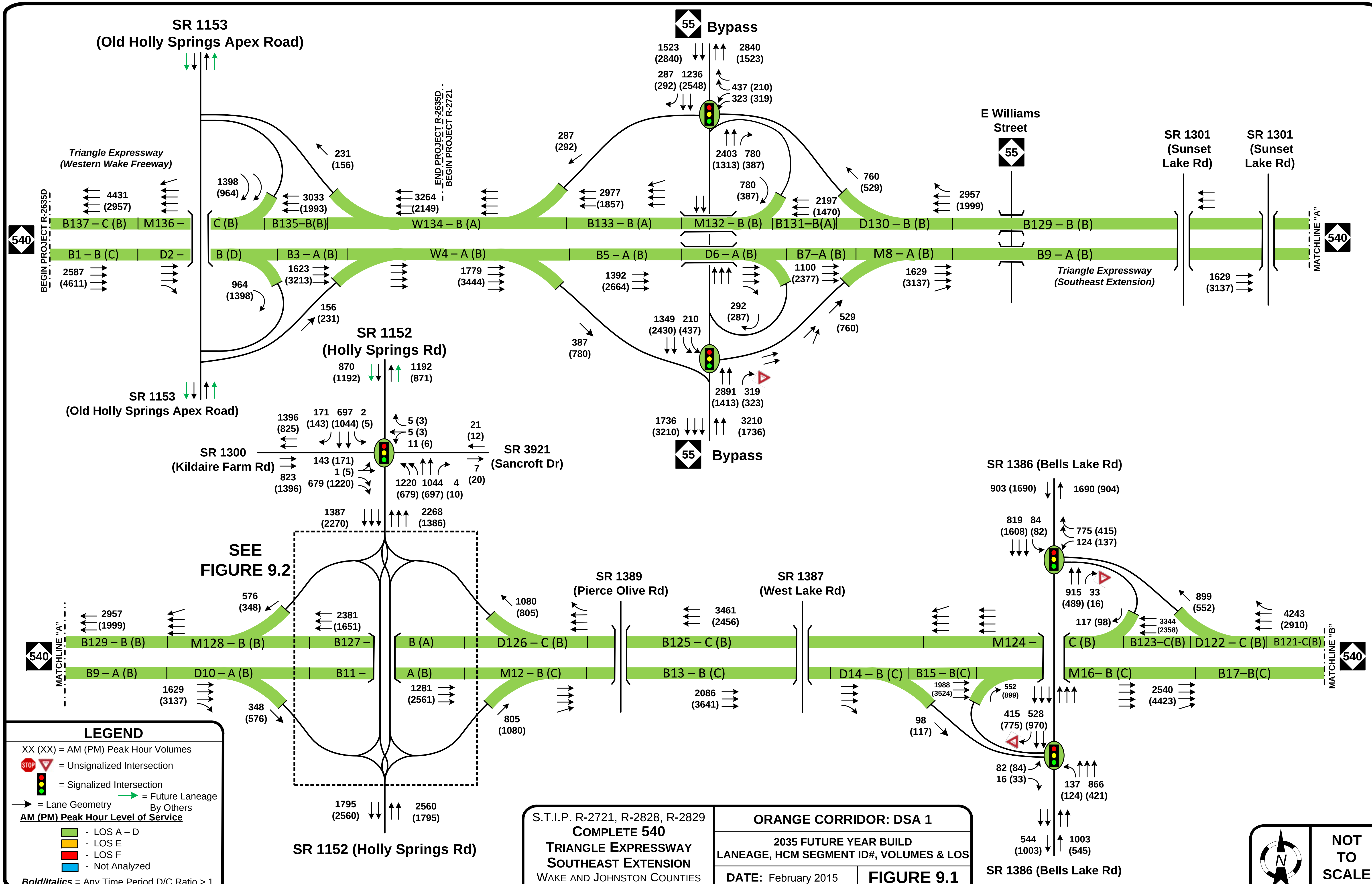
2035 FUTURE YEAR NO BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: February 2015

FIGURE 8.4



LEGEND
XX (XX) = AM (PM) Peak Hour Volumes
= Unsignalized Intersection
= Signalized Intersection
= Lane Geometry
= Future Laneage By Others
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed
Bold/Italics = Any Time Period D/C Ratio > 1
540
Business 64
SR 2516 (Hodge Rd)
SR 2515 (Old Faison Rd)
SR 2233 (Smithfield Rd)
264
Knightdale Bypass
64
D13 – B (B)
M10 – C (B)
B12 – B (C)
B11 – C (B)
B9 – B (A)
D8 – B (B)
B7 - C(B)
B22 – E (B)
M21–E(B)
B20–C(B)
W19 – E (B)
B18 – C (B)
D17 – E (C)
B16 – E (C)
M15 – E (C)
B14 – F (B)
D13 – E (B)
B12 – F (B)
B1 –B (E)
D2 – B (E)
B3–B (C)
W4 – B (E)
B5–B(C)
M6 - C(E)
B7 – C (E)
D8 – C (E)
B9 – B (D)
M10 – B (D)
B11 – C (D)
B20 – A (B)
DSA 1-17 (GREEN)
SR 1007 (Poole Rd)
SR 2516 (Hodge Rd)
Southeast Extension
MATCHLINE "I"
EASTERN CORRIDOR: US 64/264
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES
NOT TO SCALE
2035 FUTURE YEAR NO BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS
DATE: February 2015
FIGURE 8.5



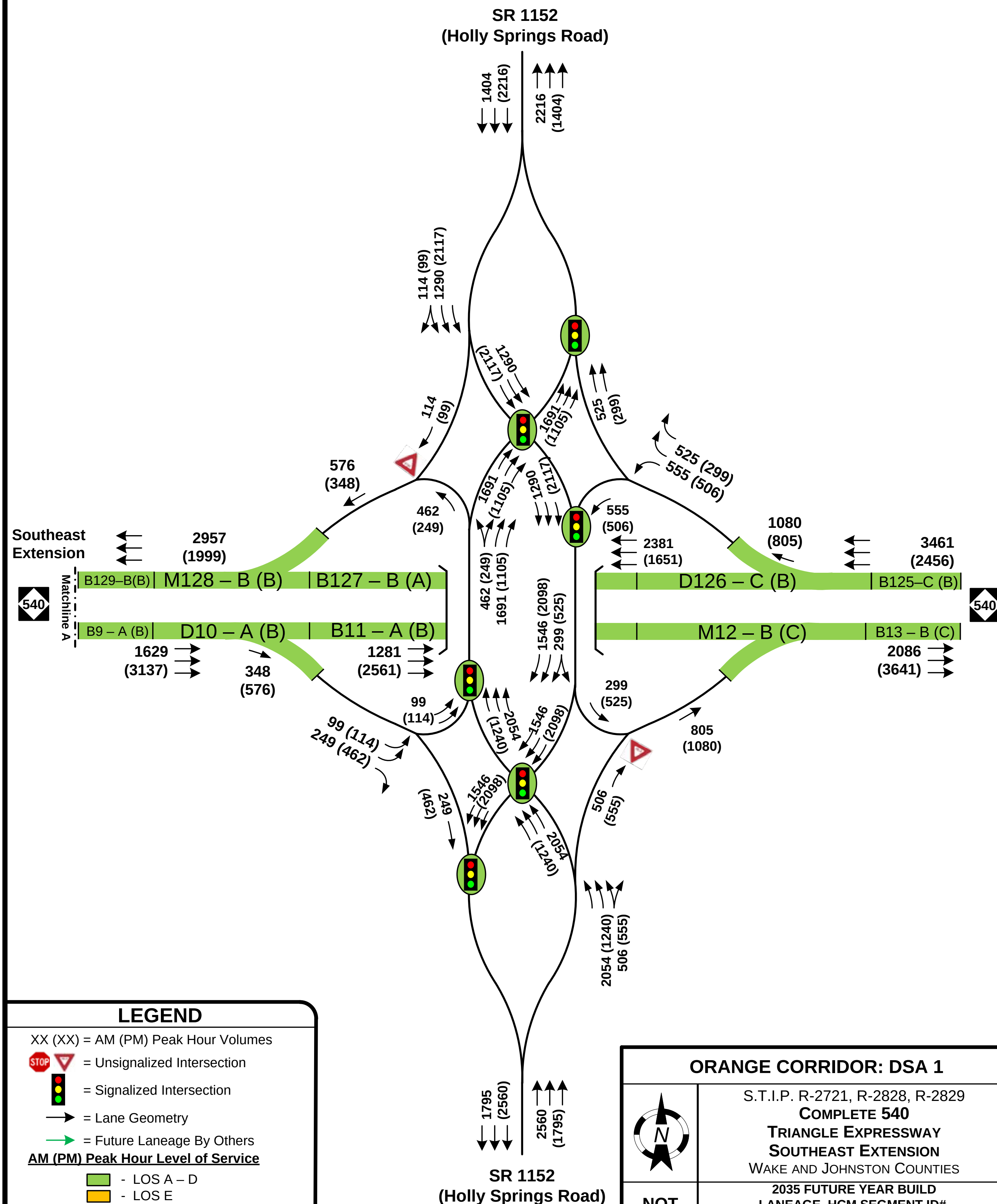
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

ORANGE CORRIDOR: DSA 1

2035 FUTURE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: February 2015

FIGURE 9.1



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

STOP = Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

= Future Laneage By Others

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

ORANGE CORRIDOR: DSA 1

S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

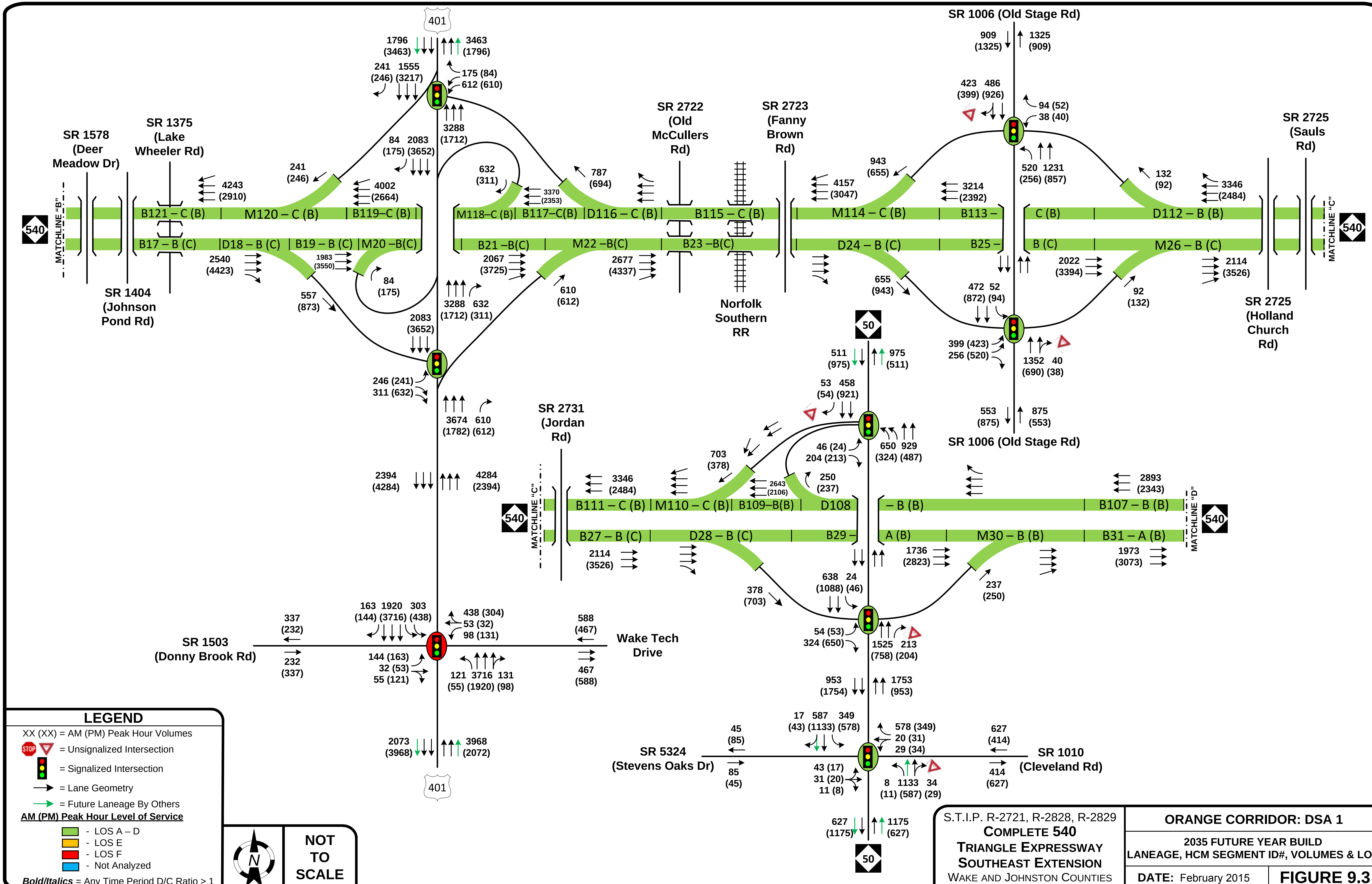
N

NOT TO SCALE

2035 FUTURE YEAR BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: February 2015

FIGURE 9.2



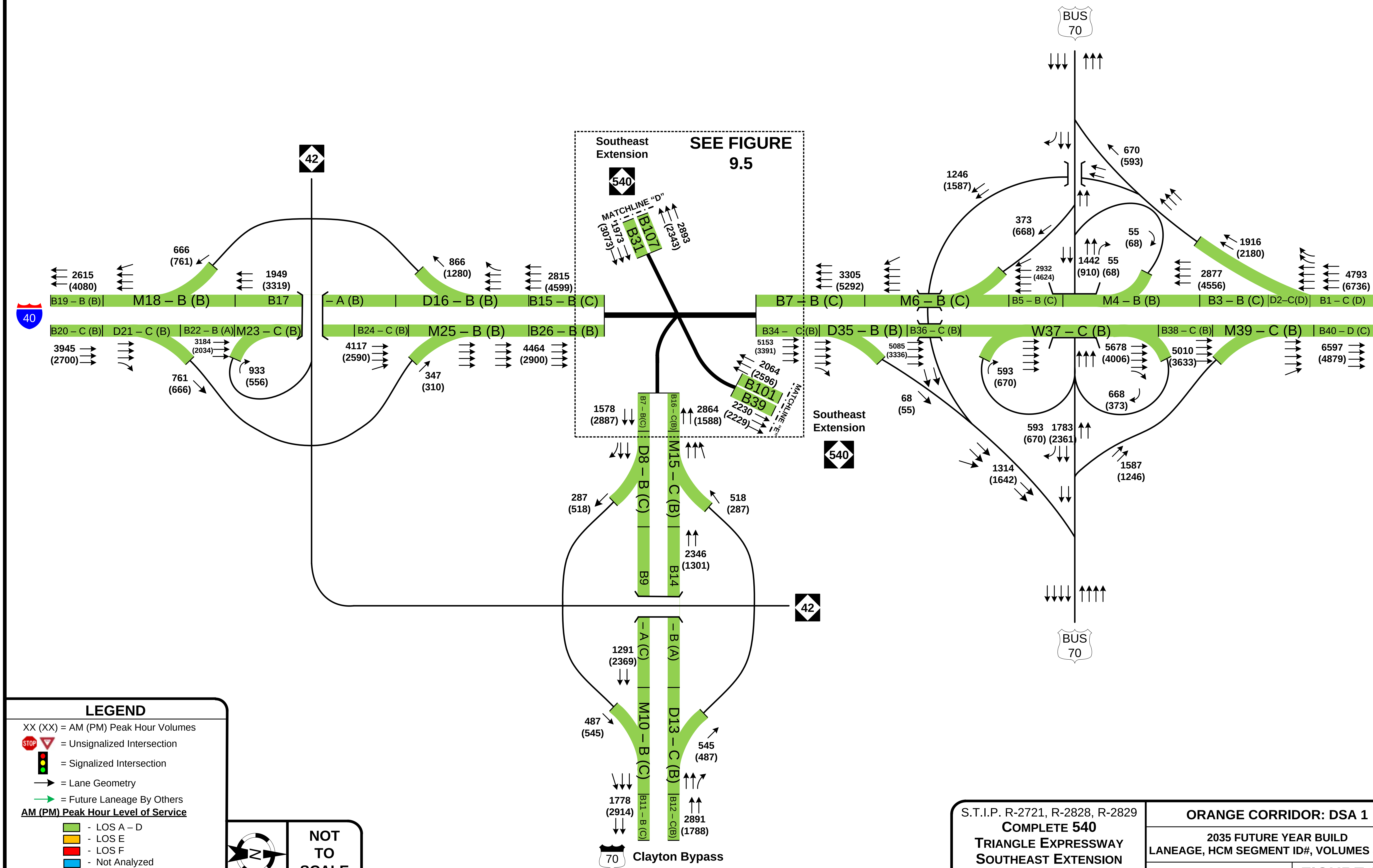
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

ORANGE CORRIDOR: DSA 1

2035 FUTURE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: February 2015

FIGURE 9.3



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes
= Unsignalized Intersection
= Signalized Intersection
= Lane Geometry
= Future Laneage By Others

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

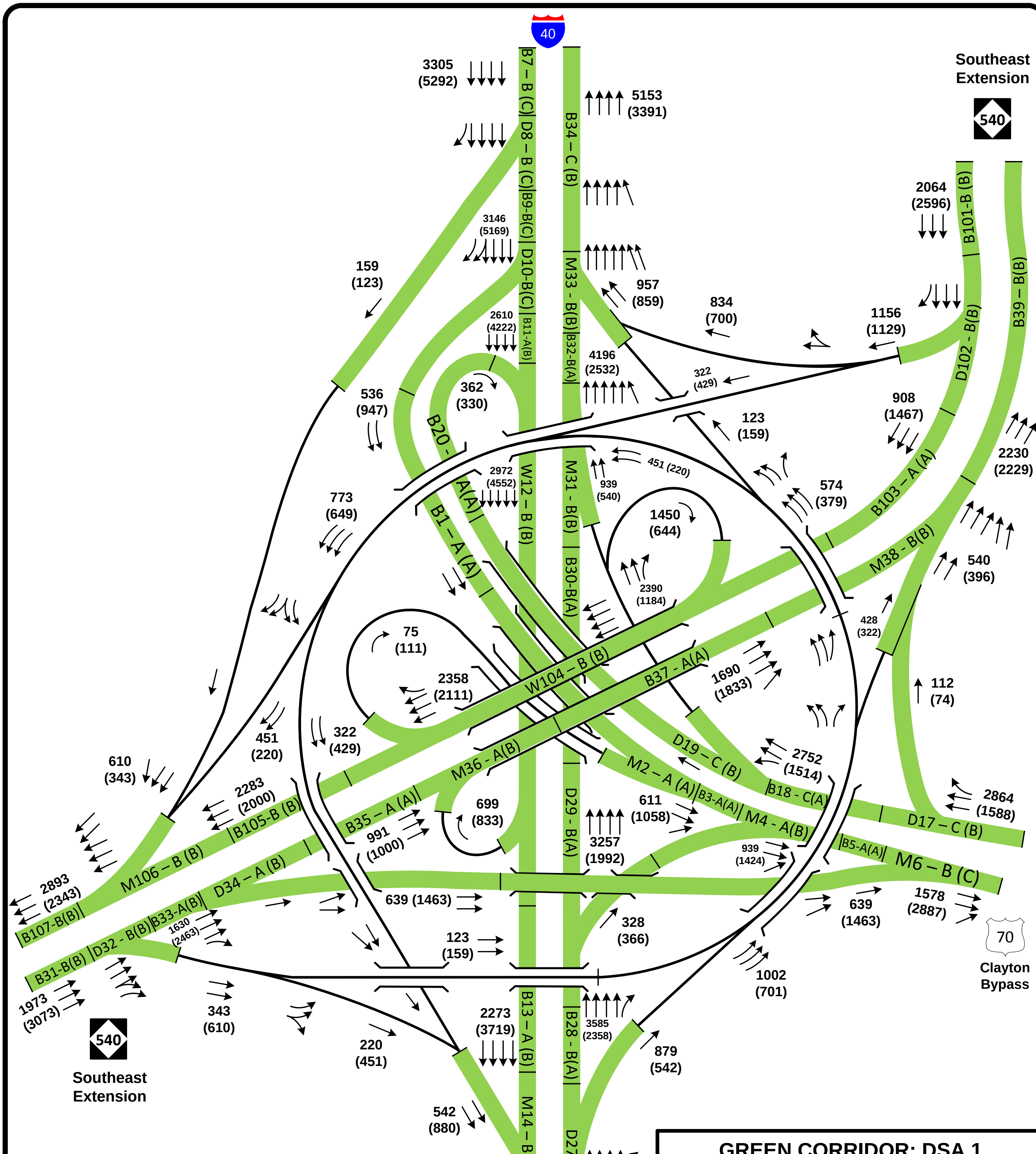
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

ORANGE CORRIDOR: DSA 1

2035 FUTURE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: February 2015

FIGURE 9.4



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

→ = Lane Geometry

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

GREEN CORRIDOR: DSA 1

S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

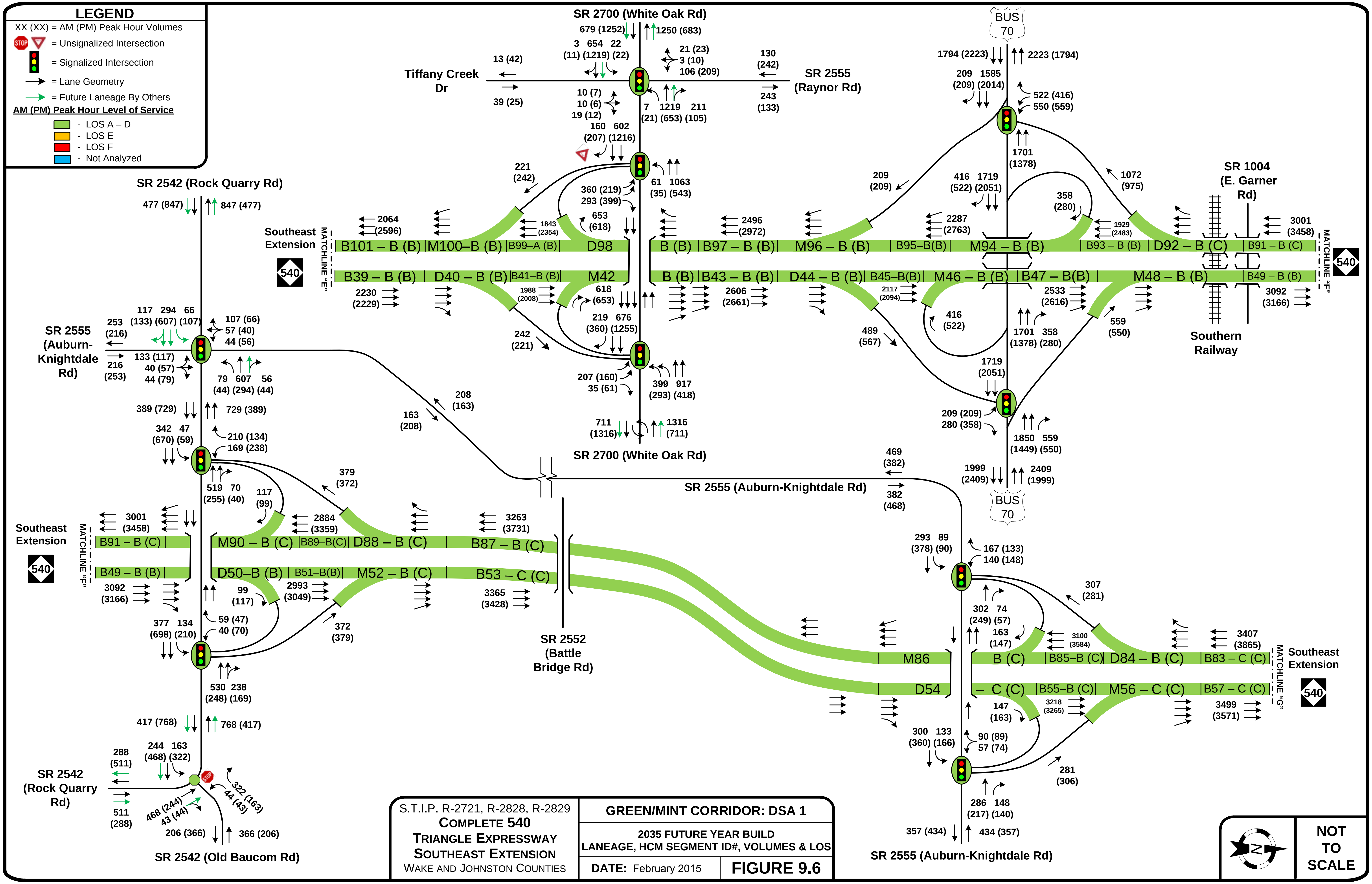
N

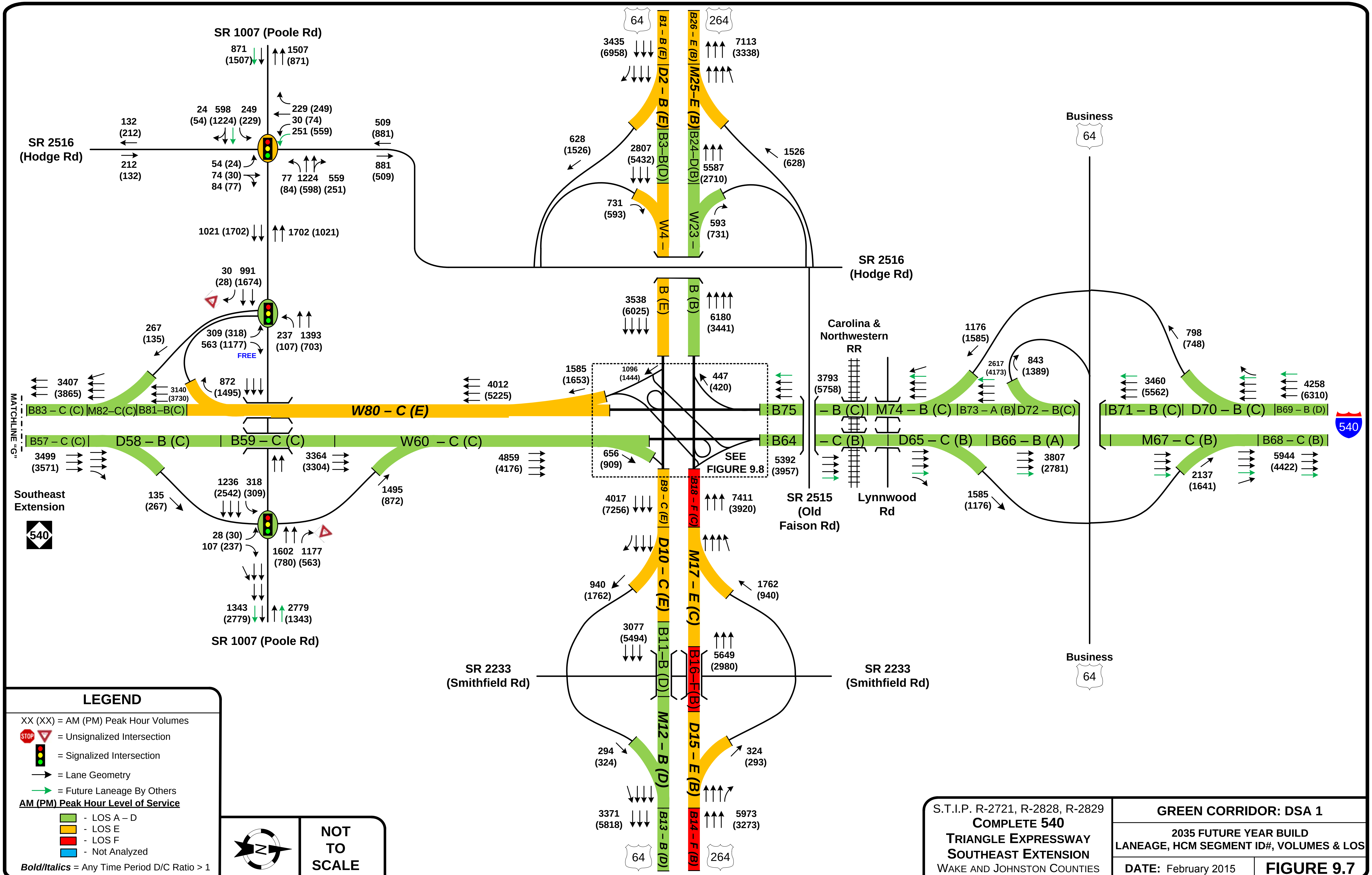
NOT TO SCALE

2035 FUTURE YEAR BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: February 2015

FIGURE 9.5


LEGEND
XX (XX) = AM (PM) Peak Hour Volumes
= Unsignalized Intersection
= Signalized Intersection
= Lane Geometry
= Future Laneage By Others
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed
SR 2700 (White Oak Rd)
Tiffany Creek Dr
SR 2555 (Raynor Rd)
BUS 70
SR 1004 (E. Garner Rd)
SR 2542 (Rock Quarry Rd)
Southeast Extension
MATCHLINE "E"
MATCHLINE "F"
MATCHLINE "G"
540
SR 2555 (Auburn-Knightdale Rd)
Southern Railway
SR 2552 (Battle Bridge Rd)
SR 2542 (Old Baucom Rd)
S.T.I.P. R-2721, R-2828, R-2829
Complete 540
Triangle Expressway
Southeast Extension
Wake and Johnston Counties
GREEN/MINT CORRIDOR: DSA 1
2035 FUTURE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS
DATE: February 2015
FIGURE 9.6
NOT TO SCALE



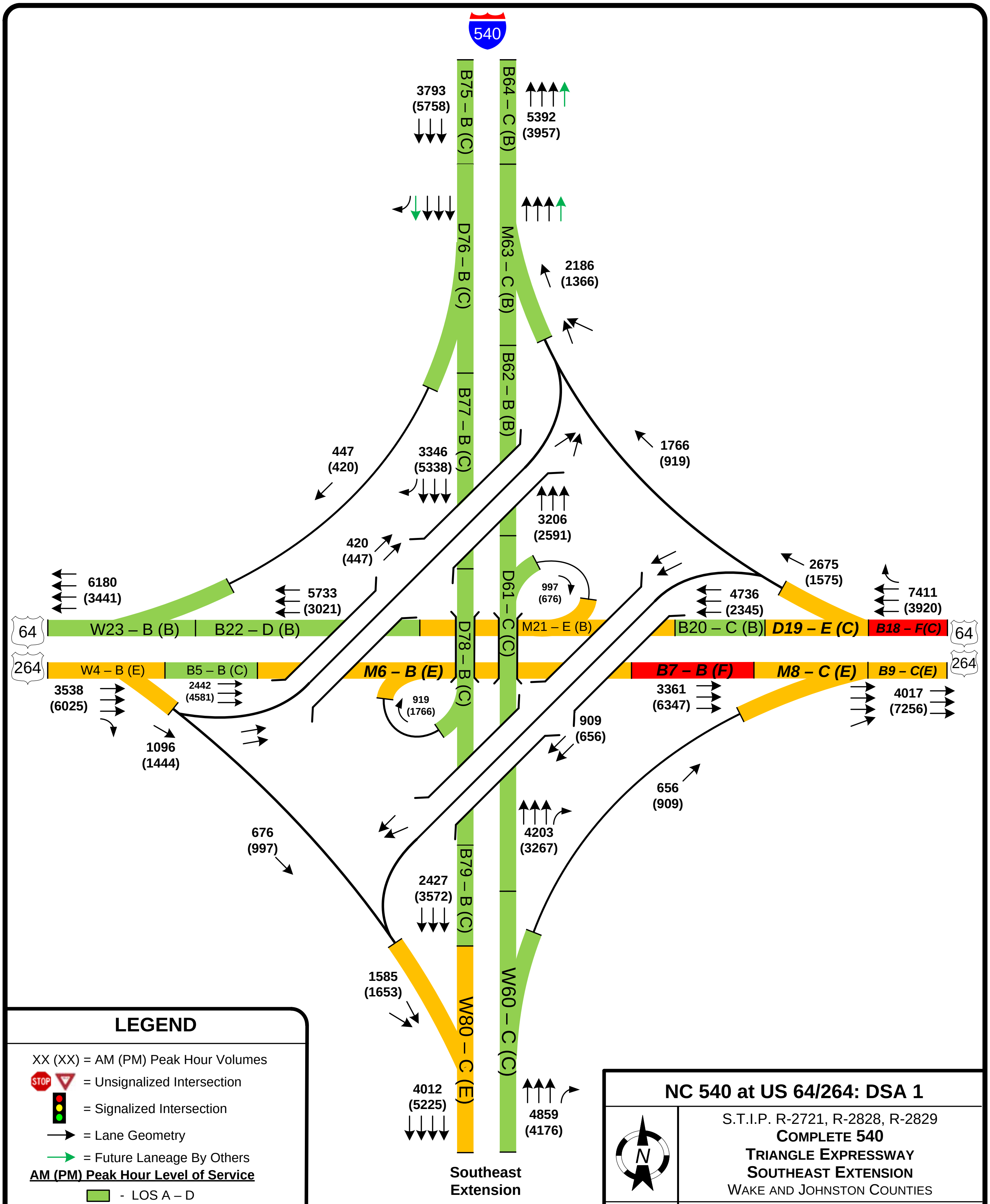
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

GREEN CORRIDOR: DSA 1

2035 FUTURE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: February 2015

FIGURE 9.7



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

STOP = Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

= Future Laneage By Others

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

NC 540 at US 64/264: DSA 1

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540

TRIANGLE EXPRESSWAY

SOUTHEAST EXTENSION

WAKE AND JOHNSTON COUNTIES

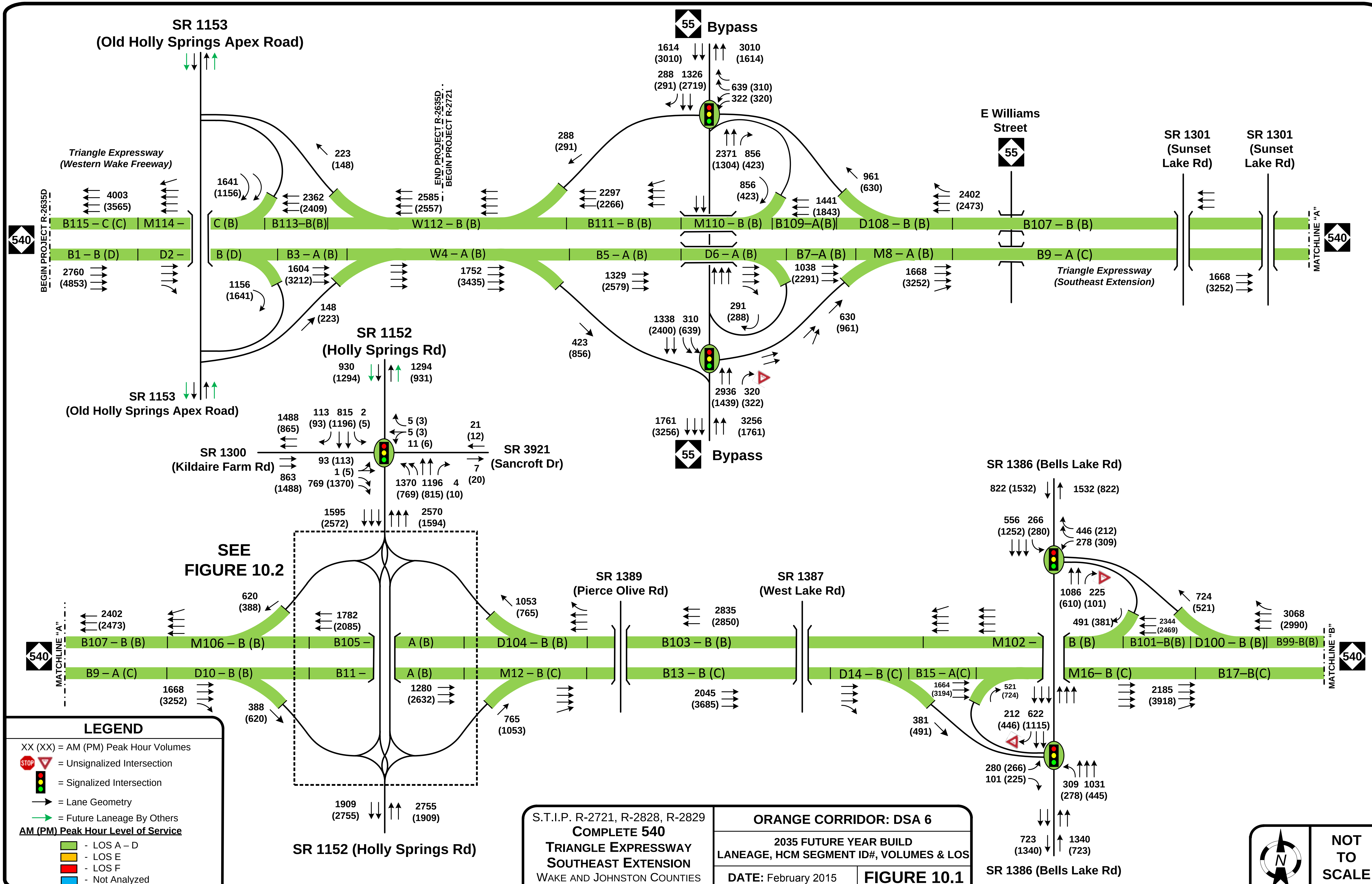
N

NOT TO SCALE

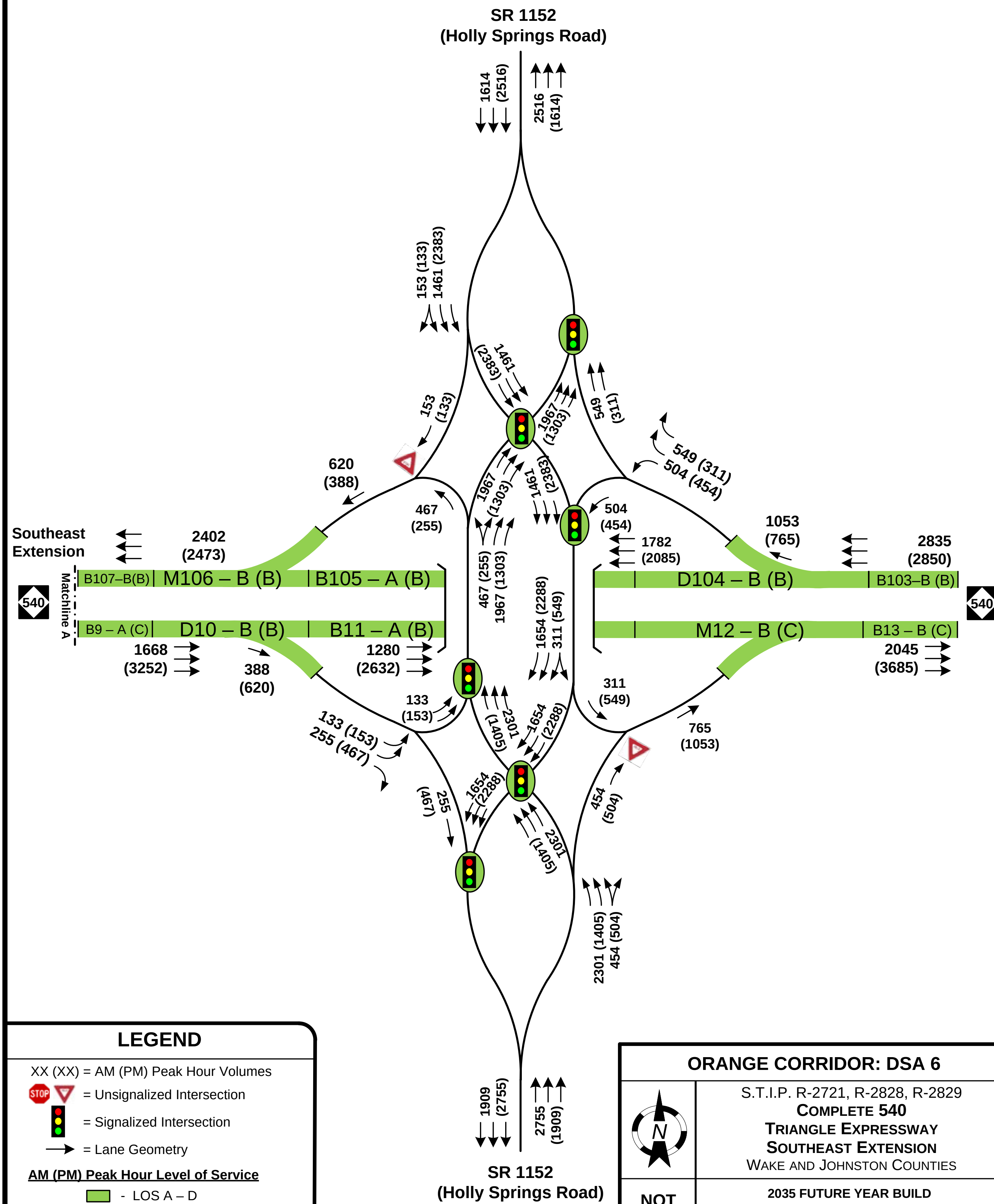
2035 FUTURE YEAR BUILD LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: February 2015

FIGURE 9.8



SR 1153
(Old Holly Springs Apex Road)
Triangle Expressway
(Western Wake Freeway)
BEGIN PROJECT R-2635D
END PROJECT R-2635D
BEGIN PROJECT R-2721
540
55 Bypass
E Williams Street
55
SR 1301 (Sunset Lake Rd)
SR 1301 (Sunset Lake Rd)
MATCHLINE "A"
B115 – C (C)
M114 –
C (B)
B113–B(B)
W112 – B (B)
B111 – B (B)
M110 – B (B)
B109–A(B)
D108 – B (B)
B107 – B (B)
B1 – B (D)
D2 –
B (D)
B3 – A (B)
W4 – A (B)
B5 – A (B)
D6 – A (B)
B7–A (B)
M8 – A (B)
B9 – A (C)
Triangle Expressway
(Southeast Extension)
SR 1152
(Holly Springs Rd)
SR 1153
(Old Holly Springs Apex Road)
SR 1300
(Kildaire Farm Rd)
SR 3921
(Sancroft Dr)
55 Bypass
SR 1386 (Bells Lake Rd)
SEE FIGURE 10.2
SR 1389
(Pierce Olive Rd)
SR 1387
(West Lake Rd)
MATCHLINE "A"
MATCHLINE "B"
B107 – B (B)
M106 – B (B)
B105 –
A (B)
D104 – B (B)
B103 – B (B)
M102 –
B (B)
B101–B(B)
D100 – B (B)
B99-B(B)
B9 – A (C)
D10 – B (B)
B11 –
A (B)
M12 – B (C)
B13 – B (C)
D14 – B (C)
B15 – A(C)
M16– B (C)
B17–B(C)
SR 1152 (Holly Springs Rd)
SR 1386 (Bells Lake Rd)
LEGEND
XX (XX) = AM (PM) Peak Hour Volumes
STOP = Unsignalized Intersection
= Signalized Intersection
= Lane Geometry
= Future Laneage By Others
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES
ORANGE CORRIDOR: DSA 6
2035 FUTURE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS
DATE: February 2015
FIGURE 10.1
N
NOT TO SCALE



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

= Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

ORANGE CORRIDOR: DSA 6

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540

TRIANGLE EXPRESSWAY

SOUTHEAST EXTENSION

WAKE AND JOHNSTON COUNTIES

N

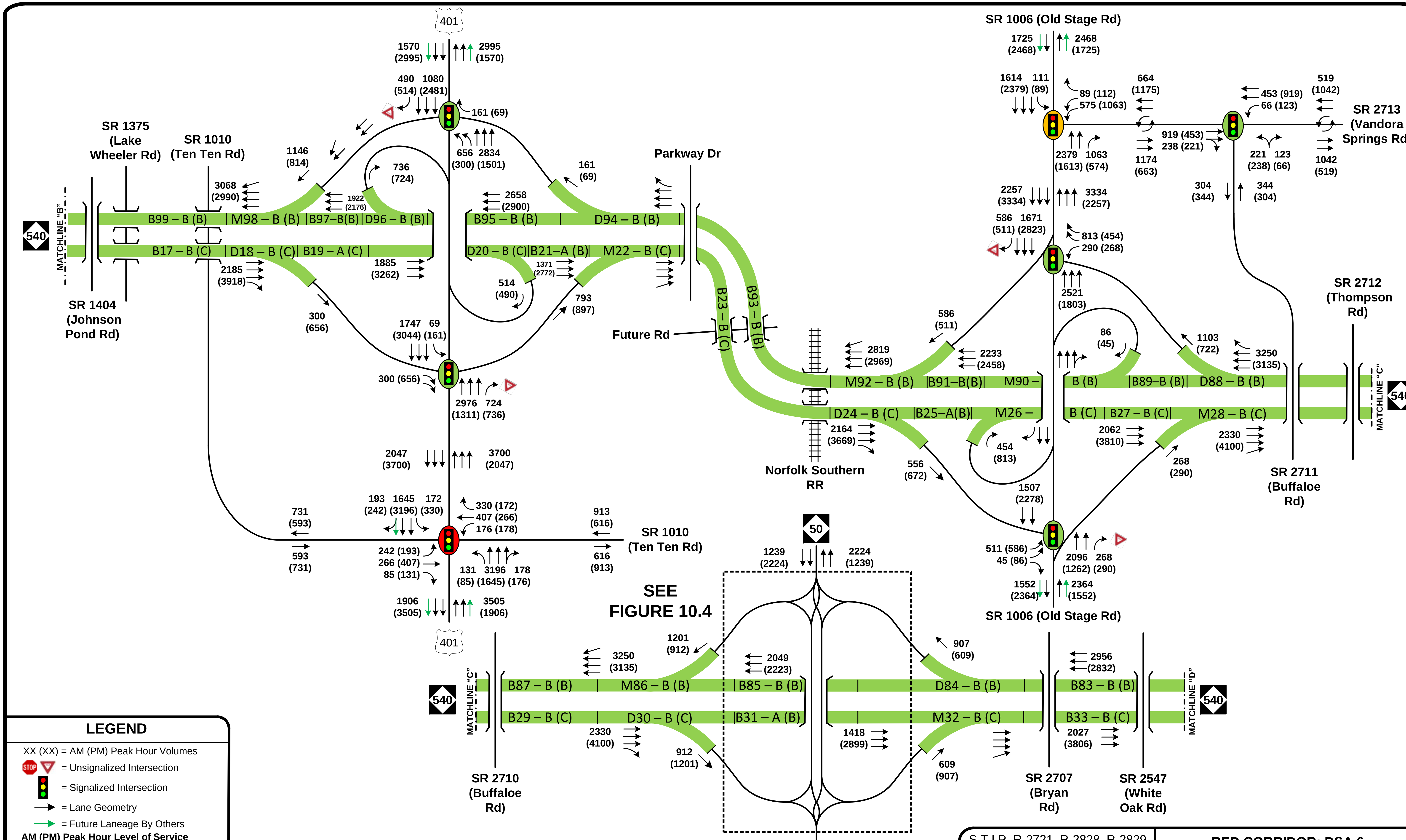
NOT TO SCALE

2035 FUTURE YEAR BUILD

LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: February 2015

FIGURE 10.2



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

= Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

= Future Laneage By Others

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

NOT TO SCALE

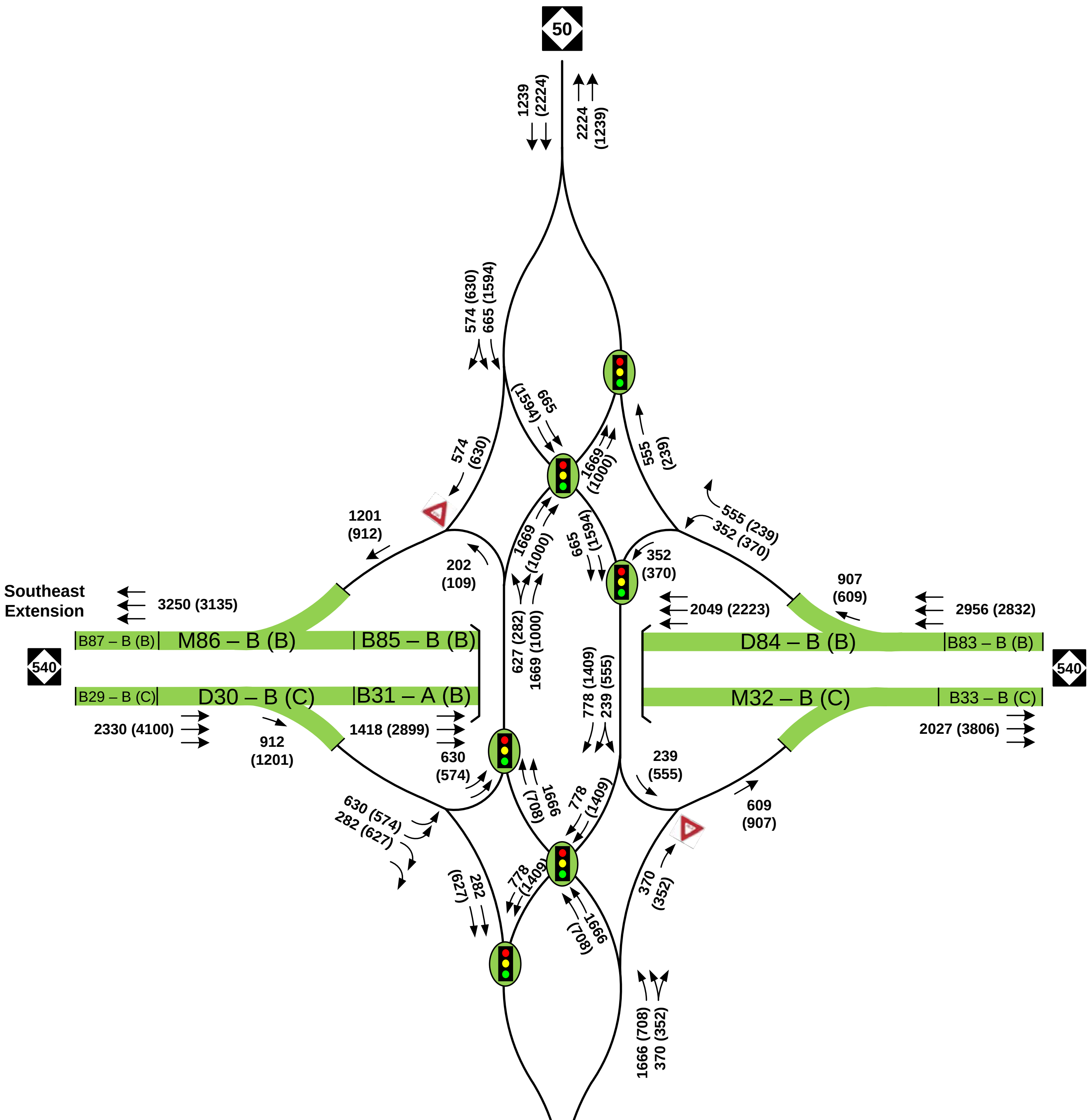
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

RED CORRIDOR: DSA 6

2035 FUTURE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: February 2015

FIGURE 10.3



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

= Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

RED CORRIDOR: DSA 6

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540

TRIANGLE EXPRESSWAY

SOUTHEAST EXTENSION

WAKE AND JOHNSTON COUNTIES

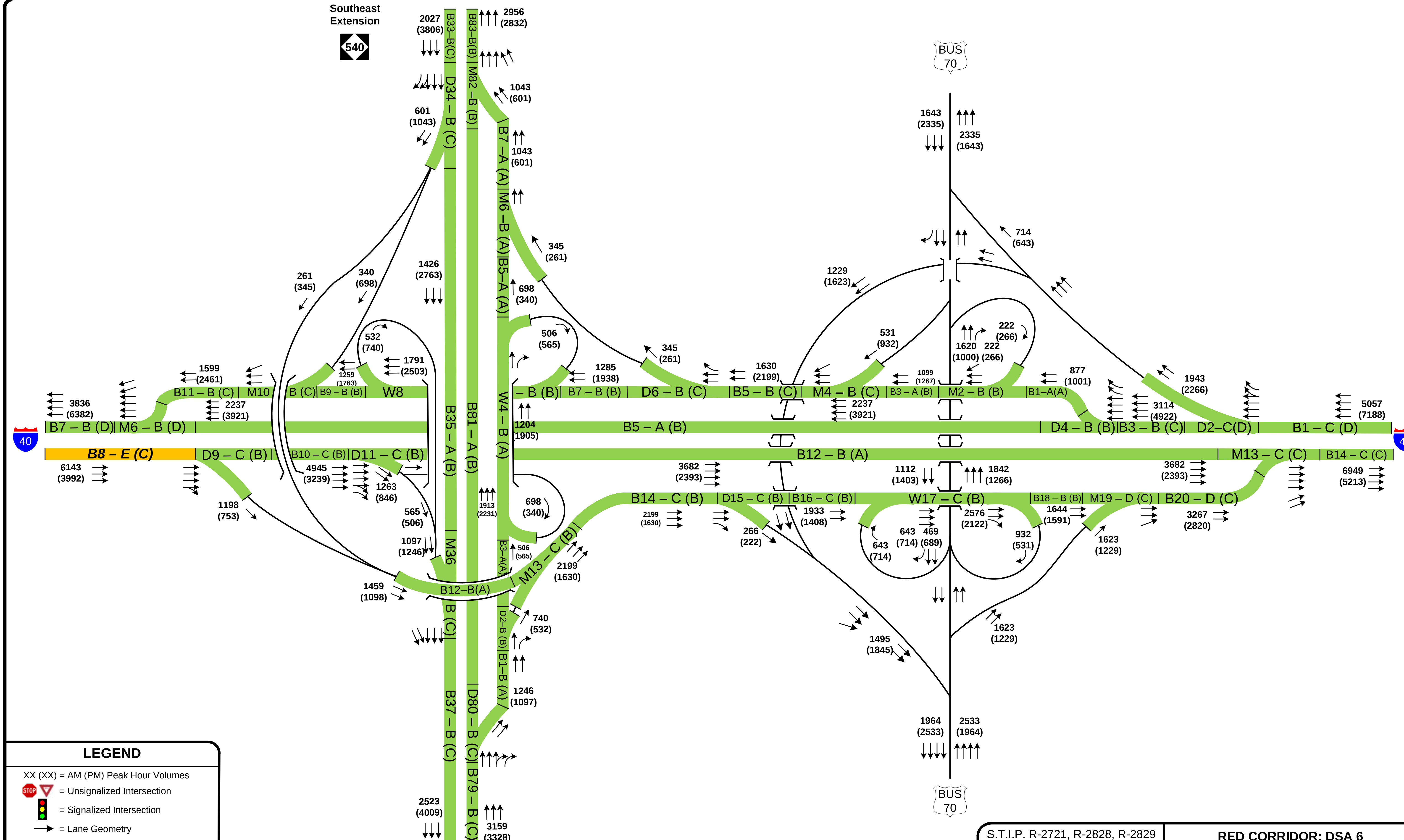
NOT TO SCALE

2035 FUTURE YEAR BUILD

LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: February 2015

FIGURE 10.4



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

STOP = Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

N

NOT TO SCALE

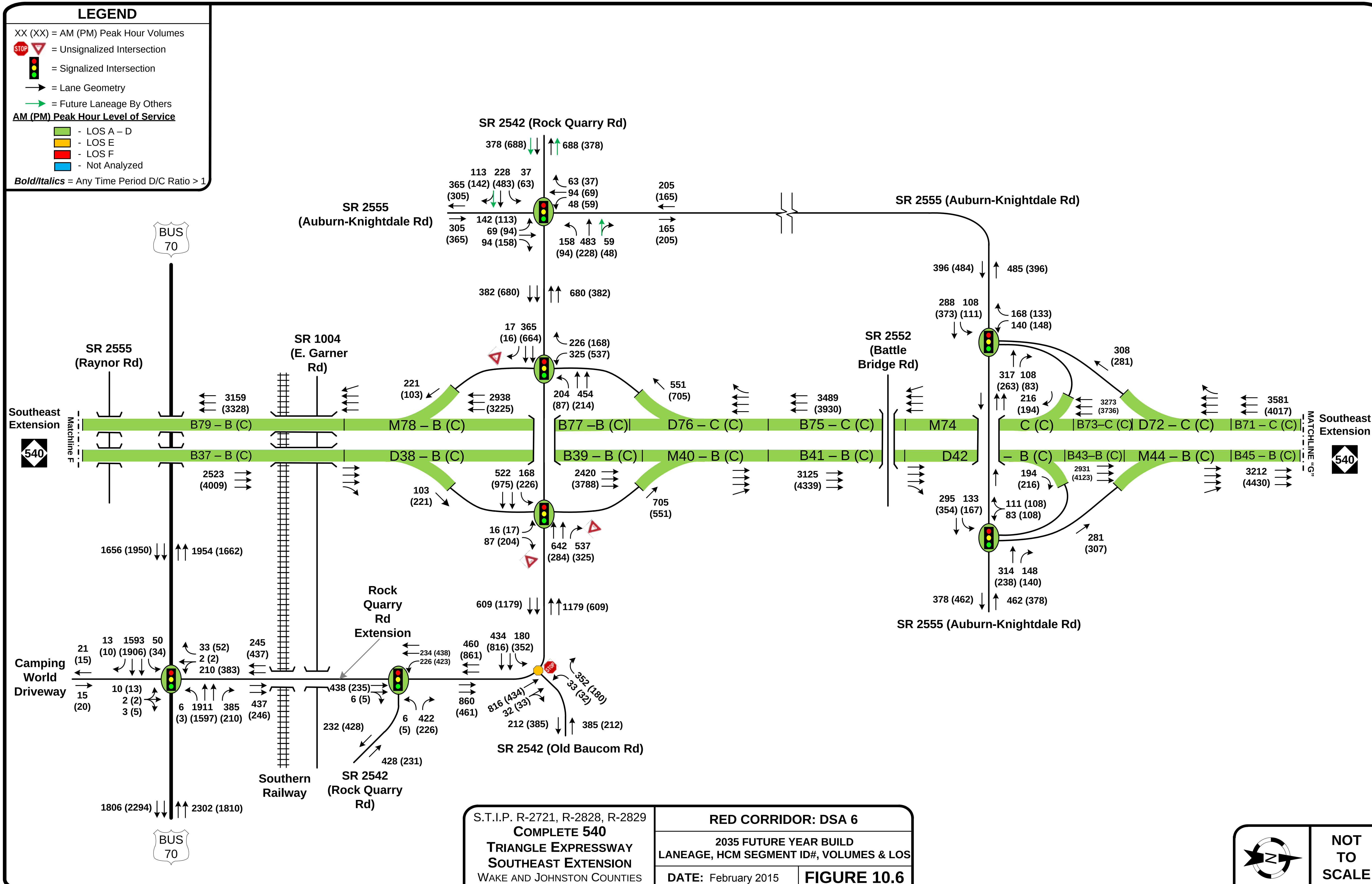
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

RED CORRIDOR: DSA 6

2035 FUTURE YEAR BUILD LANEAGE & HCM SEGMENT ID#

DATE: February 2015

FIGURE 10.5



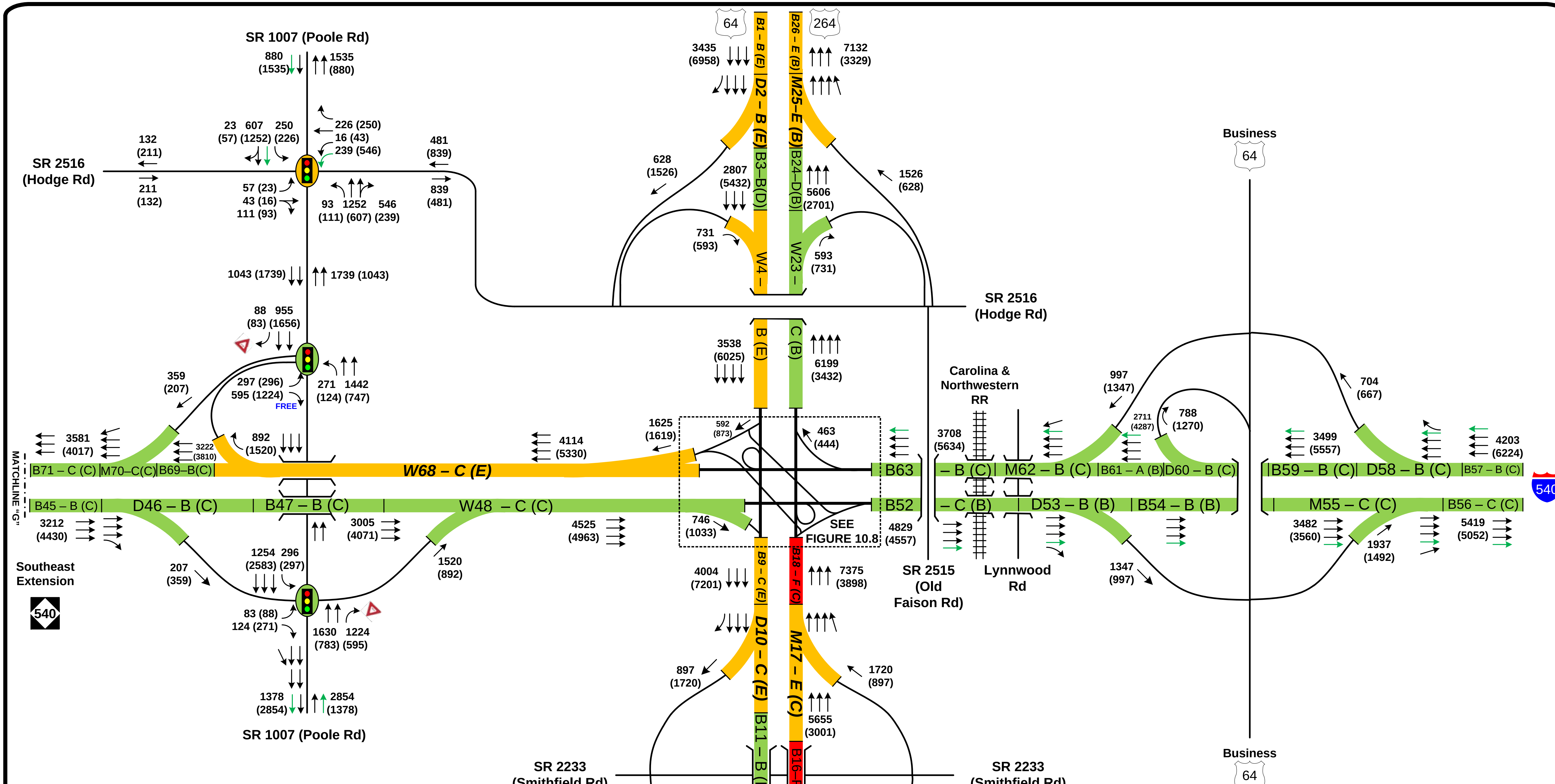
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

RED CORRIDOR: DSA 6

2035 FUTURE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: February 2015

FIGURE 10.6



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

= Unsignalized Intersection

= Signalized Intersection

= Lane Geometry

= Future Laneage By Others

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

NOT TO SCALE

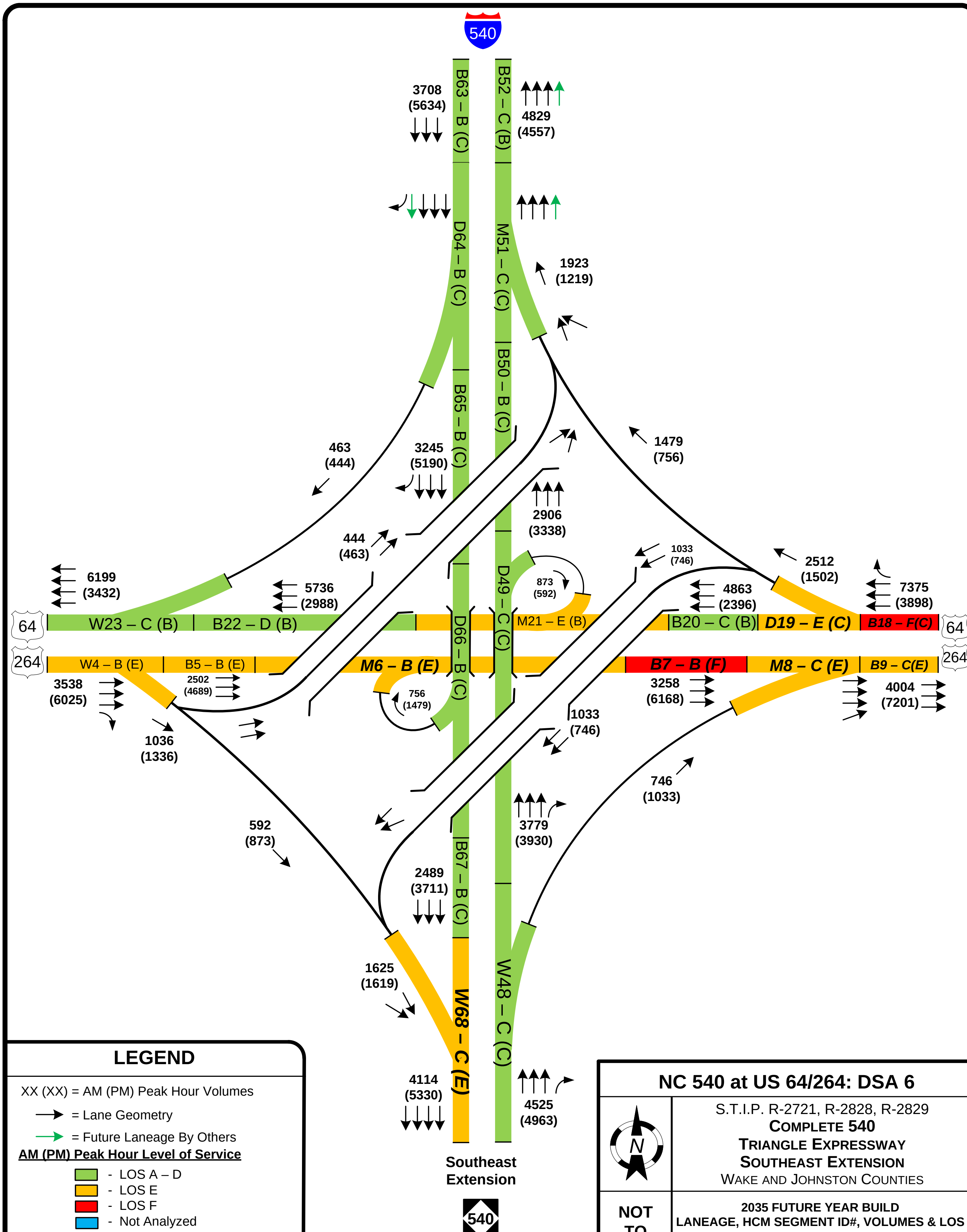
S.T.I.P. R-2721, R-2828, R-2829
Complete 540
Triangle Expressway
Southeast Extension
Wake and Johnston Counties

GREEN CORRIDOR: DSA 6

2035 FUTURE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

DATE: February 2015

FIGURE 10.7



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

= Lane Geometry

= Future Laneage By Others

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

Bold/Italics = Any Time Period D/C Ratio > 1

NC 540 at US 64/264: DSA 6

S.T.I.P. R-2721, R-2828, R-2829

COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION

WAKE AND JOHNSTON COUNTIES

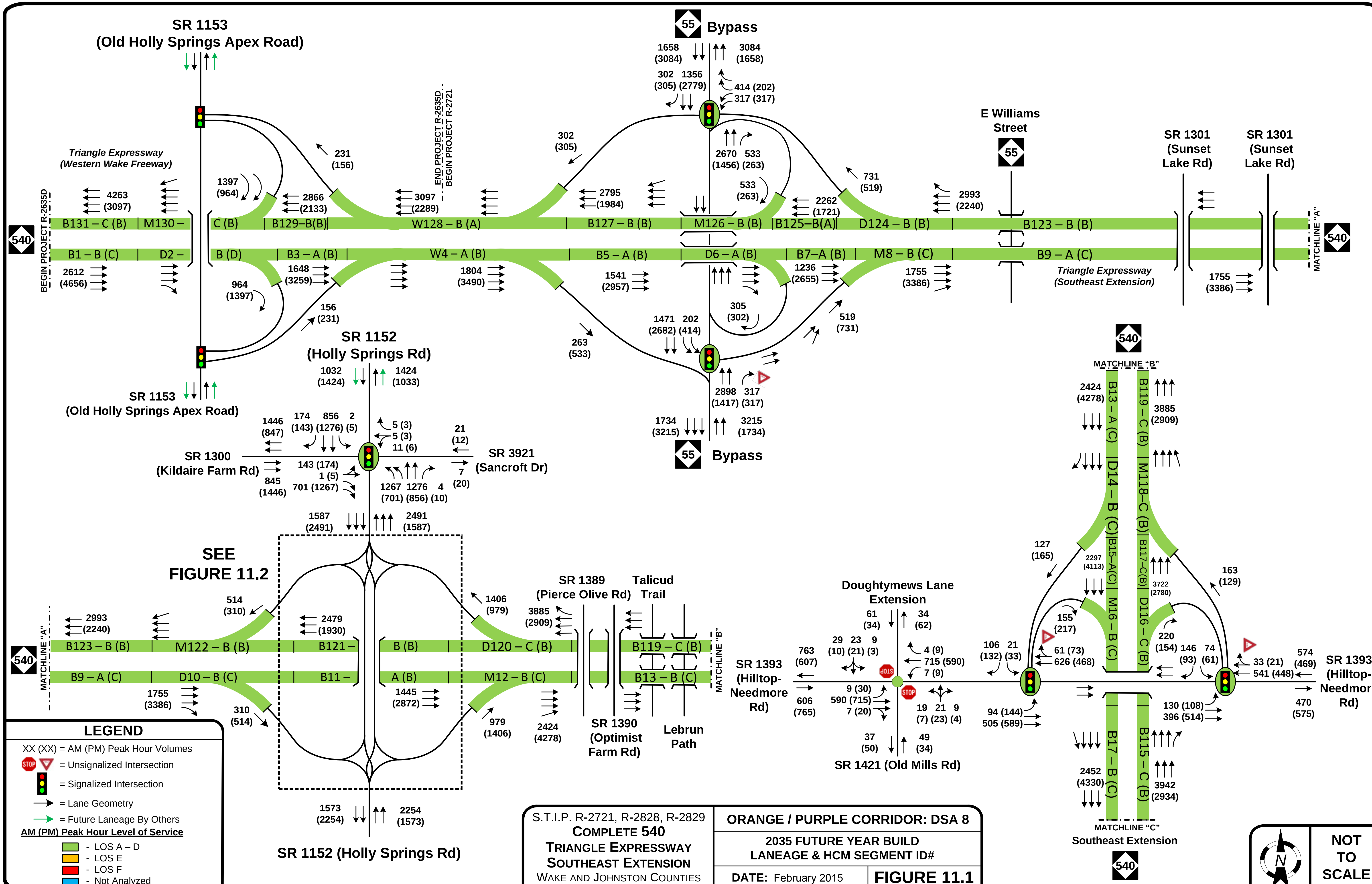
N

NOT TO SCALE

2035 FUTURE YEAR BUILD
LANEAGE, HCM SEGMENT ID#, VOLUMES & LOS

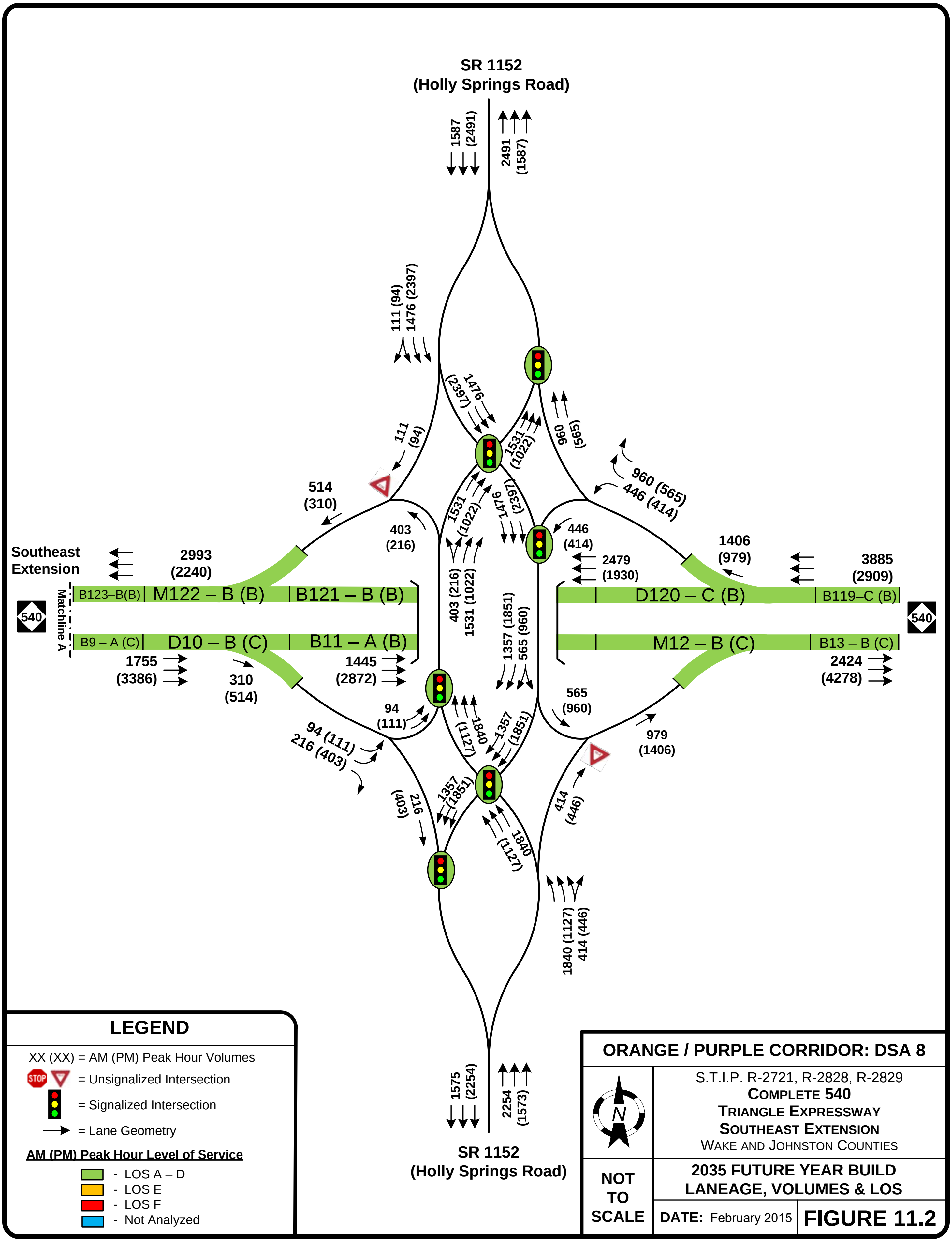
DATE: February 2015

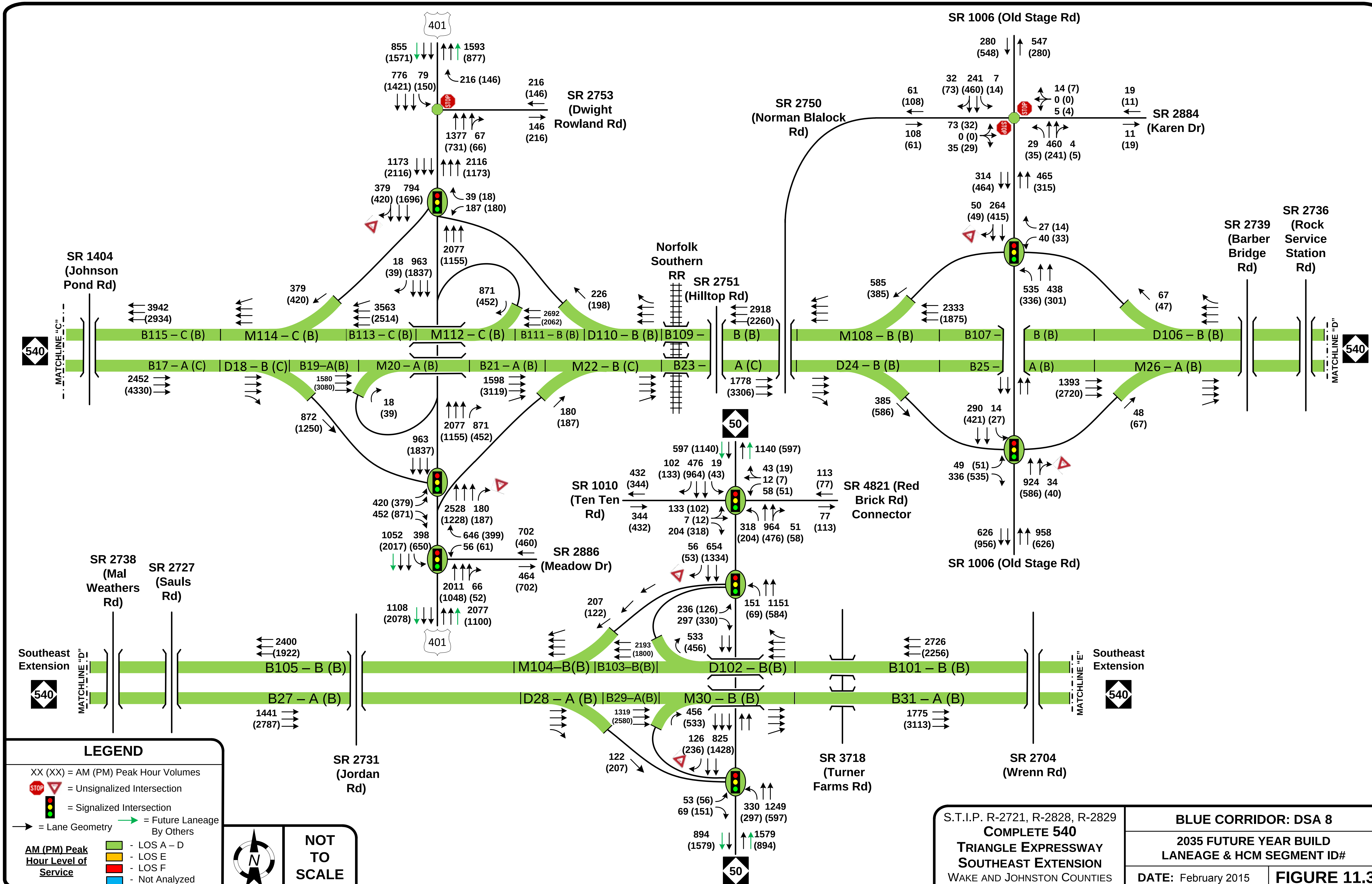
FIGURE 10.8



S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

ORANGE / PURPLE CORRIDOR: DSA 8
2035 FUTURE YEAR BUILD
LANEAGE & HCM SEGMENT ID#
DATE: February 2015
FIGURE 11.1


SR 1152
(Holly Springs Road)
1587 (2491)
2491 (1587)
111 (94)
1476 (2397)
1476 (2397)
1531 (1022)
960 (565)
111 (94)
514 (310)
403 (216)
1531 (1022)
1476 (2397)
446 (414)
960 (565)
446 (414)
Southeast Extension
2993 (2240)
2479 (1930)
1406 (979)
3885 (2909)
540
Matchline A
B123–B(B)
M122 – B (B)
B121 – B (B)
D120 – C (B)
B119–C (B)
403 (216)
1531 (1022)
1357 (1851)
565 (960)
B9 – A (C)
D10 – B (C)
B11 – A (B)
M12 – B (C)
B13 – B (C)
1755 (3386)
310 (514)
1445 (2872)
2424 (4278)
565 (960)
94 (111)
1840 (1127)
1357 (1851)
979 (1406)
94 (111)
216 (403)
216 (403)
1357 (1851)
1840 (1127)
414 (446)
1840 (1127)
414 (446)
1575 (2254)
2254 (1573)
SR 1152
(Holly Springs Road)
LEGEND
XX (XX) = AM (PM) Peak Hour Volumes
STOP
= Unsignalized Intersection
= Signalized Intersection
= Lane Geometry
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed
ORANGE / PURPLE CORRIDOR: DSA 8
N
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES
NOT TO SCALE
2035 FUTURE YEAR BUILD
LANEAGE, VOLUMES & LOS
DATE: February 2015
FIGURE 11.2



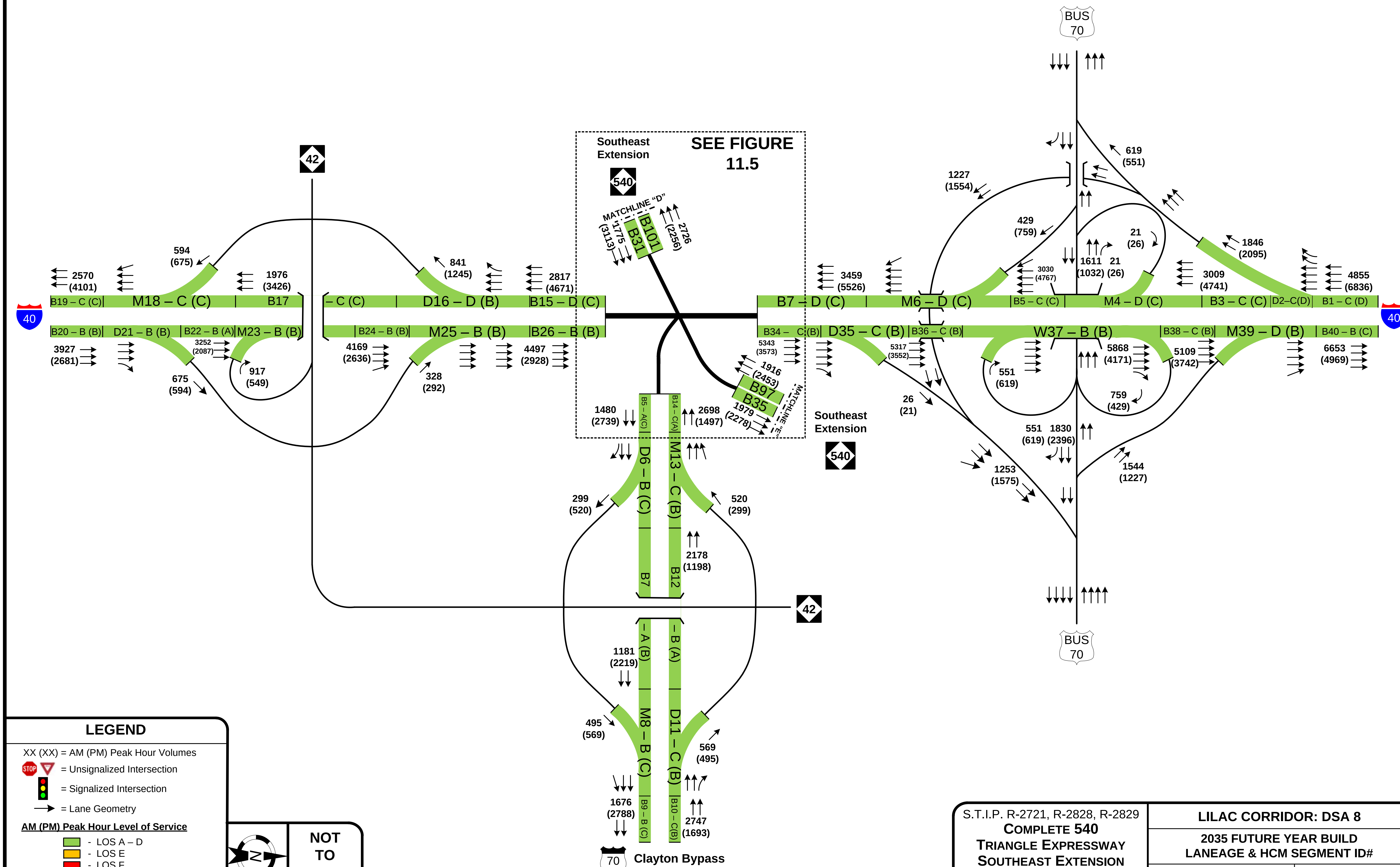
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

BLUE CORRIDOR: DSA 8

2035 FUTURE YEAR BUILD
LANEAGE & HCM SEGMENT ID#

DATE: February 2015

FIGURE 11.3



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

STOP = Unsignalized Intersection

= Signalized Intersection

→ = Lane Geometry

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

N

NOT TO SCALE

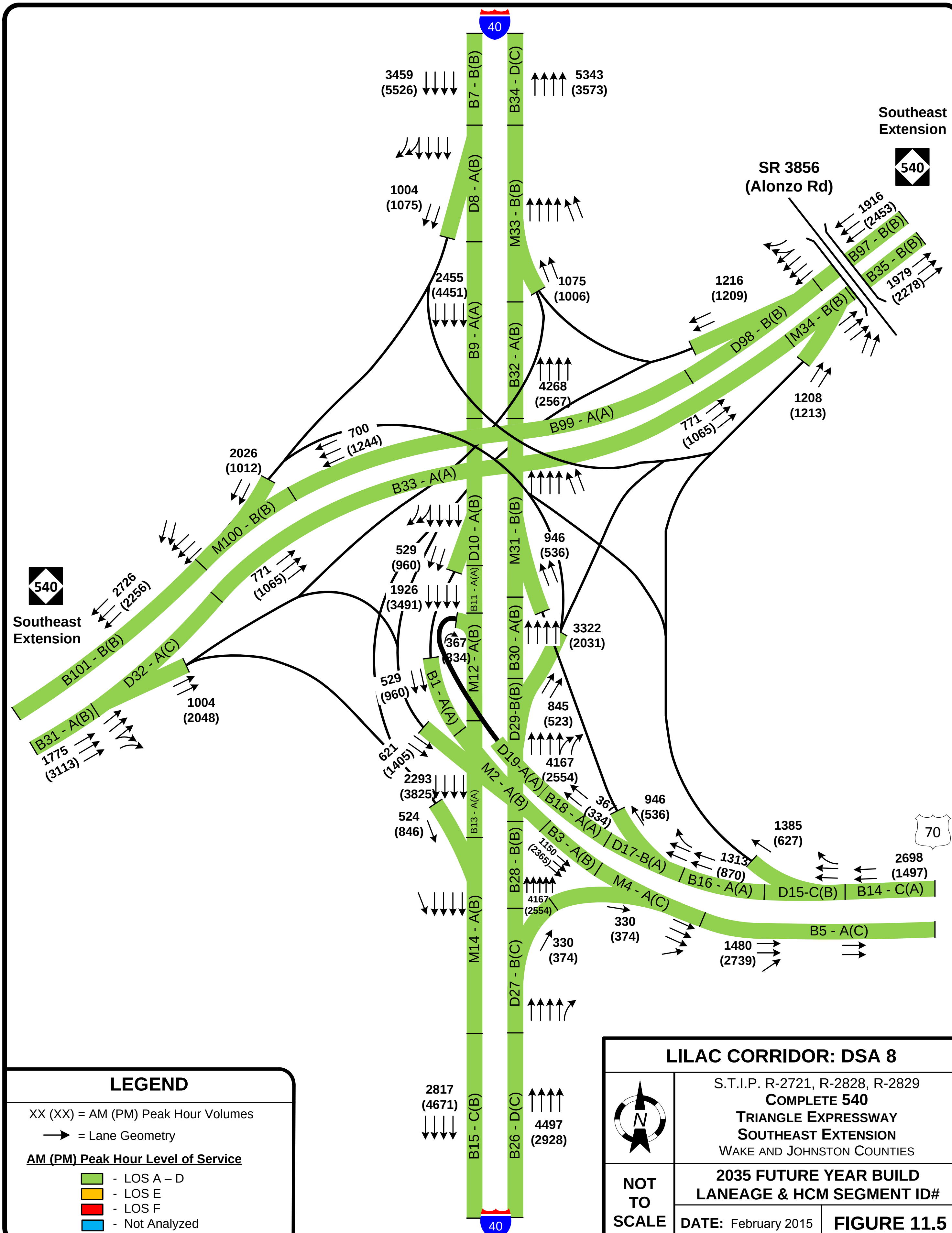
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

LILAC CORRIDOR: DSA 8

2035 FUTURE YEAR BUILD
LANEAGE & HCM SEGMENT ID#

DATE: February 2015

FIGURE 11.4



LEGEND

XX (XX) = AM (PM) Peak Hour Volumes

→ = Lane Geometry

AM (PM) Peak Hour Level of Service

- LOS A – D
- LOS E
- LOS F
- Not Analyzed

LILAC CORRIDOR: DSA 8

S.T.I.P. R-2721, R-2828, R-2829

Complete 540

Triangle Expressway

Southeast Extension

Wake and Johnston Counties

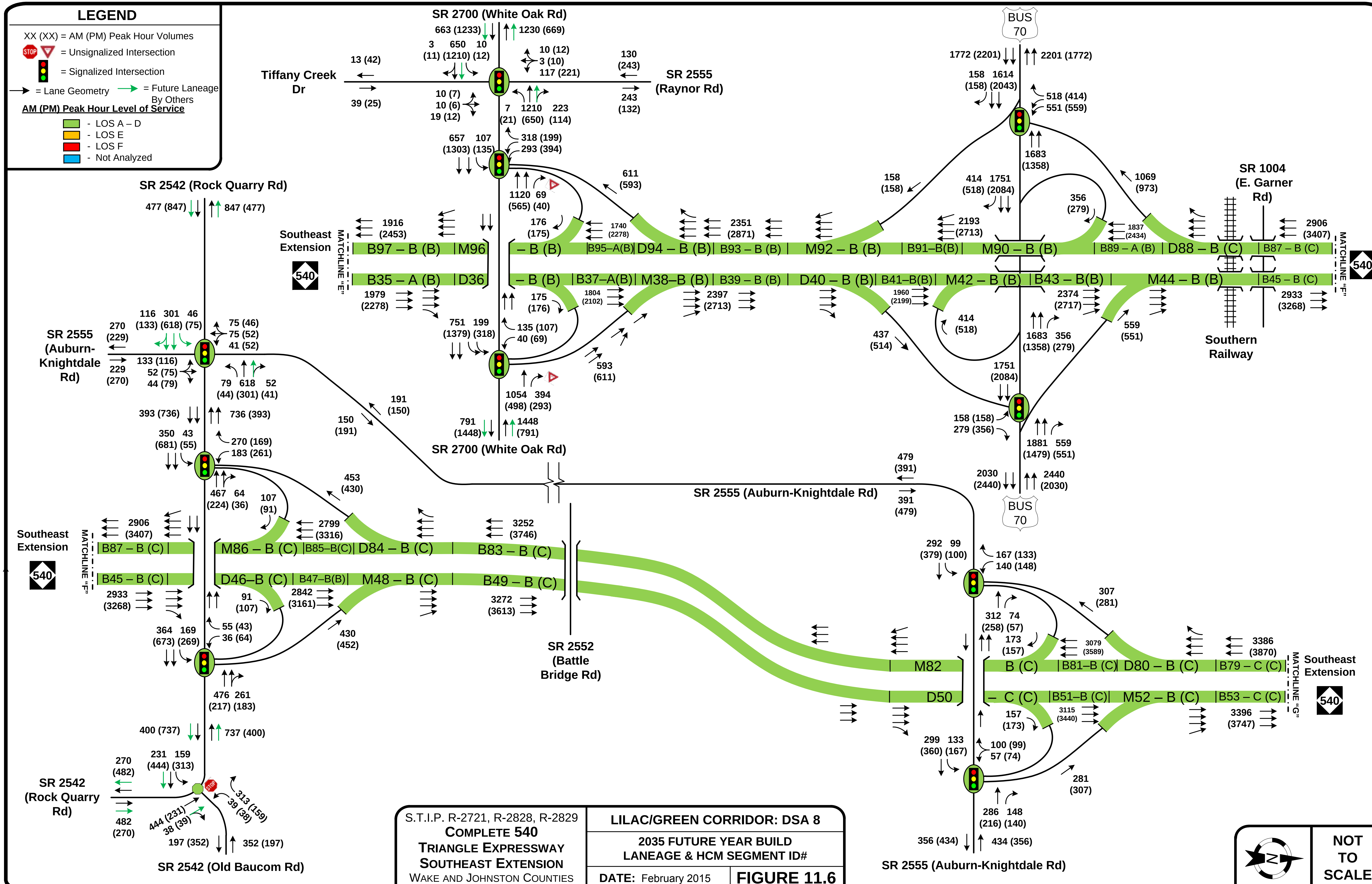
N

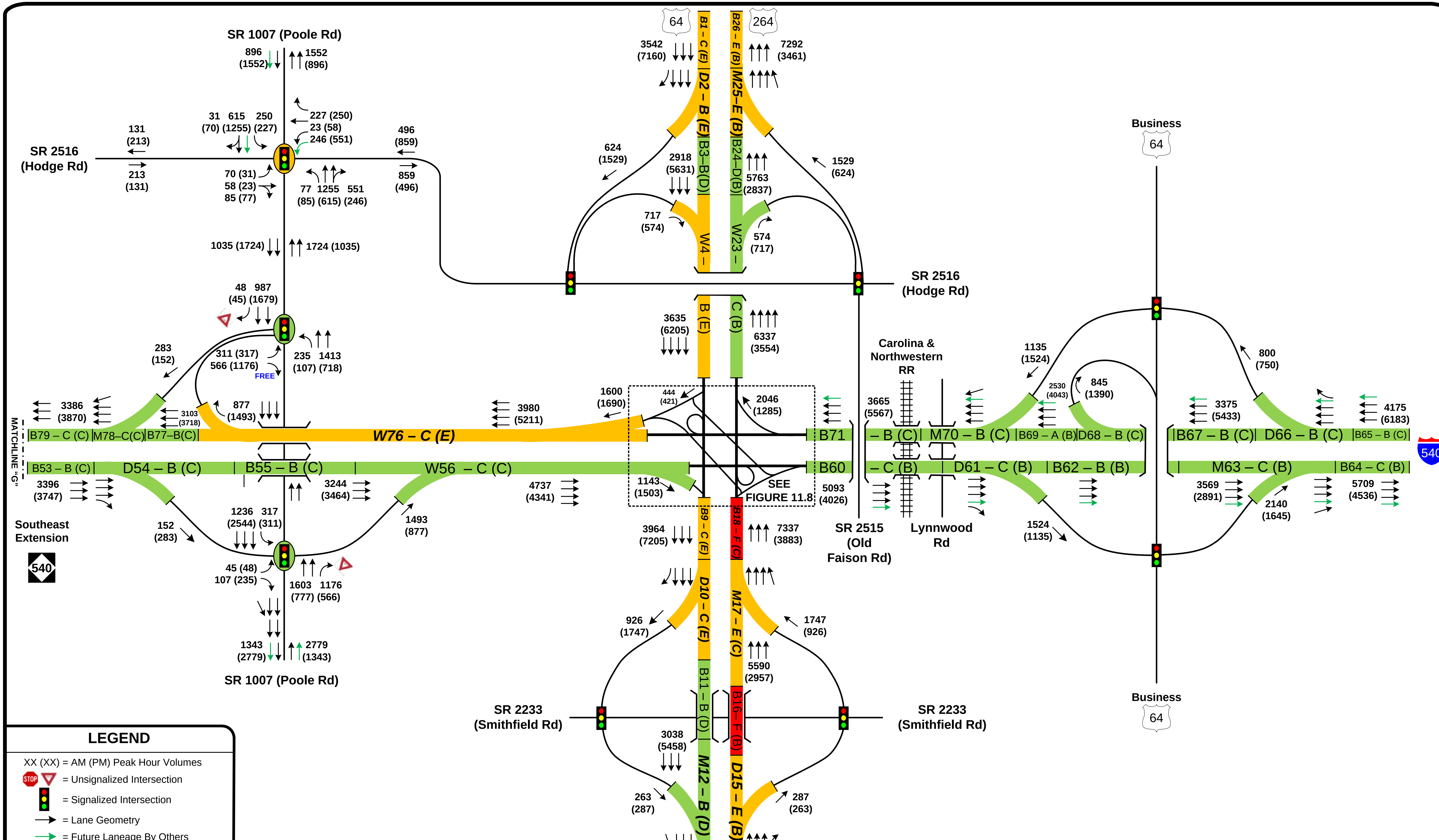
NOT TO SCALE

2035 FUTURE YEAR BUILD LANEAGE & HCM SEGMENT ID#

DATE: February 2015

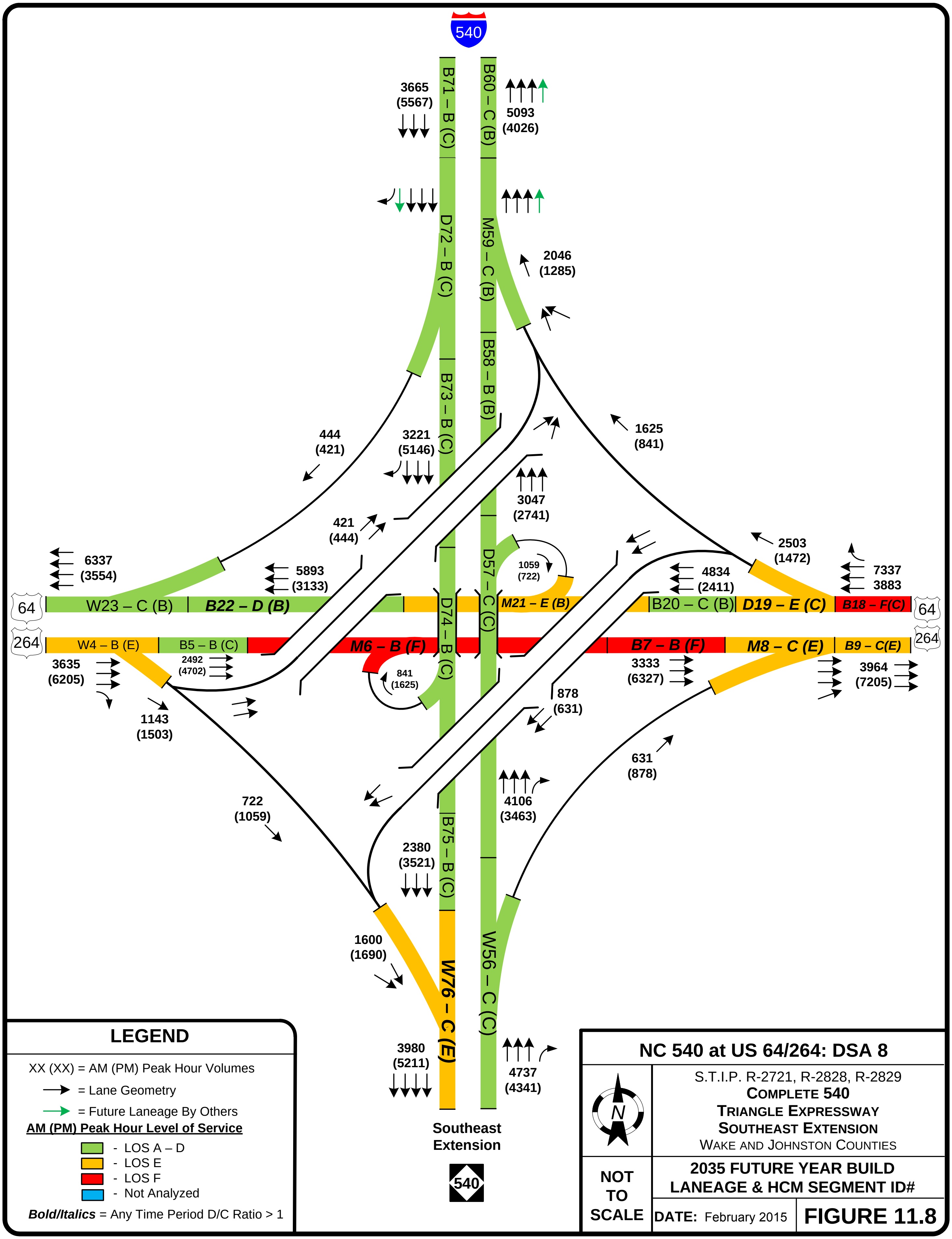
FIGURE 11.5


LEGEND
XX (XX) = AM (PM) Peak Hour Volumes
= Unsignalized Intersection
= Signalized Intersection
= Lane Geometry
= Future Laneage By Others
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed
SR 2700 (White Oak Rd)
Tiffany Creek Dr
SR 2555 (Raynor Rd)
BUS 70
SR 2542 (Rock Quarry Rd)
Southeast Extension
540
MATCHLINE "E"
B97 – B (B)
M96
B95–A(B)
D94 – B (B)
B93 – B (B)
M92 – B (B)
B91–B(B)
M90 – B (B)
B89 – A (B)
D88 – B (C)
B87 – B (C)
B35 – A (B)
D36
B37–A(B)
M38–B (B)
B39 – B (B)
D40 – B (B)
B41–B(B)
M42 – B (B)
B43 – B(B)
M44 – B (B)
B45 – B (C)
MATCHLINE "F"
SR 1004 (E. Garner Rd)
Southern Railway
SR 2555 (Auburn-Knightdale Rd)
SR 2700 (White Oak Rd)
SR 2555 (Auburn-Knightdale Rd)
B87 – B (C)
M86 – B (C)
B85–B(C)
D84 – B (C)
B83 – B (C)
B45 – B (C)
D46–B (C)
B47–B(B)
M48 – B (C)
B49 – B (C)
SR 2552 (Battle Bridge Rd)
M82
D50
B (C)
B81–B (C)
D80 – B (C)
B79 – C (C)
C (C)
B51–B (C)
M52 – B (C)
B53 – C (C)
MATCHLINE "G"
SR 2542 (Rock Quarry Rd)
SR 2542 (Old Baucom Rd)
SR 2555 (Auburn-Knightdale Rd)
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES
LILAC/GREEN CORRIDOR: DSA 8
2035 FUTURE YEAR BUILD
LANEAGE & HCM SEGMENT ID#
DATE: February 2015
FIGURE 11.6
NOT TO SCALE



S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES

GREEN CORRIDOR: DSA 8
2035 FUTURE YEAR BUILD
LANEAGE & HCM SEGMENT ID#
DATE: February 2015
FIGURE 11.7


540
B71 – B (C)
B60 – C (B)
3665
(5567)
5093
(4026)
D72 – B (C)
M59 – C (B)
2046
(1285)
B73 – B (C)
B58 – B (B)
444
(421)
3221
(5146)
1625
(841)
3047
(2741)
421
(444)
2503
(1472)
6337
(3554)
5893
(3133)
1059
(722)
4834
(2411)
7337
3883
64
W23 – C (B)
B22 – D (B)
D74 – B (C)
D57 – C (C)
M21 – E (B)
B20 – C (B)
D19 – E (C)
B18 – F(C)
64
264
W4 – B (E)
B5 – B (C)
M6 – B (F)
B7 – B (F)
M8 – C (E)
B9 – C(E)
264
3635
(6205)
2492
(4702)
841
(1625)
3333
(6327)
3964
(7205)
878
(631)
1143
(1503)
631
(878)
722
(1059)
4106
(3463)
2380
(3521)
B75 – B (C)
1600
(1690)
W76 – C (E)
W56 – C (C)
3980
(5211)
4737
(4341)
Southeast
Extension
540
LEGEND
XX (XX) = AM (PM) Peak Hour Volumes
= Lane Geometry
= Future Laneage By Others
AM (PM) Peak Hour Level of Service
- LOS A – D
- LOS E
- LOS F
- Not Analyzed
Bold/Italics = Any Time Period D/C Ratio > 1
NC 540 at US 64/264: DSA 8
N
S.T.I.P. R-2721, R-2828, R-2829
COMPLETE 540
TRIANGLE EXPRESSWAY
SOUTHEAST EXTENSION
WAKE AND JOHNSTON COUNTIES
NOT
TO
SCALE
2035 FUTURE YEAR BUILD
LANEAGE & HCM SEGMENT ID#
DATE: February 2015
FIGURE 11.8