



Lyon Station PUD
Traffic Impact Analysis

March 10, 2023

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Sign-off Sheet

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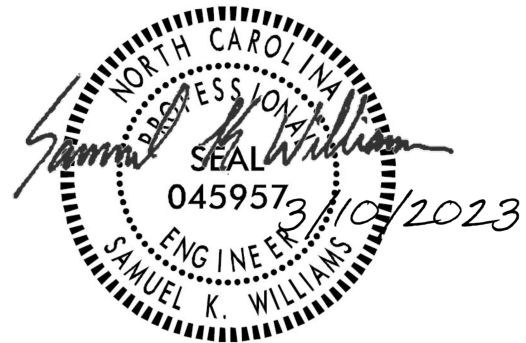


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Executive Summary

The Lyon Station Planned Unit Development (PUD) is located along Lyon Station Road in Butner, NC. Currently, the 334.16-acre site consists of open space and is zoned Rural Residential (RR) and Suburban Residential (RS). The site is intended to be rezoned to Conditional District – Planned Unit Development (CD-PUD). Construction of the site is anticipated to be completed in 2027. At full build-out, the site will consist of 799 dwelling units of single-family detached housing. Access to the site is envisioned to be provided by three (3) points along Lyon Station Road, with Accesses A and B being full-movement and Access C being partial-movement.

- Lyon Station Road at Access A (approximately 250 feet south of Otho Mangum Road)
- Lyon Station Road at Access B (approximately 2,450 feet south of Otho Mangum Road)
- Lyon Station Road at Access C (approximately 3,050 feet south of Otho Mangum Road)

Using the Institute of Transportation Engineers (ITE) Trip Generation Manual, 11th Edition⁴, it is estimated that the site will generate 6,827 new daily trips going to and from the site, with 494 trips in the AM peak hour (123 entering, 371 exiting), and 701 trips in the PM peak hour (442 entering, 259 exiting). Traffic analysis was completed for the peak hours during the years 2022 and 2027.

Based on the anticipated operations of the study area network, the following off-site improvements are recommended to be completed as part of the proposed development.

Lyon Station Road at Brogden Road

- Construct an exclusive northbound right-turn lane with 100' of full-width storage and appropriate taper

Lyon Station Road at Otho Mangum Road

- Construct an exclusive northbound left-turn lane with 100' of full-width storage and appropriate taper

It should be noted that the proposed development's impact at this intersection is minimal. Traffic volumes at Access A, located 250 feet to the south of this intersection, meets the criteria for installation of a southbound left-turn lane. Northbound left-turn volumes from Lyon Station Road onto Otho Mangum Road are currently higher than what is projected for southbound left-turns at Access A. Given the offset-T configuration of the intersection, only one left-turn lane can be installed between Otho Mangum Road and Lyon Station Road. Given that the higher volume of traffic is making a northbound left-turn onto Otho Mangum Road, it is recommended that a northbound left-turn lane from Lyon Station Road onto Otho Mangum Road be constructed.

Alternatively, the realignment of Otho Mangum Road to intersect Lyon Station Road across from Access A was discussed during project scoping to avoid the offset-T configuration and potential for left-turn conflicts. However, this configuration is likely not feasible, as realigning Otho Mangum Road would cause significant impacts to the existing cemetery. Due to this impact, the realignment of Otho Mangum Road was not considered as a reasonable alternative in this study and is therefore not recommended.



Lyon Station Road at Access A

- Construct Access A as a full-movement access point with one ingress lane and one egress lane
- Provide Access A with a minimum of 70 feet of internal stem length
- Construct an exclusive northbound right-turn lane with 100' of full-width storage and appropriate taper

Lyon Station Road at Access B

- Construct Access B as a full-movement access point with one ingress lane and one egress lane
- Provide Access B with a minimum of 100 feet of internal stem length
- Construct an exclusive northbound right-turn lane with 200' of full-width storage and appropriate taper

Lyon Station Road at Access C

- Construct Access C as a one-lane egress-only access point

Lyon Station Road at NC 56

- No improvements are recommended at this intersection

NC 56 at I-85 Southbound Ramps

- No improvements are recommended at this intersection

NC 56 at I-85 Northbound Ramps

- Extend the existing exclusive westbound right-turn lane so that it begins at the nearest upstream driveway, approximately 300' to the east, and terminates at the existing westbound channelized right-turn lane.

It should be noted that this recommended improvement does not serve traffic generated by the proposed development but is shown to mitigate the development's impact at the study intersection.

Improvements to the I-85 northbound off-ramp or the eastbound approach of NC 56 are not recommended as the bridge over I-85 prohibits the ability to widen both approaches.

A summary of the level of service and delay for this report is shown in Table ES-1. The recommended improvements are shown in Figure ES-1.

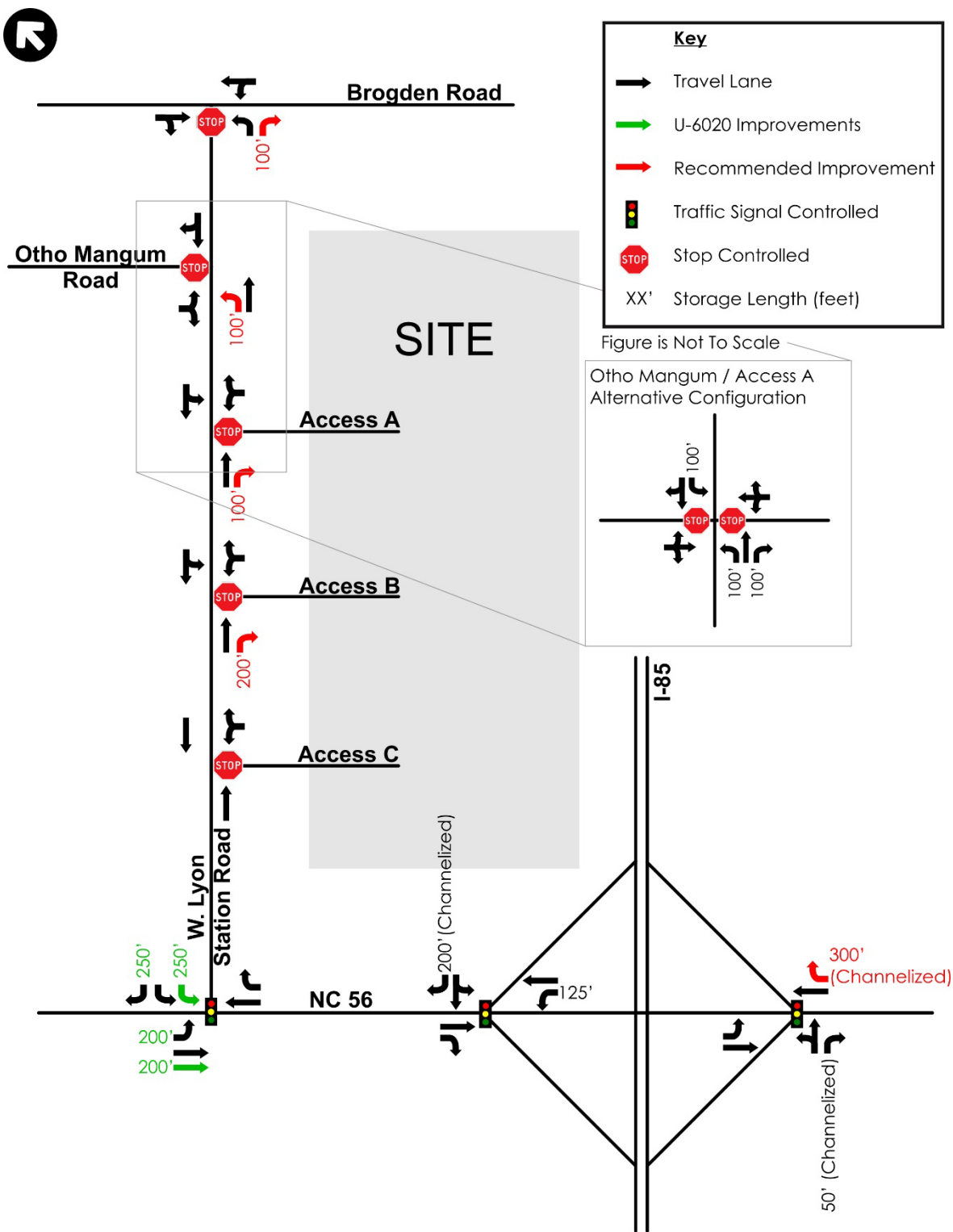


Table ES-1: Level of Service Summary

Level of Service (Delay, sec/veh)	2022 Existing		2027 No Build		2027 Build		2027 Build with Improvements	
	AM	PM	AM	PM	AM	PM	AM	PM
Lyon Station Road at Brogden Road	C (15.4)	C (24.6)	C (16.4)	D (30.7)	C (18.1)	E (48.0)	C (18.7)	E (35.5)
Lyon Station Road at Otho Mangum Road	B (12.1)	B (12.5)	B (13.4)	B (13.7)	B (13.5)	B (14.7)	B (13.5)	B (14.5)
Lyon Station Road at Site Access A					B (14.7)	C (18.1)	B (14.5)	C (17.3)
Lyon Station Road at Site Access B					C (22.3)	E (35.7)	C (20.3)	C (24.8)
Lyon Station Road at Site Access C					E (36.6)	F (69.0)	E (36.6)	F (69.0)
Lyon Station Road at NC 56	C (21.5)	B (13.5)	B (17.4)	B (11.1)	C (21.5)	B (16.8)	C (21.5)	B (16.8)
NC 56 at I-85 SB Ramps	C (20.9)	B (16.5)	B (18.0)	B (15.4)	C (20.6)	C (20.2)	C (20.7)	C (20.2)
NC 56 at I-85 NB Ramps	B (15.8)	C (31.0)	B (16.6)	D (38.2)	B (17.9)	E (65.5)	B (16.8)	D (37.6)



Figure ES-1: Recommended Improvements



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Introduction
February 22, 2023

1.0 INTRODUCTION

The Lyon Station Planned Unit Development (PUD) is located along Lyon Station Road in Butner, Granville County, NC. Currently, the 334.16-acre site consists of open space and is zoned Rural Residential (RR) and Suburban Residential (RS). The site is intended to be rezoned to Conditional District – Planned Unit Development (CD-PUD). The development's location is illustrated in Figure 1. Construction of the site is anticipated to be completed in 2027.

The traffic analysis will consider future build conditions at the build-out year (i.e. 2027). The AM and PM peak hours will be analyzed for each scenario. These scenarios are provided below:

- 2022 existing;
- 2027 no-build;
- 2027 build; and
- 2027 build with improvements.

At full build-out, the site is envisioned to consist of 799 dwelling units of single-family detached housing. An annotated site plan prepared by ESP Associates, Inc. can be found in Figure 2. A full-sized and unedited copy of the site plan can be found in the appendix.

The purpose of this report is to evaluate the development in terms of projected vehicular traffic conditions, evaluate the ability of the adjacent roadways to accommodate the additional traffic, and to recommend transportation improvements needed to mitigate congestion that may result from additional site traffic. This report presents trip generation, trip distribution, traffic analyses, and recommendations for improvements needed to meet anticipated traffic demands.

2.0 INVENTORY OF TRAFFIC CONDITIONS

2.1 STUDY AREA

Stantec coordinated with Town of Butner and North Carolina Department of Transportation (NCDOT) representatives to determine the appropriate study area and discuss design assumptions. Correspondence regarding the scoping of this study is included in the appendix. It was agreed that the following existing intersections will be analyzed to determine the impacts associated with the proposed development:

- Lyon Station Road at Brogden Road
- Lyon Station Road at Otho Mangum Road
- Lyon Station Road at NC 56
- NC 56 at I-85 Southbound Ramps
- NC 56 at I-85 Northbound Ramp



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Inventory of Traffic Conditions
February 22, 2023

2.2 PROPOSED ACCESS

Access to the site is envisioned to be provided by three (3) access points along Lyon Station Road as shown on the site plan in Figure 2. A description of each site access is provided in Table 1.

Table 1: Proposed Access

Proposed Access	Level of Access	Intersection Control	Direction of Travel	Adjacent Intersection	Distance and Direction from Adj. Intersection
Access A	Full-Movement	Two-Way Stop Control	Ingress and Egress	Lyon Station Rd. at Otho Mangum Rd.	250 feet South
Access B	Full-Movement	Two-Way Stop Control	Ingress and Egress	Lyon Station Rd. at Otho Mangum Rd.	2,450 feet South
Access C	Partial-Movement	Two-Way Stop Control	Egress Only	Lyon Station Rd. at Otho Mangum Rd.	3,050 feet South

Originally, Access C was evaluated as a full-movement access point. However, it was determined that right-of-way and an existing stream channel restrict the ability to construct an exclusive right-turn lane on Lyon Station Road. Due to the high volume of right-turns anticipated if this driveway were to allow ingress traffic, not providing an exclusive right-turn lane increases the potential for rear-end crashes. To reduce the potential for rear-end crashes, it is recommended that Access C be constructed as an egress-only access point (i.e. prohibiting entering traffic) with both left and right-turns onto Lyon Station Road being permitted. Accordingly, this study is performed assuming that ingress traffic at Access C is prohibited.

2.3 EXISTING ROADWAY CONDITIONS

Table 2 provides a detailed description of the existing study area roadway network. All functional classification and average annual daily traffic (AADT) information, where available, was obtained from NCDOT from the Go! NC GIS database. The existing roadway laneage is illustrated in Figure 3.



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Inventory of Traffic Conditions
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Table 2: Existing Roadway Conditions

Road Name	Road Number	Primary Cross-Section	NCDOT Functional Classification ¹	2021 AADT ² (vpd)	Speed Limit (mph)	Maintenance Agency ³
Lyon Station Road	SR 1215	2-Lane Undivided	Minor Collector	5,100	45	NCDOT
Brogden Road	SR 1127	2-Lane Undivided	Major Collector	3,100	Unposted*	NCDOT
Otho Mangum Road	SR 1124	2-Lane Undivided	Local	-	Unposted*	NCDOT
NC 56	NC 56	2-Lane Undivided	Minor Arterial	18,000	35	NCDOT
I-85 SB Off-Ramp	I-85	1-Lane Ramp	Interstate Ramp	3,500	Unposted**	NCDOT
I-85 SB On-Ramp	I-85	1-Lane Ramp	Interstate Ramp	3,800	Unposted*	NCDOT
I-85 NB Off-Ramp	I-85	1-Lane Ramp	Interstate Ramp	4,200	Unposted**	NCDOT
I-85 NB On-Ramp	I-85	1-Lane Ramp	Interstate Ramp	3,500	Unposted*	NCDOT

*For Synchro analysis, used 55 mph

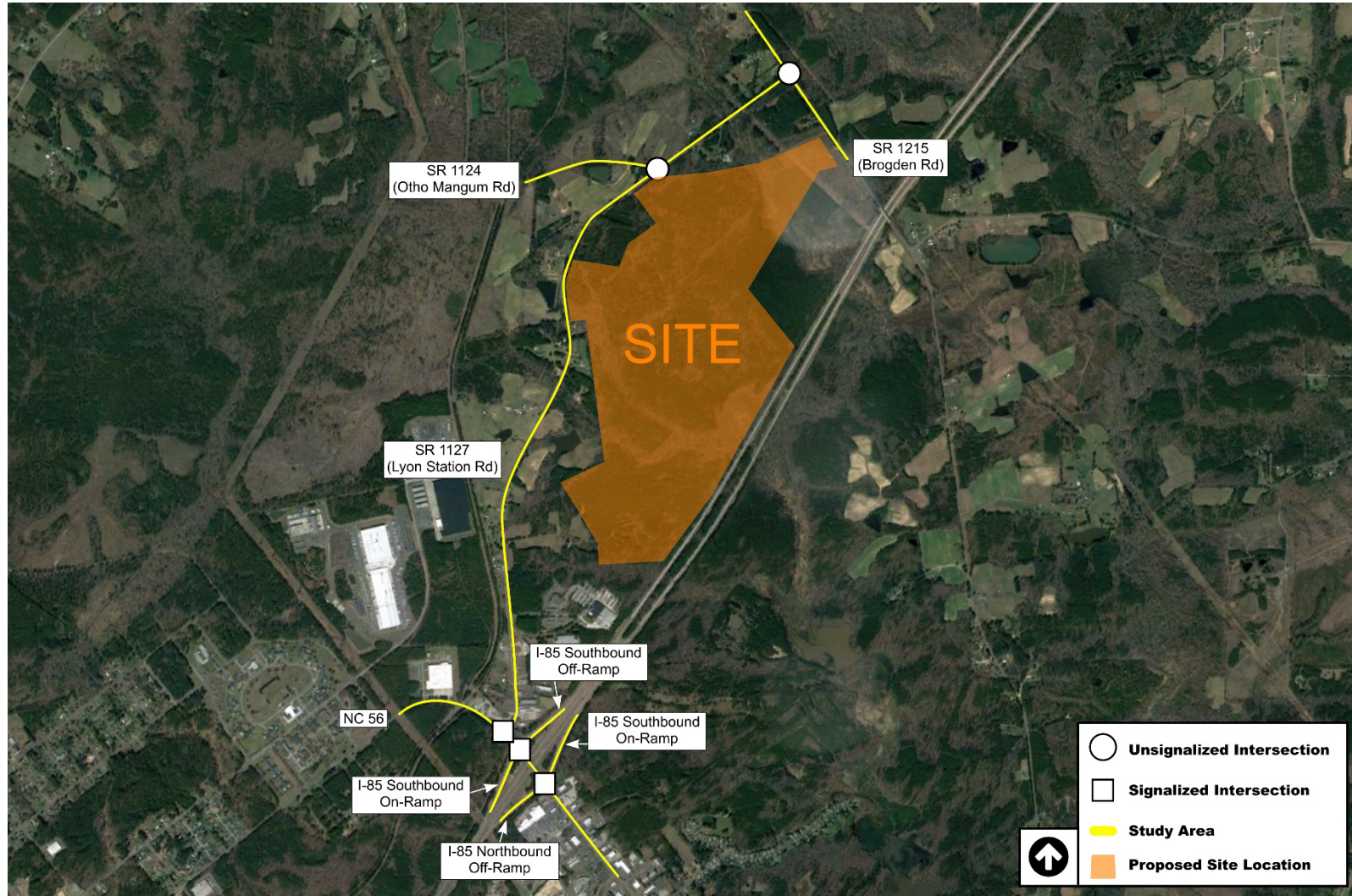
**For Synchro analysis, used 35 mph



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Inventory of Traffic Conditions
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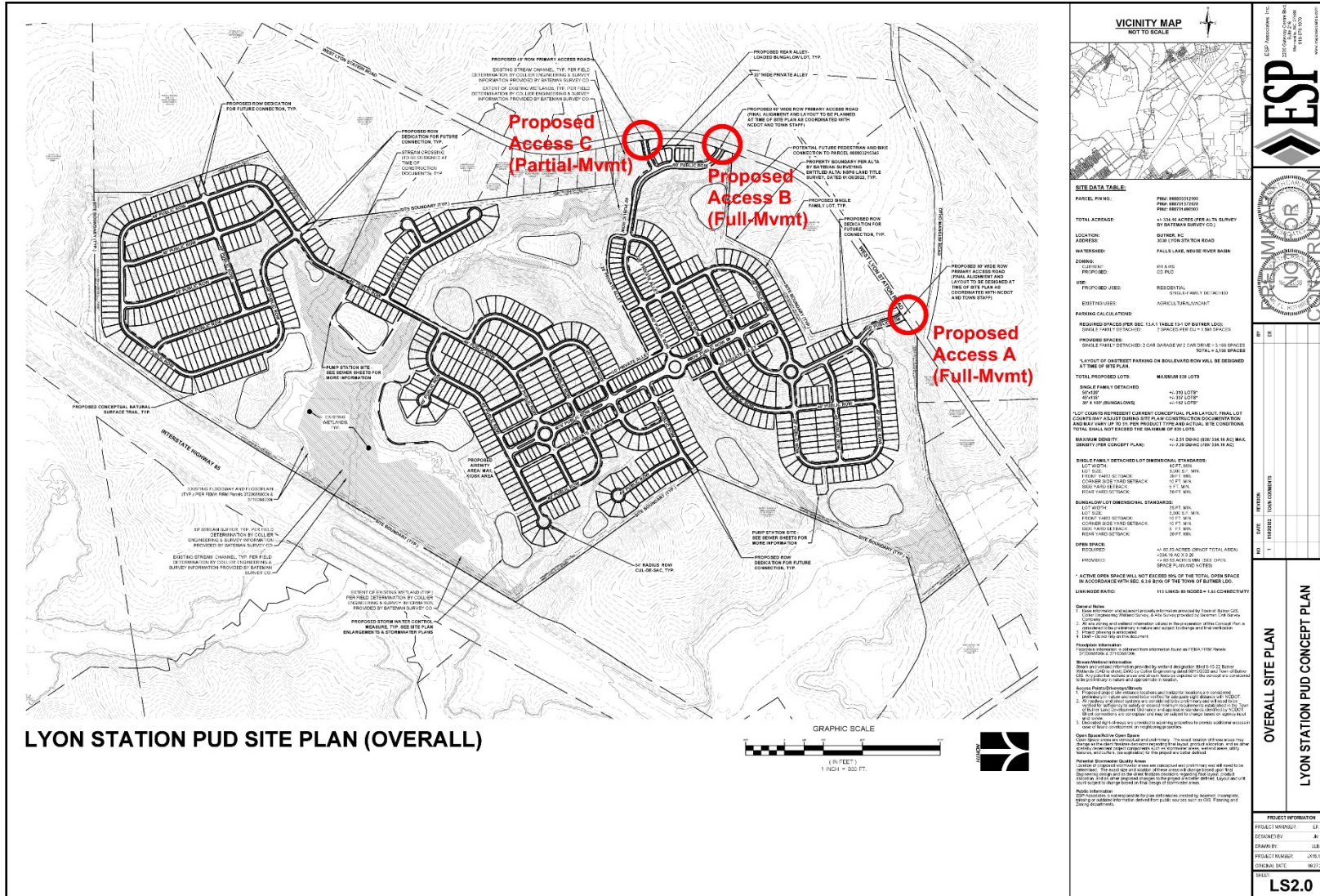
Figure 1: Study Area



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Inventory of Traffic Conditions
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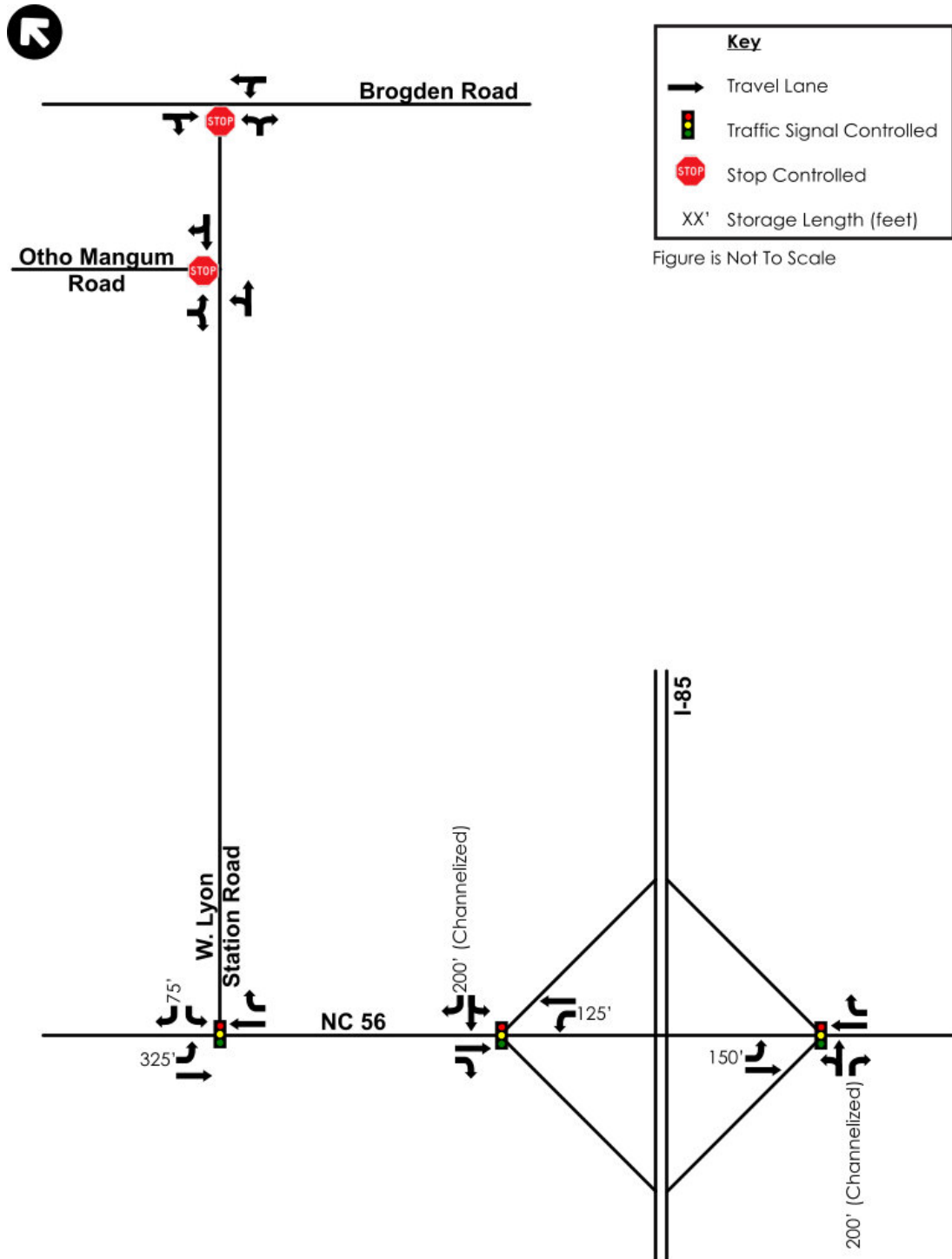
Figure 2: Annotated Site Plan



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Inventory of Traffic Conditions
February 22, 2023

Figure 3: Existing Roadway Laneage



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Inventory of Traffic Conditions
February 22, 2023

2.4 FUTURE ROADWAY CONDITIONS

2.4.1 U-6020

Prior to the full build-out of the proposed development, NCDOT project U-6020 is expected to be completed at the intersection of Lyon Station Road and NC 56. This project, with an anticipated construction year of 2025, is described as a re-alignment of Lyon Station Road at NC 56 and will increase the capacity of this intersection by adding a second southbound left turn lane from Lyon Station Road onto NC 56. Since the U-6020 improvements are expected to be in place before the final build-out year of the Butner-Lyon Station development, the improvements will be included in all future year analysis scenarios. Documentation of the U-6020 project is included in the appendix. The future roadway conditions are shown in Figure 4.

2.4.2 NC 56 Corridor Study

The NC 56 Corridor Study, completed in 2015, covers the length of NC 56 from 33rd Street in Butner to Darden Drive in Creedmoor. In the study area of the proposed development, the Corridor Study recommended widening NC 56 to a 4-lane divided section beginning west of Lyon Station Road to the Butner Town limits (i.e. east of the I-85 interchange). This is partially achieved by the U-6020 project discussed in section 2.4.1. The current State Transportation Improvement Plan (STIP) published by NCDOT does not include widening of NC 56 beyond the limits of U-6020. A copy of the NC 56 Corridor Study is included in the appendix.

2.4.3 I-85 at Brogden Road Interchange

As part of the I-85 Future Interchange Location Analysis, an interchange at Brogden Road was evaluated for feasibility. The technical memorandum, produced in 2013, performed a preliminary evaluation of an interchange at Brogden Road (in addition to Sanders Road and Smith Road). The current STIP published by NCDOT does not include construction of an interchange of I-85 at Brogden Road. A copy of the Technical Memorandum is included in the appendix.

2.4.4 26th Street Overpass

The Butner Gateway Small Area Plan (adopted 12/3/2015) notes that, "Connectivity from east to west across Interstate 85 will be improved with the construction of an overpass extending 26th Street across the interstate."

Access across I-85 is currently provided by NC 56 and Brogden Road which are closer in proximity to the proposed development than 26th Street. Therefore, traffic generated by the proposed development would not be anticipated to use the 26th Street Overpass.

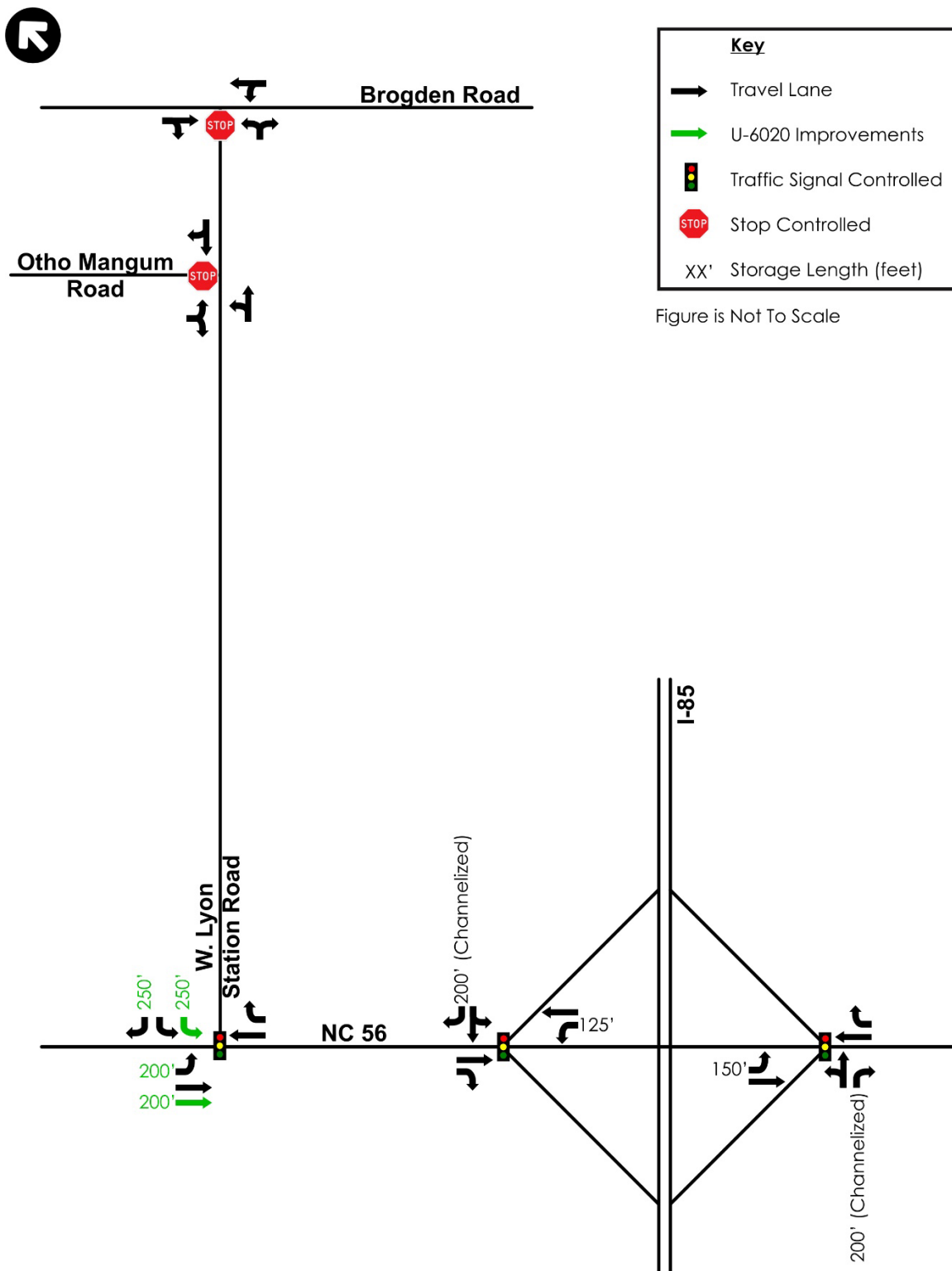
At the time of plan adoption, the STIP included U-5829 which would create this overpass and was funded for construction in 2022. The current STIP published by NCDOT no longer includes this project. A copy of the Butner Gateway Small Area Plan is included in the appendix.



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Inventory of Traffic Conditions
 February 22, 2023

Figure 4: Future Roadway Conditions



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Trip Generation
February 22, 2023

3.0 TRIP GENERATION

Trip generation for the proposed development was performed using the 11th Edition of the Institute of Transportation Engineers (ITE) Trip Generation Manual⁴. The suggested methods contained in the Rate versus Equation spreadsheet published by NCDOT⁵ was also consulted prior to performing trip generation. The trip generation for the proposed development is shown in Table 3.

Table 3: Trip Generation

Land Use	ITE LUC	Size	Daily Trips	AM Peak Hour Trips			PM Peak Hour Trips		
			Total	Total	Enter	Exit	Total	Enter	Exit
Single Family Detached Housing	210	799 d.u.	6827	494	123	371	701	442	259

4.0 TRIP DISTRIBUTION

To accurately determine the effect of the proposed development on the surrounding roadway network, an estimate of the expected distribution of traffic entering and exiting the site is needed. These percentages were developed using a combination of existing traffic volume counts, historic AADTs provided by NCDOT, and engineering judgement. This trip distribution was submitted as part of NCDOT's TIA Scoping Checklist contained in the appendix. All traffic volume calculations can be found in the appendix.

The following percentages were used in the AM and PM peak hours. These percentages are also shown in Figure 5.

- 40% to/from the south on I-85;
- 20% to/from the west on NC 56;
- 20% to/from the east on NC 56;
- 10% to/from the north on I-85;
- 5% to/from the northwest on Brogden Road; and
- 5% to/from the southeast on Brogden Road.

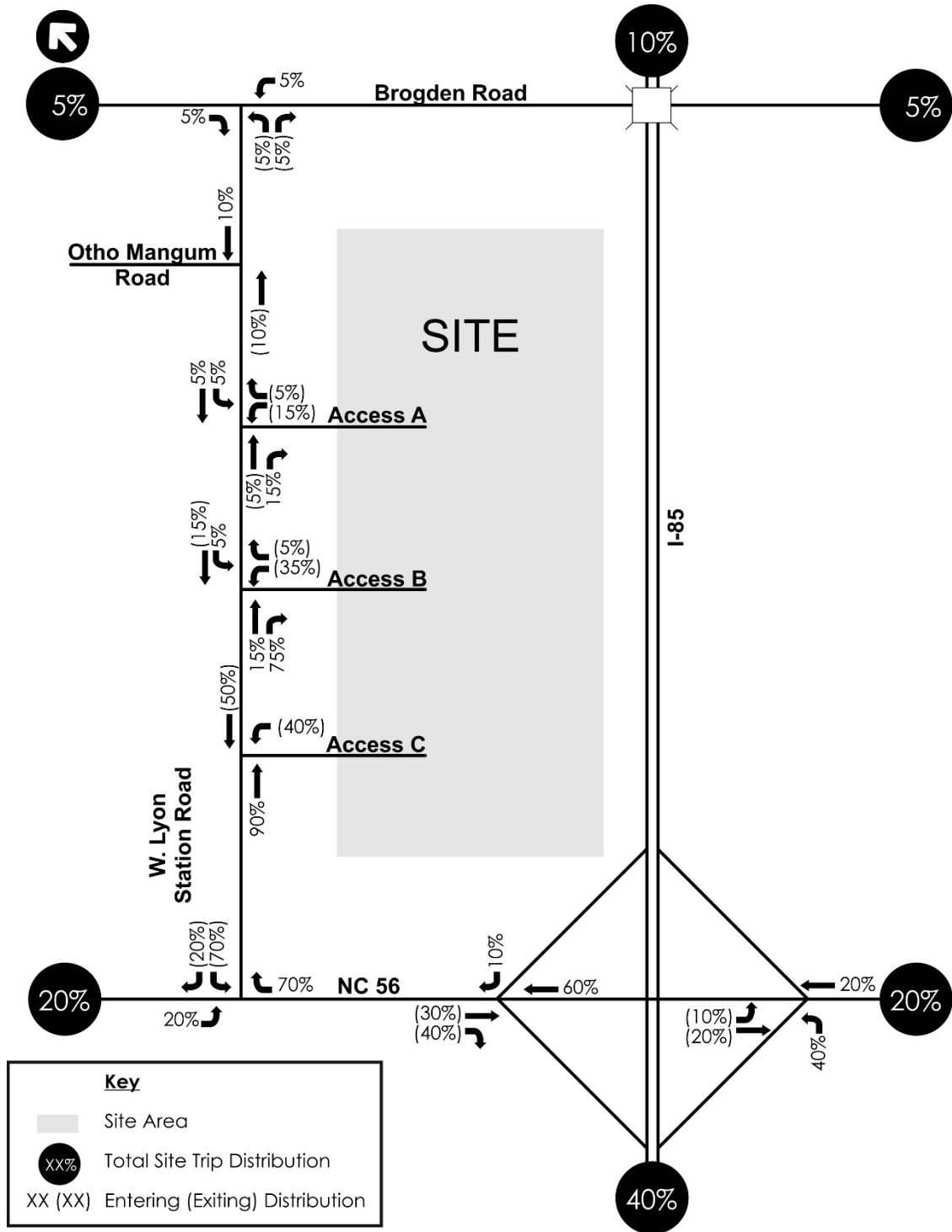
The trip generation volumes in Table 3 were applied to the network according to the trip distribution percentages above. The resulting site trip turning movement volumes are shown in Figure 6.



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Trip Distribution
February 22, 2023

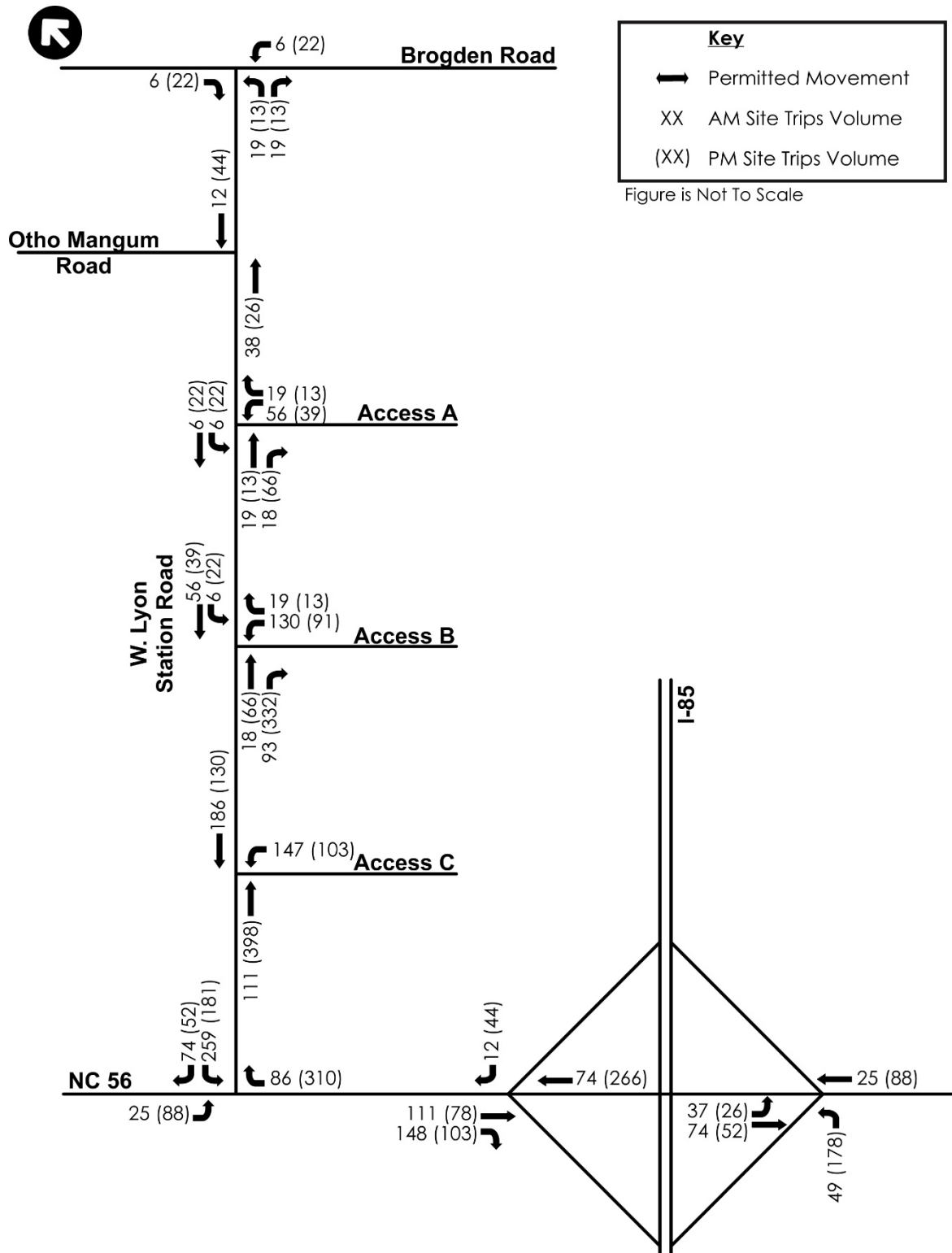
Figure 5: Site Trip Distribution



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Trip Distribution
February 22, 2023

Figure 6: Site Trip Volumes



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Traffic Volumes
February 22, 2023

5.0 TRAFFIC VOLUMES

5.1 DATA COLLECTION

Morning (7:00-9:00 AM) and evening (4:00-6:00 PM) turning movement counts were collected by Quality Counts, LLC on Tuesday, October 25, 2022, at the following locations:

- Lyon Station Road at Brogden Road
- Lyon Station Road at Otho Mangum Road
- Lyon Station Road at NC 56
- NC 56 at I-85 Southbound Ramps
- NC 56 at I-85 Northbound Ramps

It should be noted that traditional calendar schools were in session when the counts were performed. The count data is categorized by cars, heavy trucks, bicycles, and pedestrians.

Traffic counts were balanced along NC 56 between the I-85 ramp intersections and the Lyon Station Road intersection due to the absence of driveways between each pair of intersections. Along Lyon Station Road, the counted traffic volumes were not balanced due to the low volume roads and distances between study intersections.

The 2022 existing AM and PM peak hour volumes, balanced where appropriate, are shown in Figure 7. Raw count data for these locations as well as all traffic volume calculations are included in the appendix.

5.2 APPROVED DEVELOPMENT TRAFFIC

There is one (1) approved development, Mangum Farms (Phase 2), near the study area. This residential development consists of 140 single-family homes along Julian Daniel Road, off Otho Mangum Road to the northwest of the proposed development. A traffic analysis document was not provided for this study; therefore, for the purposes of this analysis, the trip generation values shown in Table 4 below were used.

Table 4: Approved Development Trip Generation – Mangum Farms

Land Use	ITE LUC	Size	AM Peak Hour Trips			PM Peak Hour Trips		
			Total	Enter	Exit	Total	Enter	Exit
Single Family Detached Housing	210	140	101	26	75	136	86	50

The site trip volumes for this development were assumed to be distributed with 75% of the total volume accessing the existing roadway network toward the east, via Otho Mangum Road and Lyon Station Road. The remaining 25% of the total volume was assumed to access the roadway network toward the west, via Old NC 75, away from the Butner-Lyon Station site. The 75% of site trips from this development passing through the Butner-Lyon Station study area were assumed to be distributed according to a similar distribution used for this study.



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Traffic Volumes
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- 40% to/from the south on I-85;
- 20% to/from the east on NC 56;
- 10% to/from the north on I-85; and
- 5% to/from the southeast on Brogden Road.

5.3 BACKGROUND TRAFFIC GROWTH

Background traffic growth is the increase in traffic volumes due to usage increase and non-specific growth throughout the area.

The 2022 existing volumes were grown by a 1 percent annual rate to estimate 2027 volumes. The growth in vehicles as a result of this background growth in 2027 for the AM and PM peak hours are shown in Figure 8 and Figure 9; respectively.

5.4 NO-BUILD TRAFFIC VOLUMES

Approved development traffic volumes were added to the background traffic to determine the 2027 no-build traffic volumes. The 2027 no-build traffic volumes for the AM and PM peak hours are shown in Figure 8 and Figure 9, respectively.

5.5 TOTAL BUILD TRAFFIC

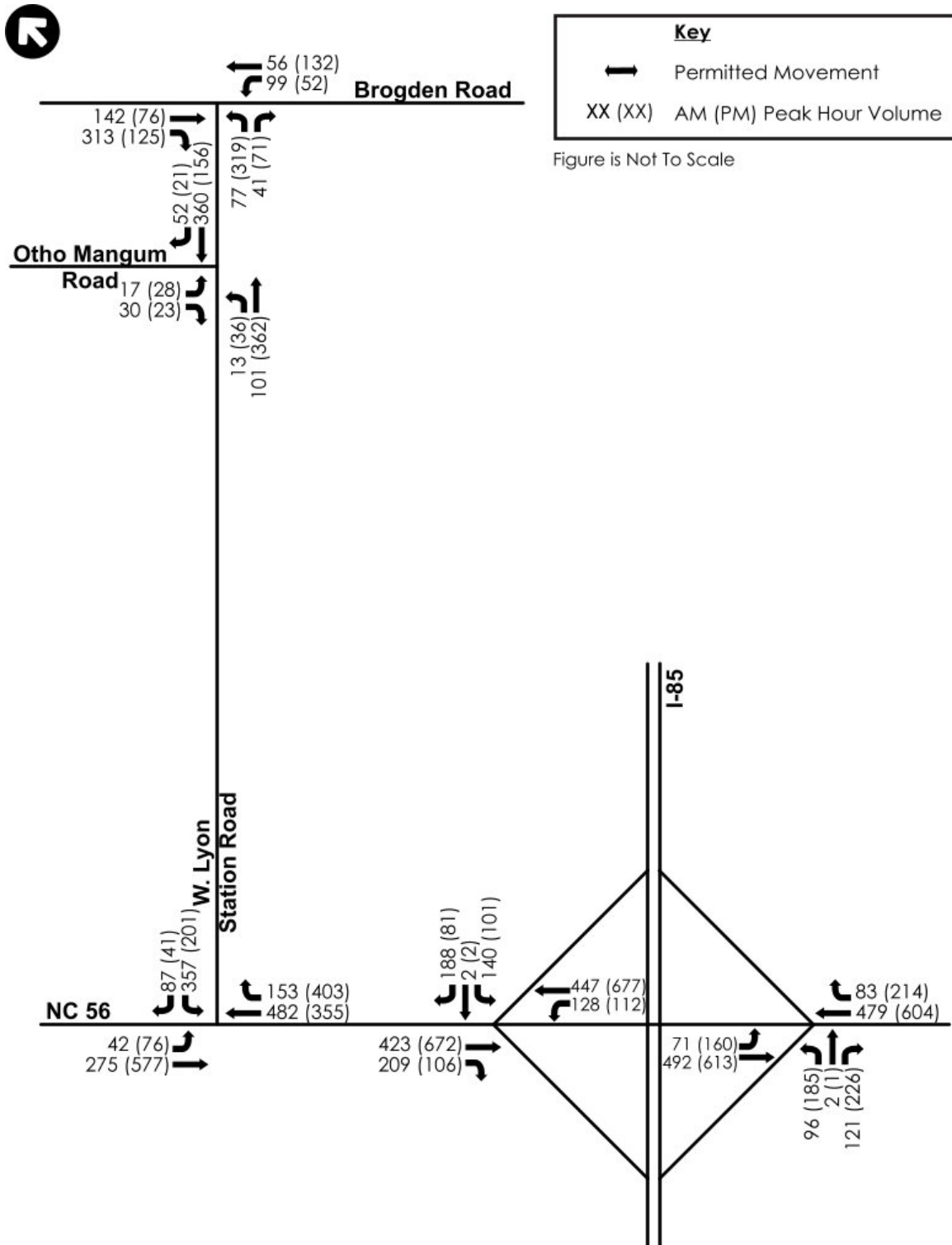
The 2027 build traffic volumes include the 2027 no-build traffic and the proposed development traffic. A discussion of the site trip distribution and assignment is provided in Section 4.0. The site trip distribution and volumes are shown in Figure 5 and Figure 6, respectively. The 2027 peak hour build AM and PM volumes are shown in Figure 10 and Figure 11, respectively.



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Traffic Volumes
February 22, 2023

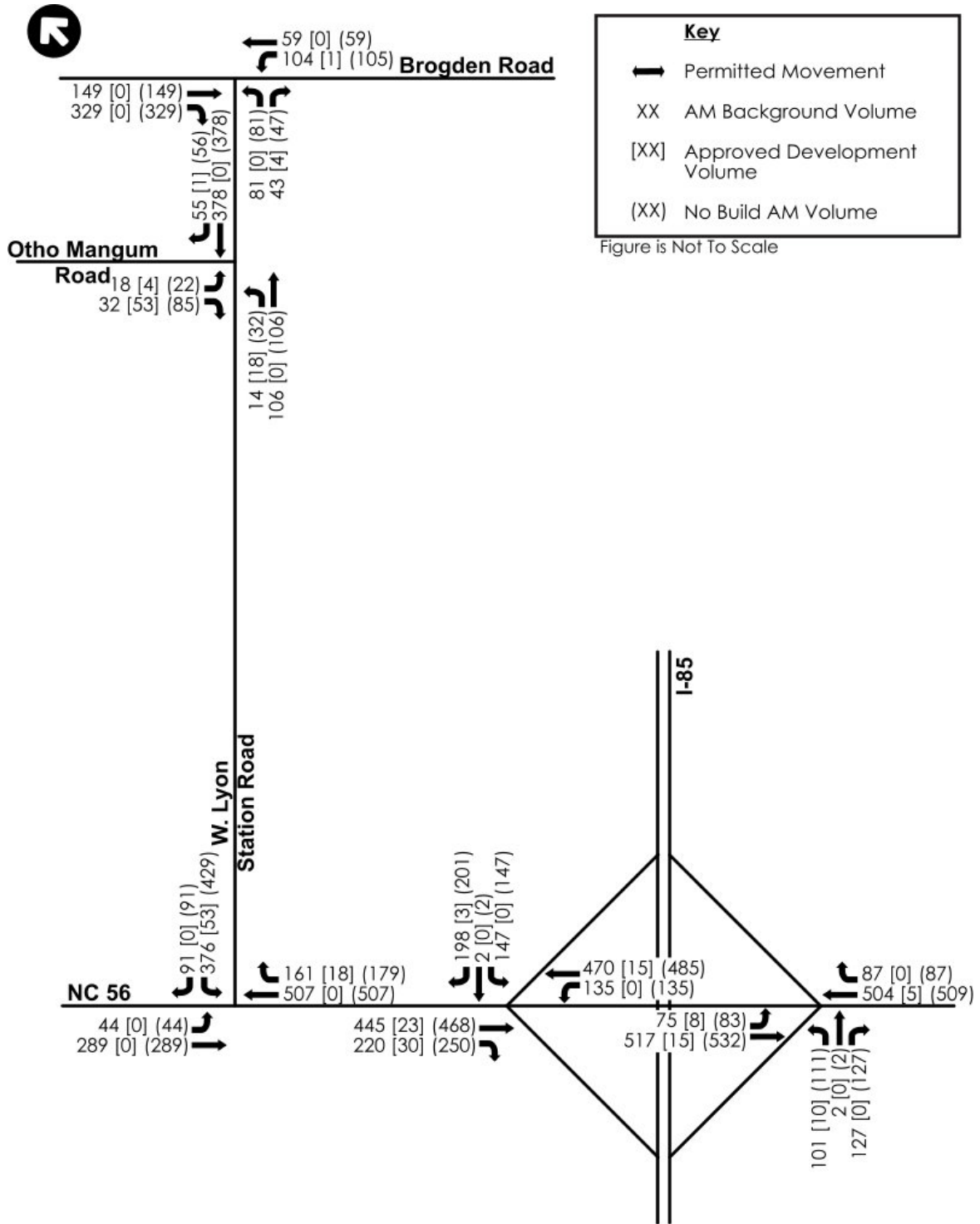
Figure 7: 2022 Existing Traffic Volumes



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Traffic Volumes
February 22, 2023

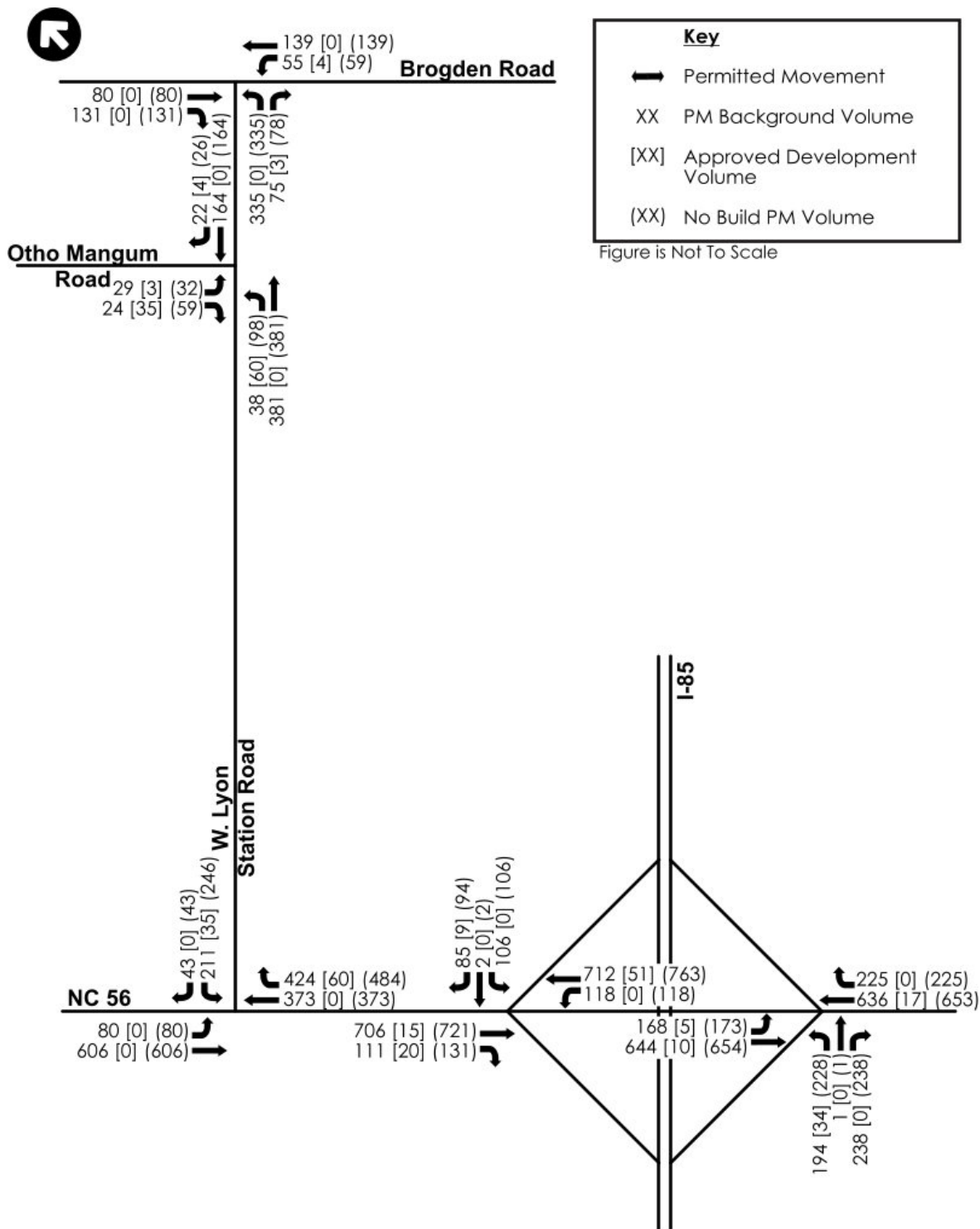
Figure 8: 2027 No-Build AM Volumes



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Traffic Volumes
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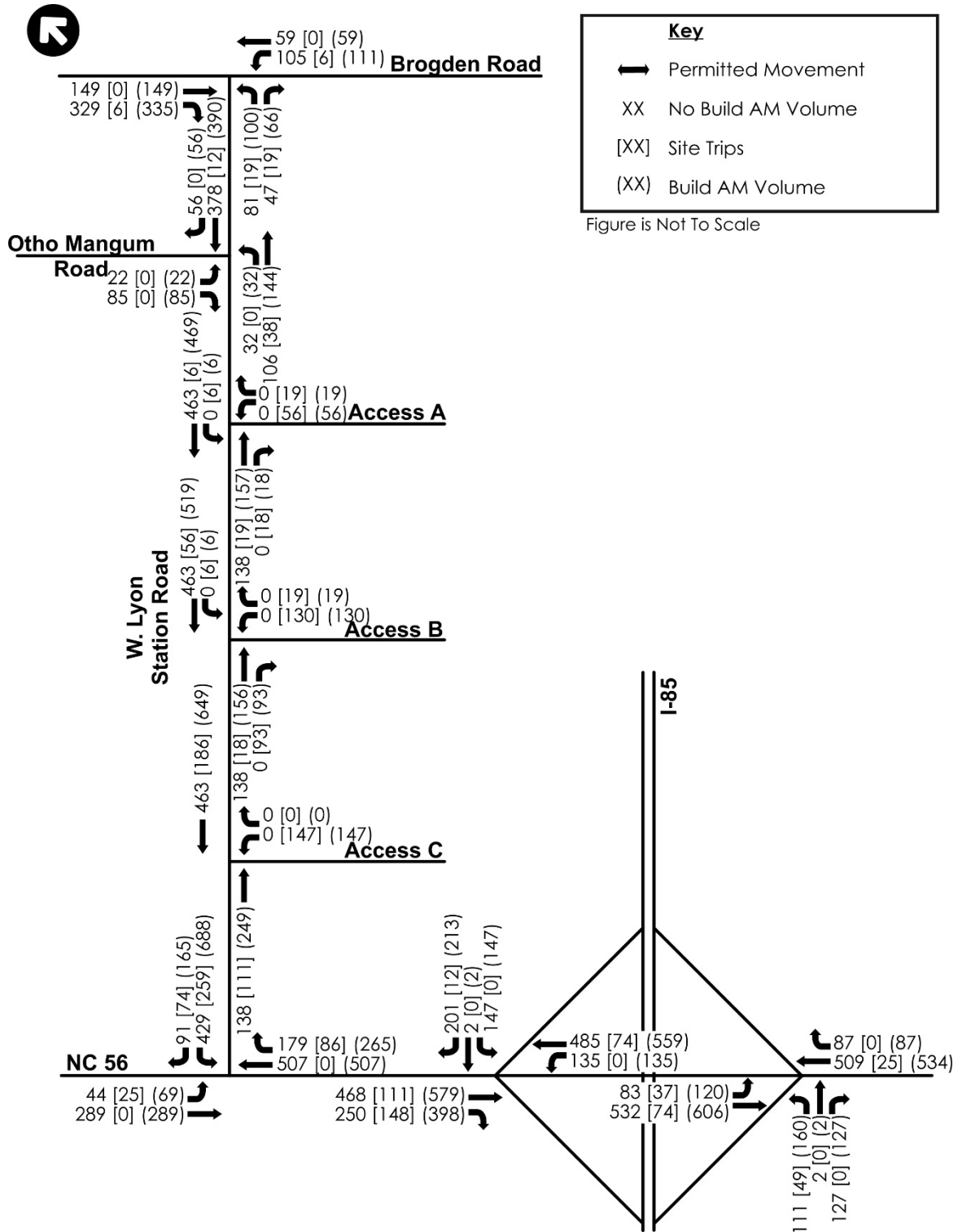
Figure 9: 2027 No-Build PM Volumes



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Traffic Volumes
February 22, 2023

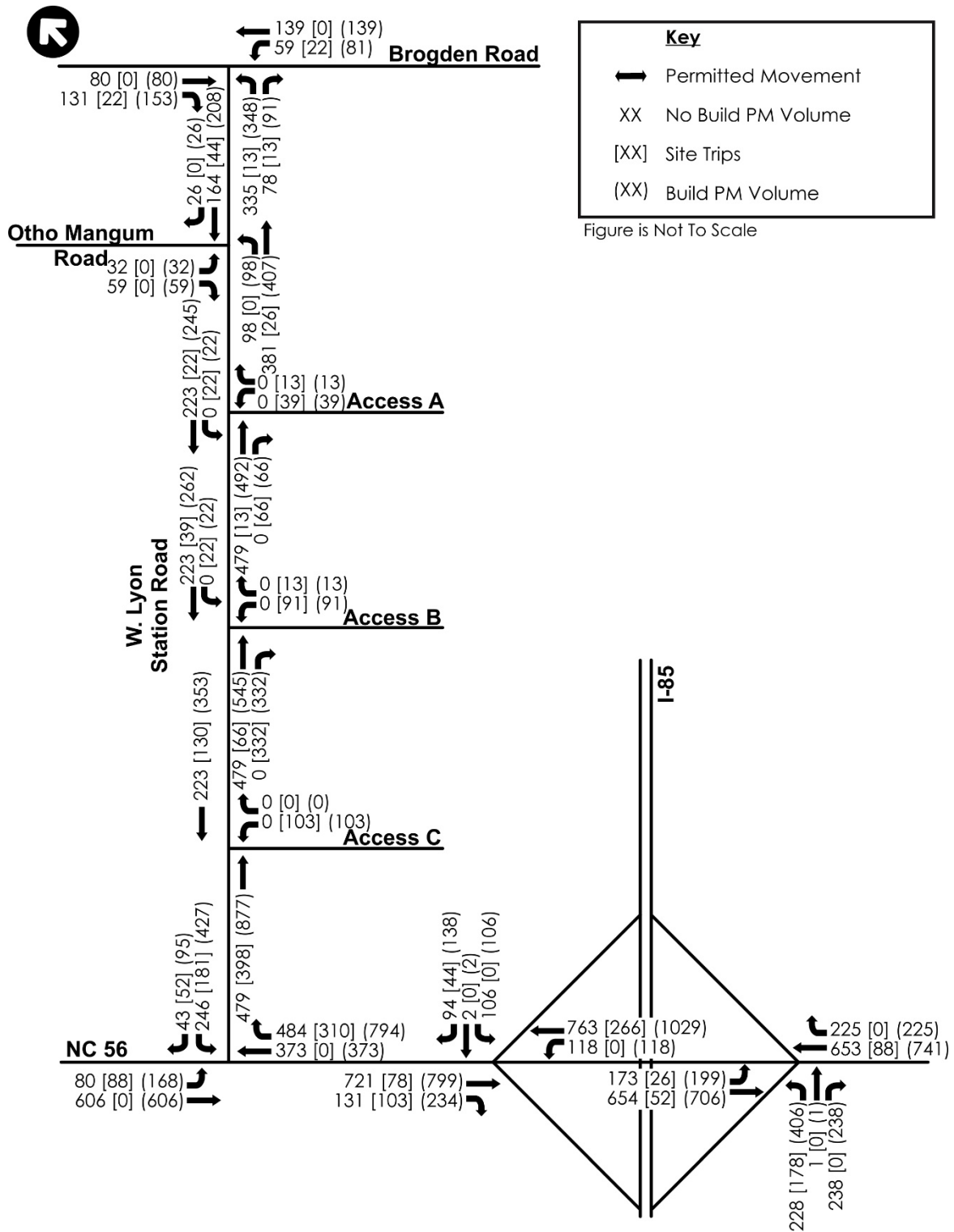
Figure 10: 2027 Build AM Volumes



LYON STATION PUD TRAFFIC IMPACT ANALYSIS

Traffic Volumes
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Figure 11: 2027 Build PM Volumes



6.0 CAPACITY ANALYSIS

Capacity analyses were performed for the roadway network in the study area. The traffic analysis program Synchro, Version 11, was used to analyze all signalized and stop-controlled intersections according to methods put forth by the Transportation Research Board’s Highway Capacity Manual⁶ (HCM). The HCM defines capacity as the “maximum rate or flow at which persons or vehicles can be reasonably expected to traverse a point or uniform section of a line or roadway during a specified time period under prevailing roadway, traffic, and control conditions, usually expressed as vehicles per lane per hour.”

Level of service (LOS) is a term used to describe different traffic conditions and is defined as a “qualitative measure describing operational conditions within a traffic stream, and their perception by motorists or passengers.” LOS varies from Level A, representing free flow, to Level F where traffic breakdown conditions are evident. At an unsignalized intersection, the primary traffic on the main roadway is virtually uninterrupted. Therefore, the overall delay for the intersection is usually less than what is calculated for the minor street movements. The overall intersection delay and the delay for the intersections’ minor movement(s) are reported in the summary tables of this report. Generally, LOS D is acceptable for signalized intersections in suburban areas during peak periods. For unsignalized intersections, it is not uncommon for some of the minor street movements or approaches to be operating at LOS F during peak hour conditions and that is not necessarily indicative of an area that requires improvements.

Capacity analyses were completed under NCDOT Congestion Management Capacity Analysis Guidelines⁷ and the Policy on Street and Driveway Access to North Carolina Highways⁸. Table 5 presents the criteria of each LOS indicated in the HCM.

Table 5: Level of Service Criteria

Level of Service (LOS)	Signalized Intersection Control Delay (seconds / vehicle)	Unsignalized Intersection Control Delay (seconds / vehicle)
A	≤ 10	≤ 10
B	> 10 and ≤ 20	> 10 and ≤ 15
C	> 20 and ≤ 35	> 15 and ≤ 25
D	> 35 and ≤ 55	> 25 and ≤ 35
E	> 55 and ≤ 80	> 35 and ≤ 50
F	> 80	> 50

Peak hour factors for all analysis scenarios were set to 0.9. All heavy vehicle percentages for all analysis scenarios were set to 2%. Any calculated volume of zero (0), one (1), two (2), or three (3) vehicles per hour was increased to four (4) vehicles per hour per NCDOT Congestion Management Capacity Analysis Guidelines⁷.

All synchro files and detailed printouts can be found in the appendix. A summary of the results of the analyses is provided in the following sub-sections.








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6.1 EXISTING CAPACITY ANALYSIS (2022)

In the base year of 2022, under the existing geometric conditions, all study intersections and approaches operate at LOS D or better in both the AM and PM peak hours with one exception being the WB approach of NC 56 at the I-85 northbound ramps in the PM peak hour. Additionally, no significant queues were observed in the model, except on the westbound approach at the NC 56 at I-85 Northbound Ramps intersection in the PM peak hour. At this location, the queue lasts for several cycle lengths, but clears by the end of the simulation. The results from the 2022 existing analysis are shown in Table 6.

Table 6: 2022 Existing Analysis Results

Intersection	Approach	Lane Group	Delay (sec. / veh.)		Level of Service (LOS)		95th % Queue (feet)		Max. Obs. Queue (feet)	
			AM	PM	AM	PM	AM	PM	AM	PM
 Lyon Station Road at Brogden Road	WB	L	8.8	7.8	A	A	65	26	95	35
	NB	LR	15.4	24.6	C	C	71	152	89	193
 Lyon Station Road at Otho Mangum Road	EB	LR	12.1	12.5	B	B	37	33	46	40
	NB	L	8.3	7.7	A	A	25	38	44	62
 Lyon Station Road at NC 56	Overall		21.5	13.5	C	B				
	EB	L	9.2	7.2	A	A	52	101	58	148
		T	10.5	12.3	B	B	138	274	169	342
	WB	T	28.4	20.8	C	C	240	183	253	208
		R	2.7	5.2	A	A	178	132	241	180
	SB	L	32.2	24.4	C	C	251	159	300	183
R		12.7	9.9	B	A	151	73	175	125	
 NC 56 at I-85 SB Ramps	Overall		20.9	16.5	C	B				
	EB	T	25	21	C	C	248	288	261	263
		L	7.6	5	A	A	79	83	101	116
	WB	T	7.4	6	A	A	153	196	172	248
		LT	33.3	43.9	C	D	112	105	138	131
SB	R	39.3	42.8	D	D	19	20	20	20	
	Overall		15.8	31	B	C				
 NC 56 at I-85 NB Ramps	EB	L	5	28	A	C	56	110	70	160
		T	6.9	7.7	A	A	145	217	179	270
	WB	T	18.7	36.1	B	D	212	818	259	814
		LT	30.1	44.7	C	D	88	160	107	196
	NB	R	32.9	65.9	C	E	17	65	17	134








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6.2 NO-BUILD CAPACITY ANALYSIS (2027)

In 2027, under the geometric conditions discussed in section 2.7, all study intersections and approaches are expected to operate at LOS D or better in both the AM and PM peak hours; with one exception. That is the westbound and northbound approaches at the intersection of NC 56 at the I-85 NB Ramps operates at LOS E in the PM peak hour. The significant westbound queue at this intersection that was present in the 2022 existing analysis is expected to increase in the 2027 no-build scenario. The results from the 2027 no-build analysis are shown in Table 7.

Table 7: 2027 No-Build Analysis Results

Intersection	Approach	Lane Group	Delay (sec. / veh.)		Level of Service (LOS)		95th % Queue (feet)		Max. Obs. Queue (feet)	
			AM	PM	AM	PM	AM	PM	AM	PM
 Lyon Station Road at Brogden Road	WB	L	8.9	7.8	A	A	66	31	86	42
	NB	LR	16.4	30.7	C	D	84	174	110	212
 Lyon Station Road at Otho Mangum Road	EB	LR	13.4	13.7	B	B	52	48	72	63
	NB	L	8.4	7.9	A	A	49	57	80	80
 Lyon Station Road at NC 56	Overall		17.4	11.1	B	B				
	EB	L	6.2	5.9	A	A	58	75	66	84
		T	6.2	6.6	A	A	91	175	112	202
	WB	T	22.3	19.8	C	B	248	206	290	242
		R	3	6	A	A	69	149	96	184
	SB	L	27	21.1	C	C	171	134	202	149
R		14.8	10.1	B	B	77	46	98	61	
 NC 56 at I-85 SB Ramps	Overall		18	15.4	B	B				
	EB	T	21.4	19	C	B	225	305	256	356
		L	8.5	5.7	A	A	87	101	112	161
	WB	T	10.1	8.5	B	A	157	234	184	317
		LT	26.5	38.3	C	D	122	111	153	134
	SB	R	30.4	38.7	C	D	22	28*	16	43*
Overall		16.6	38.2	B	D					
 NC 56 at I-85 NB Ramps	EB	L	5.3	34.9	A	C	65	148	83	221
		T	7.3	8.5	A	A	169	240	207	301
	WB	T	19.7	44.8	B	D	238	1840	305	1477
		LT	32.3	57.4	C	E	97	224	118	294
	NB	R	34.8	79	C	E	19	131	19	200

*Due to SimTraffic queuing results not being provided for the southbound right-turn movement in the PM peak hour at the NC 56 at I-85 SB Ramps intersection, the model was updated to remove the storage for that lane and the simulation was re-run to produce queue lengths. The queue lengths developed in this manner are presented for this movement only and are marked with an asterisk in the table.



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6.3 BUILD CAPACITY ANALYSIS (2027)

As part of the 2027 build analysis, three (3) access points to the proposed development were added to the network. These are detailed in Section 2.2. In 2027, with the proposed development in place, all study intersections and approaches are expected to operate at a LOS D or better, except for the three intersections listed below, which are expected to operate at an overall LOS E or F.

- Lyon Station Road at Brogden Road (PM Peak);
- Lyon Station Road at Site Access C (AM and PM Peak); and
- NC 56 at I-85 Northbound Ramps (PM Peak).

The results from the 2027 Build analysis are shown in Table 8. No significant queuing is expected in the network, except for the westbound approach of NC 56 at the I-85 Northbound Ramps which was noted in the existing and no-build analyses.

Table 8: 2027 Build Analysis Results

Intersection	Approach	Lane Group	Delay (sec. / veh.)		Level of Service (LOS)		95th % Queue (feet)		Max. Obs. Queue (feet)	
			AM	PM	AM	PM	AM	PM	AM	PM
 Lyon Station Road at Brogden Road	WB	L	9	8	A	A	81	39	92	53
	NB	LR	18.1	48	C	E	115	149	148	178
 Lyon Station Road at Otho Mangum Road	EB	LR	13.5	14.7	B	B	62	51	76	70
	NB	L	8.5	8	A	A	56	65	82	94
 Lyon Station Road at Site Access A	WB	LR	14.7	18.1	B	C	58	55	70	64
	SB	L	7.6	8.8	A	A	12	42	20	73
 Lyon Station Road at Site Access B	WB	LR	22.3	35.7	C	E	82	96	99	121
	SB	L	7.8	10.3	A	B	25	74	41	125
 Lyon Station Road at Site Access C	WB	LR	36.6	69	E	F	99	85	120	104
 Lyon Station Road at NC 56	Overall		21.5	16.8	C	B				
	EB	L	9.6	17.5	A	B	69	130	83	166
		T	8.5	13.8	A	B	97	201	116	232
	WB	T	29.6	35.2	C	D	304	221	358	259
		R	3.2	10.6	A	B	92	232	113	272
	SB	L	30.8	18	C	B	265	137	293	171
R		14.6	8.8	B	A	107	66	139	83	
 NC 56 at I-85 SB Ramps	Overall		20.6	20.2	C	C				
	EB	T	24.7	22.1	C	C	317	329	364	386
		L	9.1	6.7	A	A	112	120	165	195
	WB	T	9.9	16.7	A	B	205	231	252	257
		LT	30.6	40.1	C	D	132	125	171	158
	SB	R	38.1	48	D	D	50	67	87	122
Overall		17.9	65.5	B	E					
 NC 56 at I-85 NB Ramps	EB	L	6.6	136.9	A	F	107	227	185	249
		T	8.6	14.6	A	B	225	375	265	429
	WB	T	21.2	68.8	C	E	298	2285	335	1967
		LT	35.2	116.9	D	F	127	670	141	708
	NB	R	34.7	54.5	C	D	19	281	20	200



6.4 BUILD WITH IMPROVEMENTS CAPACITY ANALYSIS (2027)

Based on the findings of this study, specific improvements have been identified and should be completed as part of the proposed development. The recommendations are illustrated in Figure 13. The results of the analysis containing the recommended improvements are shown in Table 9.

Lyon Station Road at Brogden Road

- Construct an exclusive northbound right-turn lane with 100' of full-width storage and appropriate taper

Lyon Station Road at Otho Mangum Road

- Construct an exclusive northbound left-turn lane with 100' of full-width storage and appropriate taper

It should be noted that the proposed development's impact at this intersection is minimal. Traffic volumes at Access A, located 250 feet to the south of this intersection, meets the criteria for installation of a southbound left-turn lane. Northbound left-turn volumes from Lyon Station Road onto Otho Mangum Road are currently higher than what is projected for southbound left-turns at Access A. Given the offset-T configuration of the intersection, only one left-turn lane can be installed between Otho Mangum Road and Lyon Station Road. Given that the higher volume of traffic is making a northbound left-turn onto Otho Mangum Road, it is recommended that a northbound left-turn lane from Lyon Station Road onto Otho Mangum Road be constructed.

Alternatively, the realignment of Otho Mangum Road to intersect Lyon Station Road across from Access A was discussed during project scoping to avoid the offset-T configuration and potential for left-turn conflicts. This potential configuration was analyzed, and the results of the analysis are provided and discussed in section 6.4.3. However, this configuration is likely not feasible, as realigning Otho Mangum Road would cause significant impacts to the existing cemetery. Due to this impact, the realignment of Otho Mangum Road was not considered as a reasonable alternative in this study and is therefore not recommended.

Lyon Station Road at Access A

- Construct Access A as a full-movement access point with one ingress lane and one egress lane
- Provide Access A with a minimum of 70 feet of internal stem length
- Construct an exclusive northbound right-turn lane with 100' of full-width storage and appropriate taper

Lyon Station Road at Access B

- Construct Access B as a full-movement access point with one ingress lane and one egress lane
- Provide Access B with a minimum of 100 feet of internal stem length
- Construct an exclusive northbound right-turn lane with 200' of full-width storage and appropriate taper

Lyon Station Road at Access C

- Construct Access C as a one-lane egress-only access point



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Lyon Station Road at NC 56

- No improvements are recommended at this intersection

NC 56 at I-85 Southbound Ramps

- No improvements are recommended at this intersection

NC 56 at I-85 Northbound Ramps

- Extend the existing exclusive westbound right-turn lane so that it begins at the nearest upstream driveway, approximately 300' to the east, and terminates at the existing westbound channelized right-turn lane.

It should be noted that this recommended improvement does not serve traffic generated by the proposed development but is shown to mitigate the development's impact at the study intersection.

Improvements to the I-85 northbound off-ramp or the eastbound approach of NC 56 are not recommended as the bridge over I-85 prohibits the ability to widen both approaches.



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6.4.1 Build with Improvements Analysis Results

The results of the capacity analysis with the recommended improvements in-place are as follows:

Table 9: 2027 Build with Improvements Analysis Results

Intersection	Approach	Lane Group	Delay (sec. / veh.)		Level of Service (LOS)		95th % Queue (feet)		Max. Obs. Queue (feet)	
			AM	PM	AM	PM	AM	PM	AM	PM
STOP Lyon Station Road at Brogden Road	WB	L	9	8	A	A	71	46	93	61
		L	18.7	35.5	C	E	71	165	93	217
	NB	R	10.8	9.7	B	A	52	76	62	116
STOP Lyon Station Road at Otho Mangum Road	EB	LR	13.5	14.5	B	B	52	51	67	66
	NB	L	8.5	8	A	A	36	50	39	60
STOP Lyon Station Road at Site Access A	WB	LR	14.5	17.3	B	C	48	48	59	59
	SB	L	7.6	8.8	A	A	11	40	20	63
STOP Lyon Station Road at Site Access B	WB	LR	20.3	24.8	C	C	77	68	103	91
	SB	L	7.8	10.3	A	B	5	53	8	88
STOP Lyon Station Road at Site Access C	WB	LR	36.6	69	E	F	92	80	120	96
Lyon Station Road at NC 56	Overall		21.5	16.8	C	B				
	EB	L	9.6	17.5	A	B	74	140	91	196
		T	8.5	13.8	A	B	99	211	121	231
	WB	T	30	35.2	C	D	319	273	383	306
		R	3.3	10.6	A	B	92	260	117	307
	SB	L	30.5	18	C	B	247	182	280	205
		R	14.4	8.8	B	A	110	66	127	84
Lyon Station Road at NC 56	Overall		20.7	20.2	C	C				
	EB	T	24.9	22.1	C	C	279	313	328	366
		L	9.1	6.7	A	A	97	110	139	179
	WB	T	9.9	16.7	A	B	196	255	254	298
		LT	30.4	40.1	C	D	130	117	162	146
	SB	R	37.9	48	D	D	43	53	87	93
Lyon Station Road at NC 56	Overall		16.8	37.6	B	D				
	EB	L	6.7	46.7	A	D	109	221	161	249
		T	9.6	14.6	A	B	229	358	288	413
	WB	T	20	42.1	B	D	232	586	268	641
	NB	LT	31	75.5	C	E	139	474	171	518
		R	30.6	38.2	C	D	43	257	73	200

With the recommended improvements in place, all study intersections are expected to operate at LOS D or better, except for the Lyon Station Road at Brogden Road intersection and the Lyon Station Road at Site Access C intersection. While the recommended mitigation at the Lyon Station Road at Brogden Road intersection is not expected to cause the intersection to operate at a level of service equivalent to no-build conditions, it is expected to mitigate a large portion of the delay added by the site traffic and to reduce the delay to only 0.5 seconds above the LOS E threshold. Additionally, while the model results show that the Lyon Station Road at Site Access C intersection is expected to operate at LOS E in the AM peak hour and LOS F in the PM peak hour, it is likely that drivers will adapt their behavior over time and that the delays experienced at Site Accesses B and C will become more balanced.



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With the addition of the recommended improvements, the queueing observed in the network, particularly at the I-85 Northbound Ramps intersection, is significantly reduced. At this location, the queues in the PM peak hour are expected to be reduced substantially and to a level less than what was observed in the 2027 No Build model. Throughout the rest of the study area, queues are expected to be minimal and to not affect general operations of the network.

6.4.2 Access A Alternative Configuration Analysis

As an alternative to the offset-T configuration analyzed in the Build scenario for the Lyon Station Road at Otho Mangum Road and Access A intersections, a single, four-leg intersection alternative was also studied. In this alternative configuration, Access A would connect to Lyon Station Road as an added fourth leg at the existing Lyon Station Road at Otho Mangum Road T-intersection. For the purposes of this analysis, the traffic model assumed that the recommended northbound left at Otho Mangum Road and northbound right at Site Access A were to be constructed in this scenario. In addition, due to the adjusted configuration of the intersections, an exclusive southbound left turn lane into Site Access A, can be provided and is recommended in this scenario. The results of this isolated intersection analysis are shown Table 10.

Table 10: 2027 Access A Alternative Configuration Results

Intersection	Approach	Lane Group	Delay (sec. / veh.)		Level of Service (LOS)		95th % Queue (feet)		Max. Obs. Queue (feet)	
			AM	PM	AM	PM	AM	PM	AM	PM
 Lyon Station Road at Otho Mangum Road and Site Access A	EB	LTR	14.4	17.8	B	C	57	55	79	80
	WB	LTR	19.7	25.5	C	D	53	47	64	58
	NB	L	1.5	1.4	A	A	22	34	32	44
	SB	L	0.1	0.8	A	A	5	21	11	26

The results of this isolated intersection analysis indicate that the Otho Mangum Road and Site Access A combined intersection is expected to operate at a LOS D or better in both the AM and PM peak hours. However, the delays reported by the traffic model are slightly higher than in the Build with Improvements scenario, which includes the offset intersection configuration. As in the 2027 Build with Improvements scenario, there were no queueing issues observed at this location in either peak hour.



7.0 RECOMMENDATIONS

Based on the analysis and information presented herein, all study intersections are expected to operate with acceptable levels of service with the proposed development and recommended improvements in-place, except the Lyon Station Road and Brogden Road in the PM peak hour. The recommended improvements are described below and shown in Figure 13.

Lyon Station Road at Brogden Road

- Construct an exclusive northbound right-turn lane with 100' of full-width storage and appropriate taper

Lyon Station Road at Otho Mangum Road

- Construct an exclusive northbound left-turn lane with 100' of full-width storage and appropriate taper

It should be noted that the proposed development's impact at this intersection is minimal. Traffic volumes at Access A, located 250 feet to the south of this intersection, meets the criteria for installation of a southbound left-turn lane. Northbound left-turn volumes from Lyon Station Road onto Otho Mangum Road are currently higher than what is projected for southbound left-turns at Access A. Given the offset-T configuration of the intersection, only one left-turn lane can be installed between Otho Mangum Road and Lyon Station Road. Given that the higher volume of traffic is making a northbound left-turn onto Otho Mangum Road, it is recommended that a northbound left-turn lane from Lyon Station Road onto Otho Mangum Road be constructed.

Alternatively, the realignment of Otho Mangum Road to intersect Lyon Station Road across from Access A was discussed during project scoping to avoid the offset-T configuration and potential for left-turn conflicts. This potential configuration was analyzed, and the results of the analysis are provided and discussed in section 6.4.3. However, this configuration is likely not feasible, as realigning Otho Mangum Road would cause significant impacts to the existing cemetery. Due to this impact, the realignment of Otho Mangum Road was not considered as a reasonable alternative in this study and is therefore not recommended.

Lyon Station Road at Access A

- Construct Access A as a full-movement access point with one ingress lane and one egress lane
- Provide Access A with a minimum of 70 feet of internal stem length
- Construct an exclusive northbound right-turn lane with 100' of full-width storage and appropriate taper

Lyon Station Road at Access B

- Construct Access B as a full-movement access point with one ingress lane and one egress lane
- Provide Access B with a minimum of 100 feet of internal stem length
- Construct an exclusive northbound right-turn lane with 200' of full-width storage and appropriate taper

Lyon Station Road at Access C

- Construct Access C as a one-lane egress-only access point



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Lyon Station Road at NC 56

- No improvements are recommended at this intersection

NC 56 at I-85 Southbound Ramps

- No improvements are recommended at this intersection

NC 56 at I-85 Northbound Ramps

- Extend the existing exclusive westbound right-turn lane so that it begins at the nearest upstream driveway, approximately 300' to the east, and terminates at the existing westbound channelized right-turn lane.

It should be noted that this recommended improvement does not serve traffic generated by the proposed development but is shown to mitigate the development's impact at the study intersection.

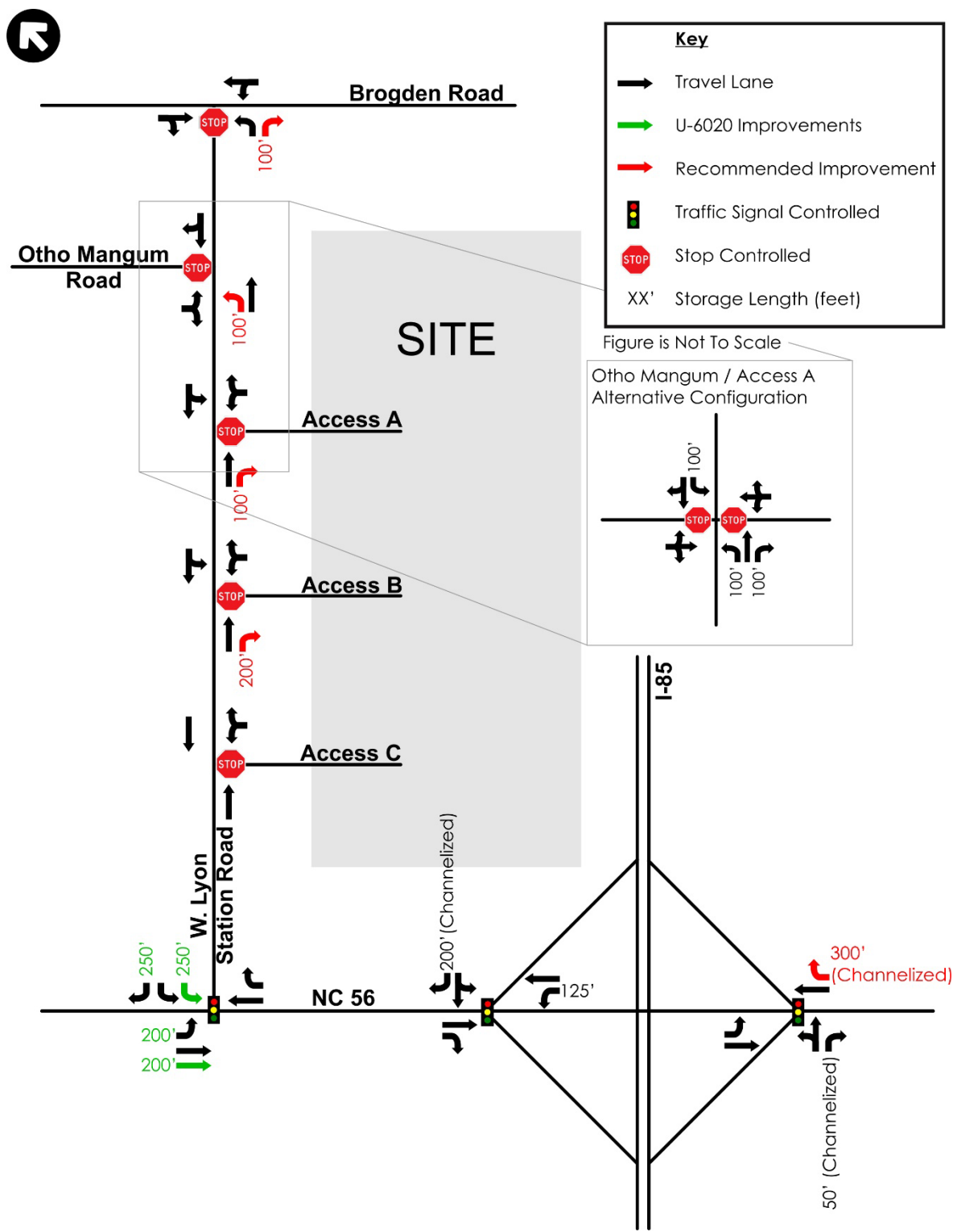
Improvements to the I-85 northbound off-ramp or the eastbound approach of NC 56 are not recommended as the bridge over I-85 prohibits the ability to widen both approaches.



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Figure 12: 2027 Build with Improvements Geometry



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References

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8.0 REFERENCES

¹ NCDOT Functional Class, *NCDOT*, October 2019

<http://ncdot.maps.arcgis.com/home/webmap/viewer.html?layers=029a9a9fe26e43d687d30cd3c08b1792>

² NCDOT AADT Web Map, *NCDOT*, February 2020

<http://ncdot.maps.arcgis.com/home/webmap/viewer.html?webmap=b7a26d6d8abd419f8c27f58a607b25a1>

³ NCDOT State Maintained Network Map, *NCDOT*, October 2019

<http://ncdot.maps.arcgis.com/home/webmap/viewer.html?webmap=5d3ad78971714a30be7ff97fd580e4d5>

⁴ Trip Generation Manual, 11th Edition, *Institute of Transportation Engineers*, September 2021

⁵ NCDOT Congestion Management Rate vs. Equation Spreadsheet, *NCDOT*, July 2022

<https://connect.ncdot.gov/resources/safety/Congestion%20Mngmt%20and%20Signing/DRAFT%20-%20Trip%20Generation%20Rate%20Eqn.xlsm>

⁶ Highway Capacity Manual 6th Edition: A Guide for Multimodal Mobility Analysis, *Transportation Research Board*, 2016

⁷ NCDOT Congestion Management Capacity Analysis Guidelines, *NCDOT*, July 2015

<https://connect.ncdot.gov/resources/safety/Congestion%20Mngmt%20and%20Signing/Congestion%20Management/Capacity%20Analysis%20Guidelines.pdf>

⁸ Policy on Street and Driveway Access to North Carolina Highways, *NCDOT*, July 2003



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9.0 APPENDIX

A link containing all relevant files is electronically sent with this report:

- NCDOT Scoping Checklist
- Site Plan
- Raw Traffic Count Data
- Signal Plans
- Approved Development Information
- Traffic Volume Calculations
- U-6020 Information
- NC 56 Corridor Study
- I-85 Future Interchange Location Analysis (Technical Memorandum #2: Feasibility)
- Butner Gateway Study
- Synchro Files
- Synchro / SimTraffic Reports

