

Traffic Impact Analysis for
Camellia Gardens
Harrisburg, North Carolina

Prepared for:

Town of Harrisburg
Harrisburg, North Carolina

Prepared by:

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1.0 Executive Summary

The purpose of this Traffic Impact Analysis (TIA) is to evaluate the vehicular traffic impacts on the surrounding transportation infrastructure as a result of the proposed Camellia Gardens subdivision.

The primary objectives of the study are:

- To estimate trip generation and distribution for the proposed development.
- To perform intersection capacity analyses for the identified study area.
- To determine the potential traffic impacts of the proposed development.
- To identify improvements to mitigate the proposed development's traffic impacts.

The proposed Camellia Gardens subdivision is located south of Stallings Road and east of Harrisburg Veterans Road in Harrisburg, North Carolina. Based on the site plan provided by the applicant, the proposed development is currently envisioned to consist of approximately 165 single-family homes.

For the purposes of this TIA, a build-out year of 2023 was considered at the direction of the Town. Based on the provided site plan and information provided by the applicant, the proposed development will be accessed via the following:

- Site Access #1 – right-in/right-out access at the existing Stallings Road and Stallings Road Park Drive intersection
- Site Access #2 – full-movement at the existing Stallings Road and Harrisburg Elementary School Drive intersection.

A TIA scoping meeting was held with the Town of Harrisburg and representatives of the applicant in Harrisburg on May 23, 2018, to obtain background information and to ascertain the scope and parameters to be included in this TIA. A Memorandum of Understanding (MOU) was developed based on discussions from this meeting and additional coordination with the Town and the Applicant in November 2018 that documented all scoping parameters to be used for the TIA. This scope was reviewed and agreed upon by the Town of Harrisburg and the applicant. Additionally, North Carolina Department of Transportation (NCDOT) reviewed and approved the MOU, which is included in the **Appendix**.

The following AM and PM peak-hour scenarios were analyzed to determine the proposed development's transportation impacts on the surrounding network:

- 2018 Existing Conditions
- 2023 Background Conditions
- 2023 Build-out Conditions

Based on coordination with the Town, NCDOT and the applicant, this TIA evaluated operations under each of the AM and PM peak-hour scenarios above for the following study area intersections:

1. Robinson Church Road and Tom Query Road
2. Stallings Road and Harrisburg Veterans Road
3. Stallings Road and Stallings Road Park Drive/Site Access #1
4. Stallings Road and Harrisburg Elementary School Drive/Site Access #2
5. Stallings Road and Raging Ridge Road/Stallings Road Subdivision

Note that for the purposes of this analysis, Stallings Road was considered to have an east/west orientation.

Kimley-Horn was retained to determine the potential traffic impacts of this development (in accordance with the traffic study guidelines in the *NCDOT Policy on Street and Driveway Access to North Carolina Highways* and set forth by the *Town of Harrisburg Unified Development Ordinance – Appendix F*), and to identify transportation improvements that may be required to mitigate these impacts. This report presents trip generation, distribution, capacity analyses, and identified transportation improvements required to mitigate anticipated traffic demands produced by the subject development.

Based on the capacity analyses performed at each of the identified study intersections, along with review of the auxiliary turn-lane warrants contained herein, the following improvements are identified to mitigate the impact of the proposed development on the adjacent street network:

Robinson Church Road and Tom Query Road

- Contribution of 25% of the overall cost of planned Town improvements to this intersection, not to exceed \$100,000

Stallings Road and Harrisburg Veterans Road

- Restriping of the eastbound through lane to provide a shared through-left lane
- Implementation of split phasing on the eastbound and westbound approaches
- Installation of a traffic signal at the intersection of Stallings Road and Hickory Ridge Road to be connected to the signal cabinet at Stallings Road and Harrisburg Veterans Road

Stallings Road and Stallings Road Park Drive/Site Access #1

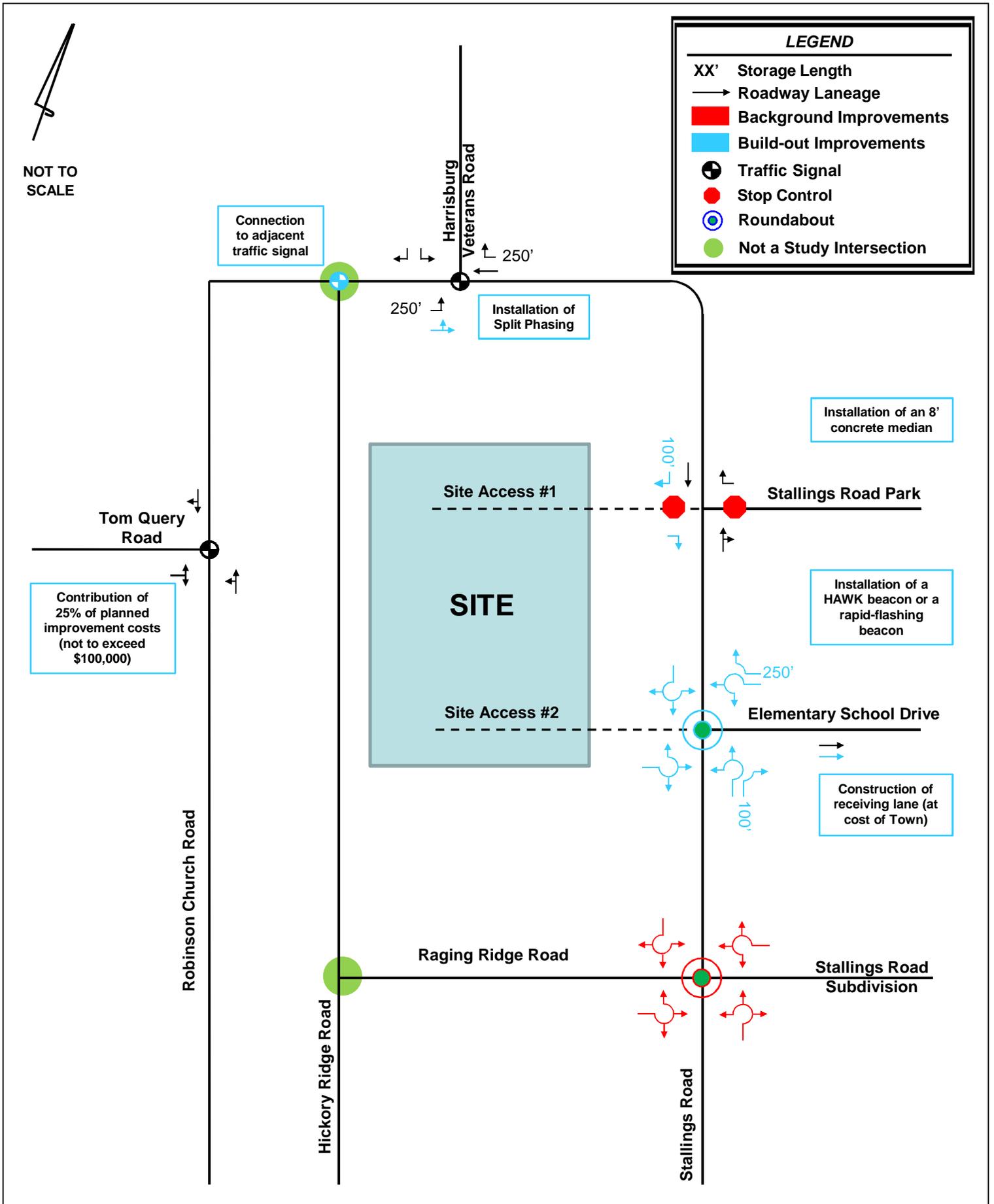
- Installation of an eastbound right-turn lane from Stallings Road into Site Access #1 with 100 feet of storage
- Installation of an 8' concrete median to serve as a refuge for pedestrian crossing and to convert the intersection to a right-in/right-out

Stallings Road and Harrisburg Elementary School Drive/Site Access #2

- Installation of a roundabout
- Construction of a single lane northbound approach
- Construction of a southbound right-turn lane from the Elementary School Drive onto Stallings Road with a minimum of 250 feet of storage (accomplished via restriping of the existing turn lanes)
- Construction of a single lane eastbound approach
- Construction of a westbound right-turn lane from Stallings Road into the Elementary School Drive with 100 feet of storage
- Construction of second receiving lane on the Elementary School Drive (this lane will be constructed by the developer at the cost of the Town)

Per the Town, installation of a High-Intensity Activated Crosswalk (HAWK) beacon or rapid-flashing beacon will be required to provide a connection from the proposed development to Stallings Road Park.

The mitigation identified within the study area is shown in **Figure 1.1**. The improvements shown in this figure are subject to approval by NCDOT and the Town of Harrisburg. All additions and attachments to the State and Town roadway system shall be properly permitted, designed and constructed in conformance to standards maintained by the agencies.



2.0 Introduction

The proposed Camellia Gardens subdivision is located south of Stallings Road and east of Harrisburg Veterans Road in Harrisburg, North Carolina. Based on the site plan provided by the applicant, the proposed development is currently envisioned to consist of approximately 165 single-family homes.

For the purposes of this TIA, a build-out year of 2023 was considered at the direction of the Town. Based on the provided site plan and information provided by the applicant, the proposed development access will be access via the following:

- Site Access #1 – right-in/right-out access at the existing Stallings Road and Stallings Road Park Drive intersection
- Site Access #2 – full-movement at the existing Stallings Road and Harrisburg Elementary School Drive intersection

A TIA scoping meeting was held with the Town of Harrisburg and representatives of the applicant in Harrisburg on May 23, 2018, to obtain background information and to ascertain the scope and parameters to be included in this TIA. A Memorandum of Understanding (MOU) was developed based on discussions from this meeting and additional coordination with the Town and the Applicant in November 2018 that documented all scoping parameters to be used for the TIA. This scope was reviewed and agreed upon by the Town of Harrisburg and the applicant. Additionally, North Carolina Department of Transportation (NCDOT) reviewed and approved the MOU, which is included in the **Appendix**.

Kimley-Horn was retained to determine the potential traffic impacts of this development (in accordance with the traffic study guidelines in the *NCDOT Policy on Street and Driveway Access to North Carolina Highways* and set forth by *Town of Harrisburg Unified Development Ordinance – Appendix F*), and to identify transportation improvements that may be required to mitigate these impacts. This report presents trip generation, distribution, capacity analyses, crash analyses and identified transportation improvements required to mitigate anticipated traffic demands produced by the subject development.

3.0 Existing Traffic Conditions

Existing traffic conditions were coordinated with Town of Harrisburg and NCDOT staff and collected through field observations and turning-movement counts to establish the existing conditions baseline analysis.

3.1 STUDY AREA

Based on coordination with the Town, NCDOT and the applicant, the study area for this TIA includes the following existing intersections:

1. Robinson Church Road and Tom Query Road
2. Stallings Road and Harrisburg Veterans Road
3. Stallings Road and Stallings Road Park Drive/Site Access #1
4. Stallings Road and Harrisburg Elementary School Drive/Site Access #2
5. Stallings Road and Raging Ridge Road/Stallings Road Subdivision

Note that for the purposes of this analysis, Stallings Road was considered to have an east/west orientation.

Figure 3.1 shows the study area intersections and the site location, **Figure 3.2** shows the proposed site plan for the development as provided by the applicant and **Figure 3.3** shows the existing roadway geometry at the study intersections.

The primary roadways in the vicinity of the site are Stallings Road, Robinson Church Road, Robinson Church Road, and Harrisburg Veterans Road.

Stallings Road is currently a two-lane, undivided local road with a posted speed limit of 35 miles per hour (mph) in the vicinity of Harrisburg Veterans Road and 45 mph from Stallings Road Park to Rocky River Road. It should be noted that from 7:45 – 8:45 am and 2:30 – 3:30 pm the Stallings Road and Harrisburg Elementary School Drive and the Stallings Road and Raging Ridge Road intersections falls within a school zone with a posted speed limit of 35 mph. Stallings Road carries an annual average daily traffic (AADT) volume of 6,700 vehicles per day (vpd) east of Hickory Ridge Road based on 2017 NCDOT AADT data.

Robinson Church Road is currently a two-lane, undivided major collector with a posted speed limit of 45 mph. Robinson Church Road carries an AADT volume of 10,000 vpd west of Stallings Road based on 2017 NCDOT AADT data.

Tom Query Road is currently a two-lane, undivided local road with a posted speed limit of 45 mph. Tom Query Road carries an AADT volume of 6,000 vpd west of Robinson Church Road based on 2017 NCDOT AADT data.

Harrisburg Veterans Road is currently a four-lane, undivided major collector with a posted speed limit of 35 mph. Harrisburg Veterans Road does not have a posted NCDOT AADT.

3.2 EXISTING TRAFFIC VOLUME DEVELOPMENT

AM (7:00-9:00 AM) and PM (4:00-6:00 PM) intersection turning-movement, heavy-vehicle, pedestrian and bicycle counts were performed by National Data & Surveying Services on Thursday, September 20, 2018, at the following intersections:

1. Stallings Road and Harrisburg Veterans Road
2. Stallings Road and Raging Ridge Road/Stallings Road Subdivision

Intersection turning-movement counts were collected by Quality Counts, LLC on Tuesday, June 4, 2019, for the following intersections:

1. Stallings Road and Stallings Road Park Drive
2. Stallings Road and Harrisburg Elementary School Drive

Additionally, intersection turning-movement counts were collected by National Data & Surveying Services on Wednesday, November 28, 2018 for the intersection of Robinson Church Road and Tom Query Road.

Volume balancing was performed along Stallings Road between Stallings Road Park Drive and Harrisburg Elementary School Drive but was not performed between the remaining study area intersections due to the presence of driveways and distance between the intersections. Peak-hour intersection turning-movement count data is provided in the **Appendix**.

Figure 3.4 illustrates the 2018 existing AM and PM peak-hour traffic volumes.



NOTE: 4" TALL BORN TO BE INSTALLED WITHIN 2' OF LANDSCAPE GRABBER.

NOTE: EXISTING TRENCH-WALLED PUMP STATION CAN COME OFF-PIE.

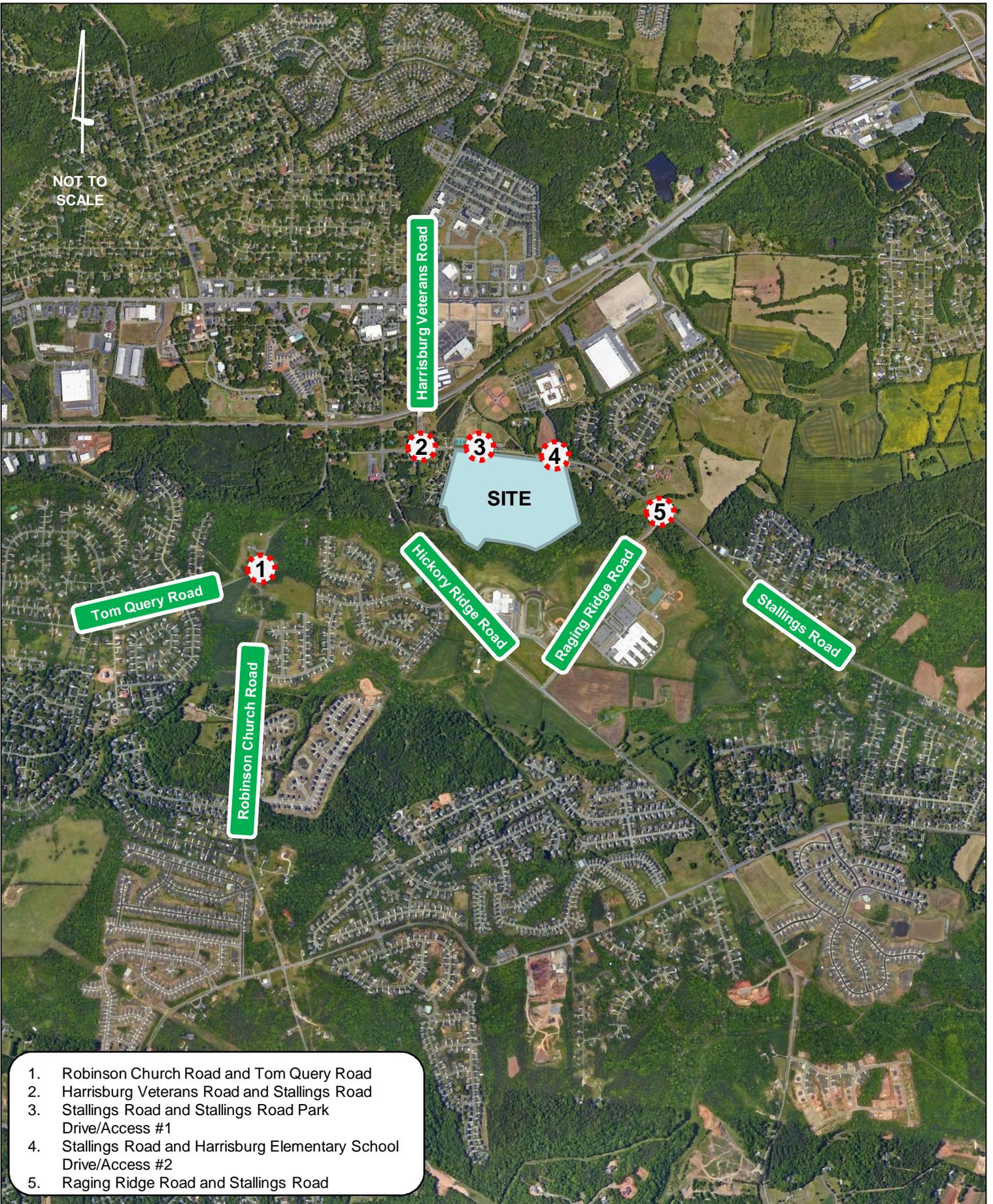
NOTE: ALIGNMENT OF THIS PORTION OF GREENWAY PATH AND THE TRUSS BRIDGE LOCATION IS SUBJECT TO CHANGE. ALL UTILITIES CONTIGUOUS EXISTING. THE DEVELOPER WILL CONSTRUCT ALL OF DRIVEWAY PATH SHOWN AND CONNECT TO PUBLIC SIDEWALK ALONG STALLINGS ROAD.

FLOODPLAIN AREA TO REMAIN UNDISTURBED EXCEPT FOR UTILITY CONNECTION & GREENWAY PATH

Project Manager
AHS
 Designer
AHS
 Checked by
HJ
 Date
05-14-18
 Project Number
18021

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REZONE SITE PLAN
CAMELLIA GARDENS
 HARRISBURG, NORTH CAROLINA
 FOR
SHEA HOMES

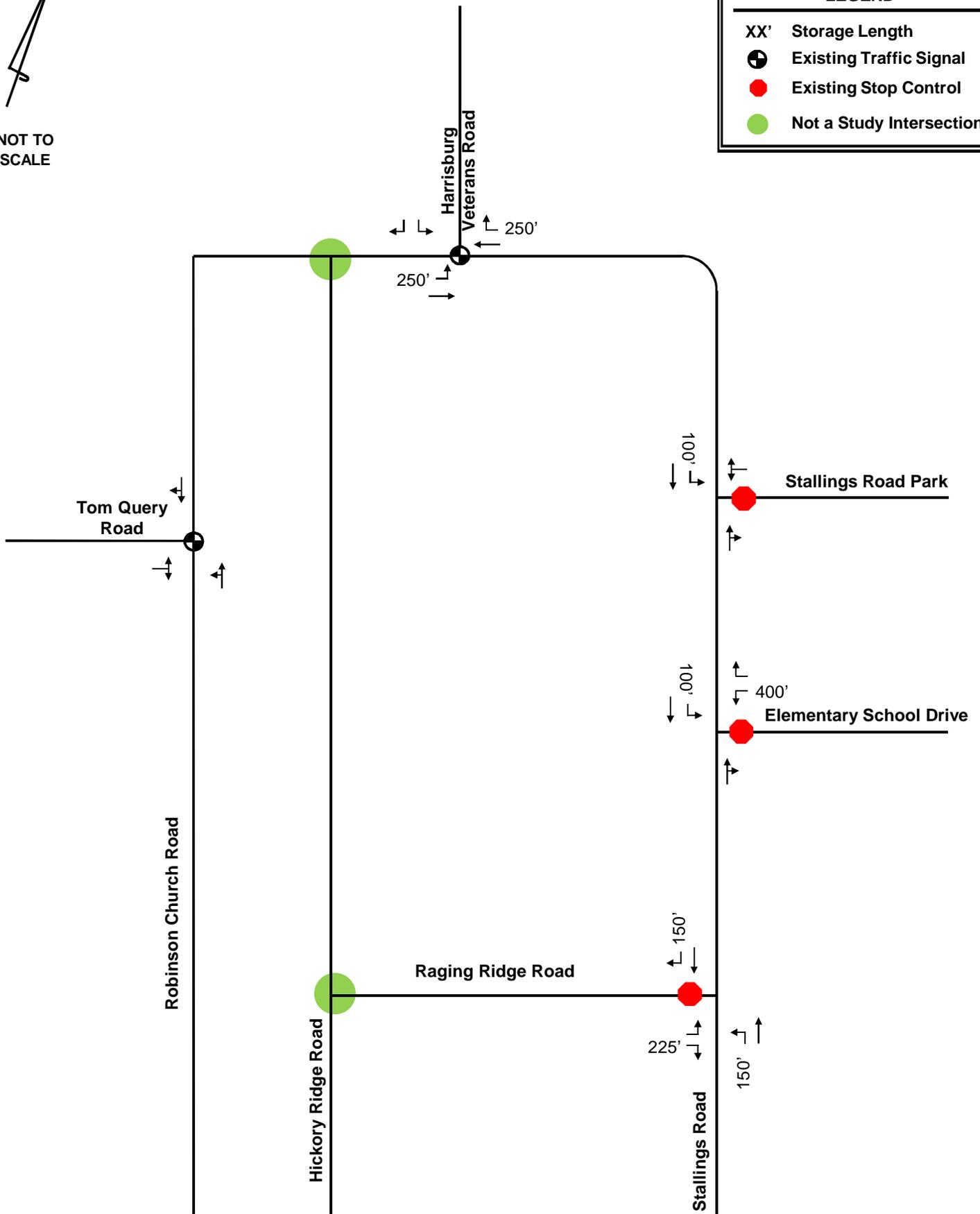




NOT TO SCALE

LEGEND

- XX' Storage Length
- ⊕ Existing Traffic Signal
- Existing Stop Control
- Not a Study Intersection

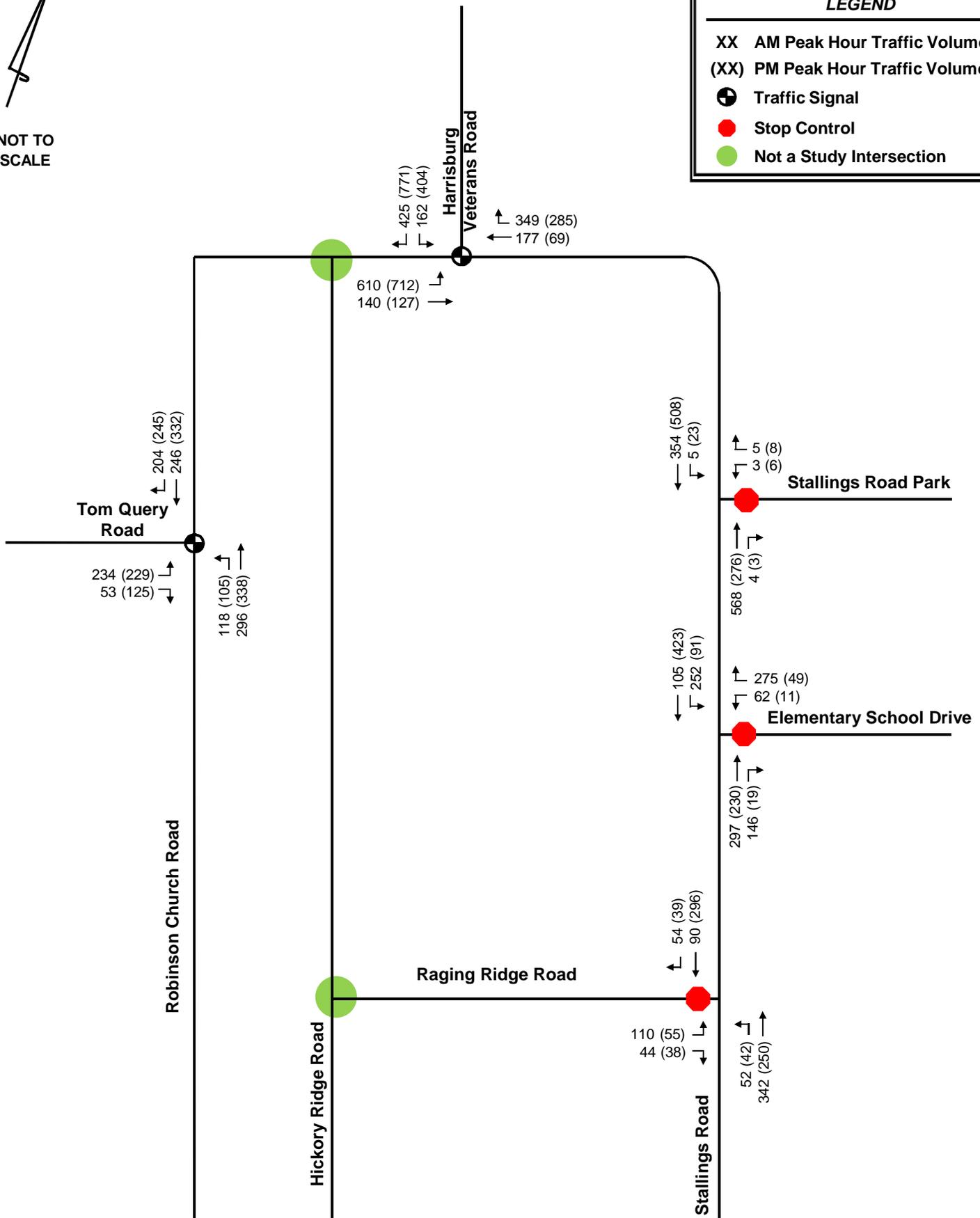




NOT TO SCALE

LEGEND

- XX AM Peak Hour Traffic Volumes
- (XX) PM Peak Hour Traffic Volumes
- ⦿ Traffic Signal
- Stop Control
- Not a Study Intersection



4.0 Background Traffic Volume Development

Projected background (non-project) traffic is defined as the expected growth or change in traffic volumes on the surrounding roadway network between the year the existing counts were collected and the expected build-out year absent the construction and opening of the proposed project. This includes both non-specific general growth based on historical increase in local traffic volumes (historical background growth), along with specific growth and/or change in traffic volumes caused by either approved, but not yet fully-constructed, off-site developments and/or planned transportation projects specifically identified within the vicinity of the proposed development.

4.1 HISTORICAL BACKGROUND GROWTH TRAFFIC

Historical background growth is the increase in existing traffic volumes due to usage increases and non-specific growth throughout the area, and accounts for growth that is independent of specific off-site developments or planned transportation projects. Historical background growth traffic is calculated using an annual growth rate, which is applied to the existing traffic volumes up to the future horizon years. For this analysis, an annual growth rate of 2.0% was applied to the 2018 existing peak-hour traffic volumes to calculate base 2023 background traffic volumes. This methodology was determined based on coordination with Town of Harrisburg and NCDOT staff.

4.2 APPROVED DEVELOPMENTS

At the direction of the Town of Harrisburg and NCDOT staff, two approved developments, Harris Square and Stallings Road Subdivision, are expected to impact traffic volumes within the study area and were included in the background traffic volumes for this TIA. Per coordination with the Town, the Harris Square and Stallings Road Subdivision developments were assumed to be 40% and 0% built-out, respectively.

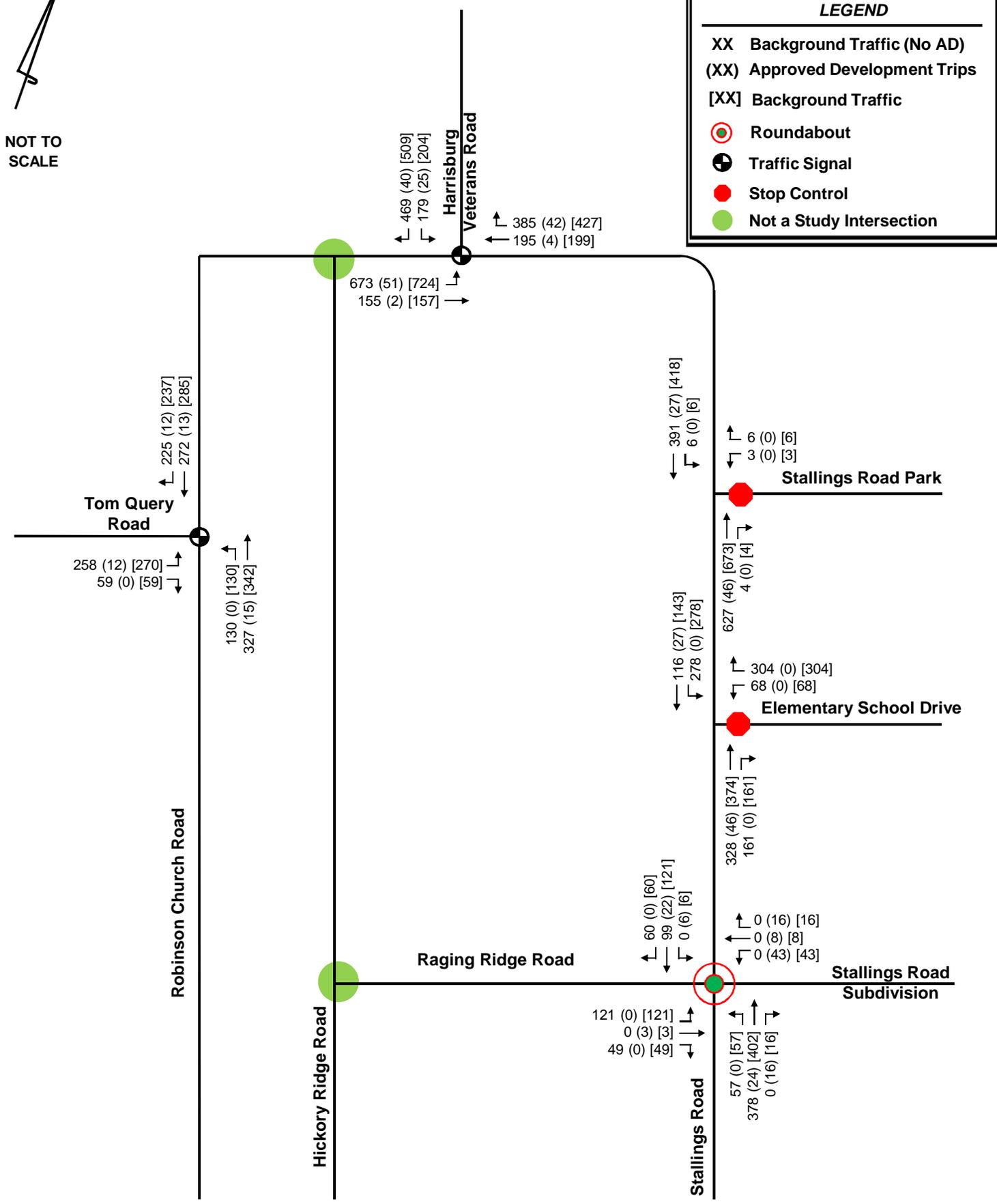
Volumes for these developments were obtained from the *Harris Square TIA* (Kimley- Horn, April 2016) and the *Stallings Road Subdivision TIA* (Kimley-Horn, October 2018). The existing traffic splits were used to carry and assign volumes appropriately at study area intersections that were not included in the approved TIAs.

Figures 4.1 and **4.2** show the 2023 background AM and PM peak-hour traffic volumes, respectively, that include the historical growth traffic and approved development trips.

NOT TO SCALE

LEGEND

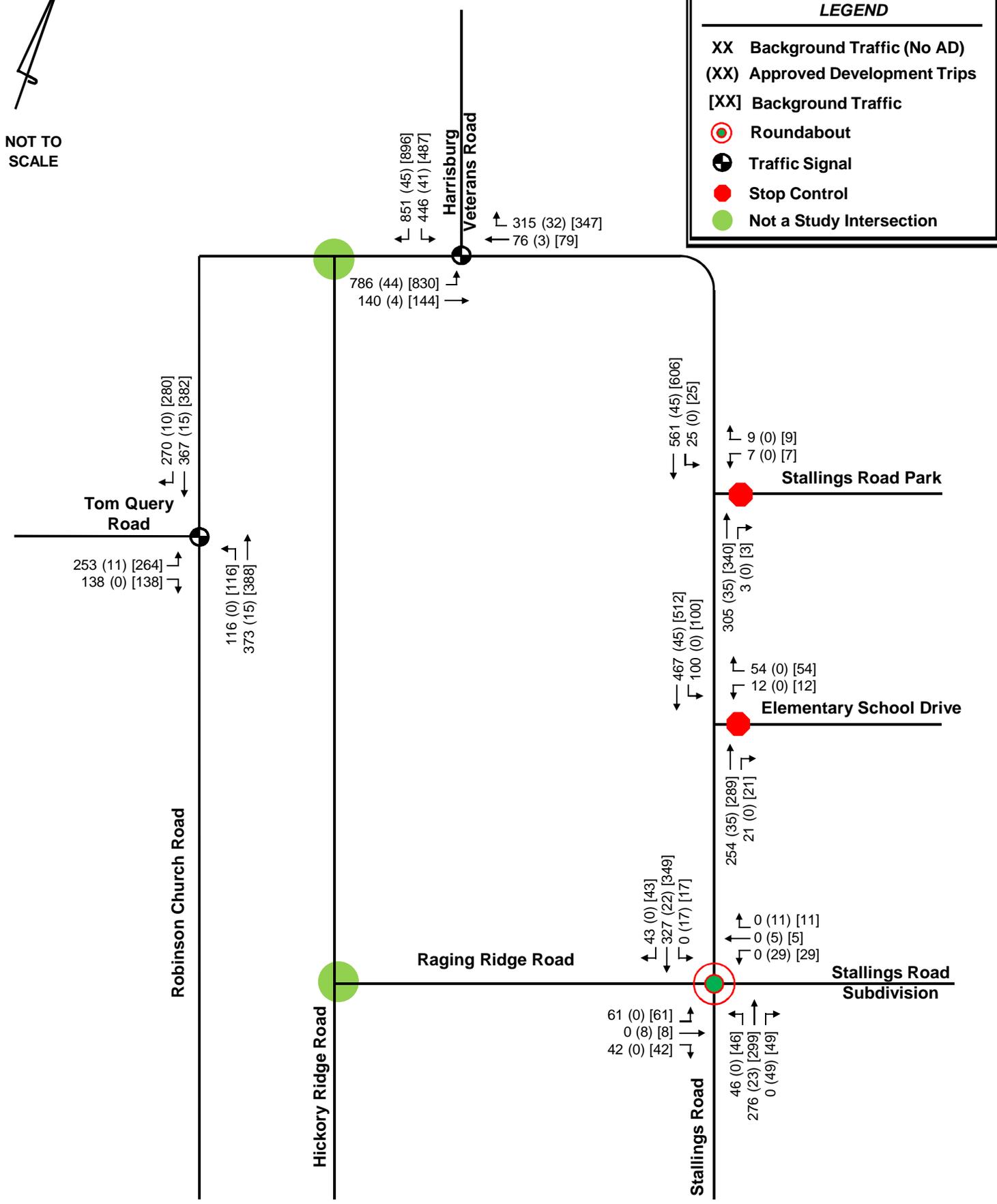
- XX Background Traffic (No AD)
- (XX) Approved Development Trips
- [XX] Background Traffic
- ⊙ Roundabout
- ⦿ Traffic Signal
- Stop Control
- Not a Study Intersection



NOT TO SCALE

LEGEND

- XX Background Traffic (No AD)
- (XX) Approved Development Trips
- [XX] Background Traffic
- ⊙ Roundabout
- ⦿ Traffic Signal
- Stop Control
- Not a Study Intersection



5.0 Site Traffic Volume Development

Site traffic developed for this TIA is defined as the vehicle trips expected to be generated and added to the study area by construction of the proposed development, and the distribution and assignment of that traffic throughout the surrounding network.

5.1 SITE ACCESS

Based on the provided site plan and information provided by the applicant, the proposed development will be accessed via the following:

- Site Access #1 – right-in/right-out access at the existing Stallings Road and Stallings Road Park Drive intersection
- Site Access #2 – full-movement at the existing Stallings Road and Harrisburg Elementary School Drive intersection.

It should be noted that in the build-out condition, the Stallings Road Park Drive will be converted to right-in/right-out as well. Redistribution of left-turns in and out of this access were considered in the analysis and can be seen in **Figure 5.2** and **Figure 5.3**.

5.2 TRAFFIC GENERATION

The traffic generation potential of the proposed development was determined using the trip generation rates published in *Trip Generation* (Institute of Transportation Engineers, Tenth Edition, 2017).

Based on the site plan provided by the applicant, the proposed development is envisioned to include 165 single-family homes. **Table 5.1** summarizes the projected trip generation for the proposed residential development. During a typical weekday, the proposed development has the potential to generate 122 and 164 net new external trips during the AM and PM peak hours, respectively.

Land Use	Intensity	Daily	AM Peak Hour			PM Peak Hour		
			Total	In	Out	Total	In	Out
Single-Family Homes [ITE 210]	165 DU	1,648	122	31	91	164	103	61
Net New External Trips		1,648	122	31	91	164	103	61

5.3 SITE TRAFFIC DISTRIBUTION AND ASSIGNMENT

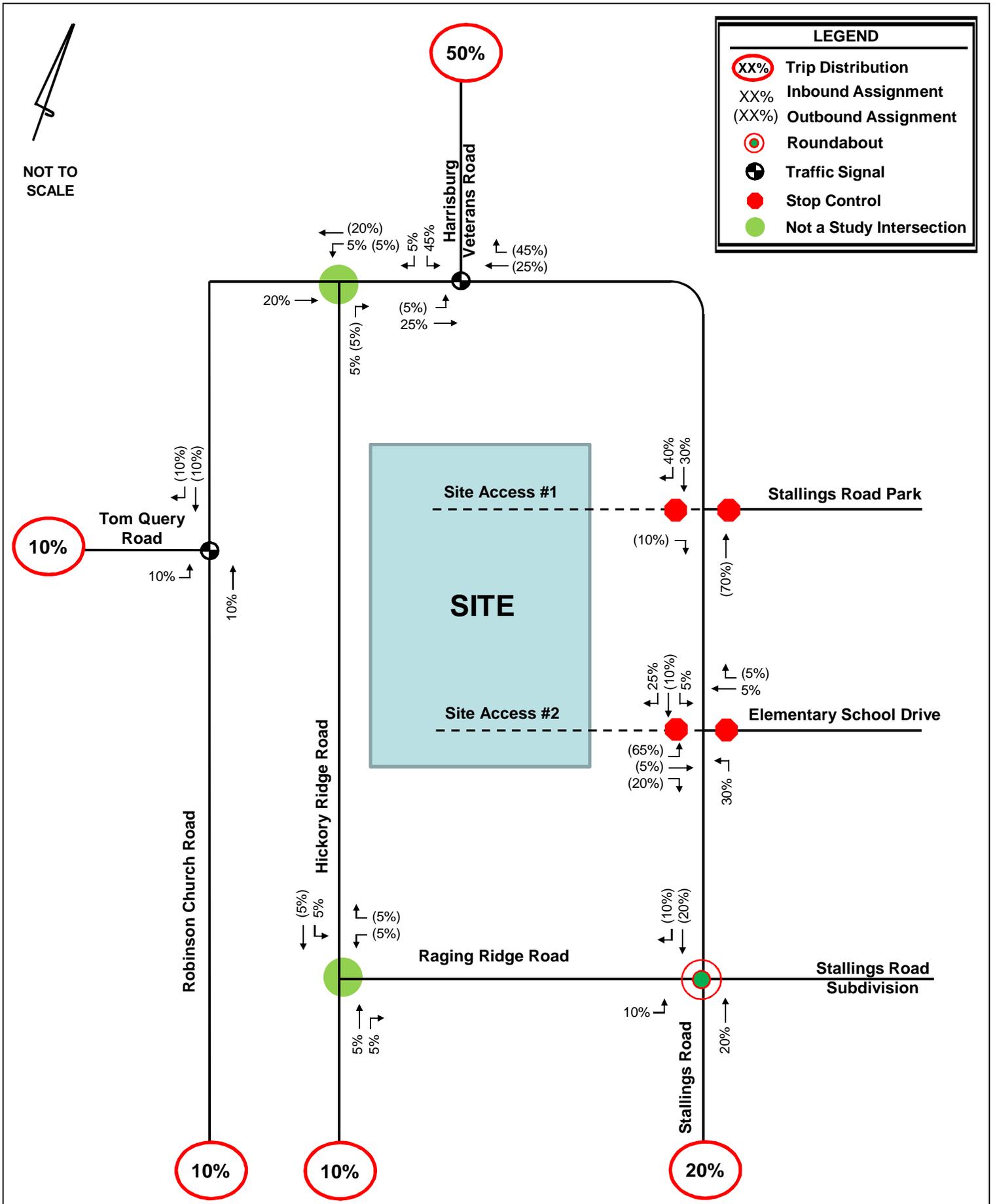
The proposed development's trips were assigned to the surrounding network based on existing peak-hour turning movements, surrounding land uses, locations of similar land use and population densities in the area. The following site traffic distribution was reviewed and approved as part of the MOU by the Town of Harrisburg, NCDOT and the applicant:

- 10% to/from the west along Tom Query Road
- 10% to/from the south along Robinson Church Road
- 20% to/from the south along Stallings Road
- 10% to/from the south along Hickory Ridge Road
- 50% to/from the north along Harrisburg Veterans Road

The overall site traffic distribution and assignment are shown in **Figure 5.1**.

5.4 BUILD-OUT TRAFFIC VOLUMES

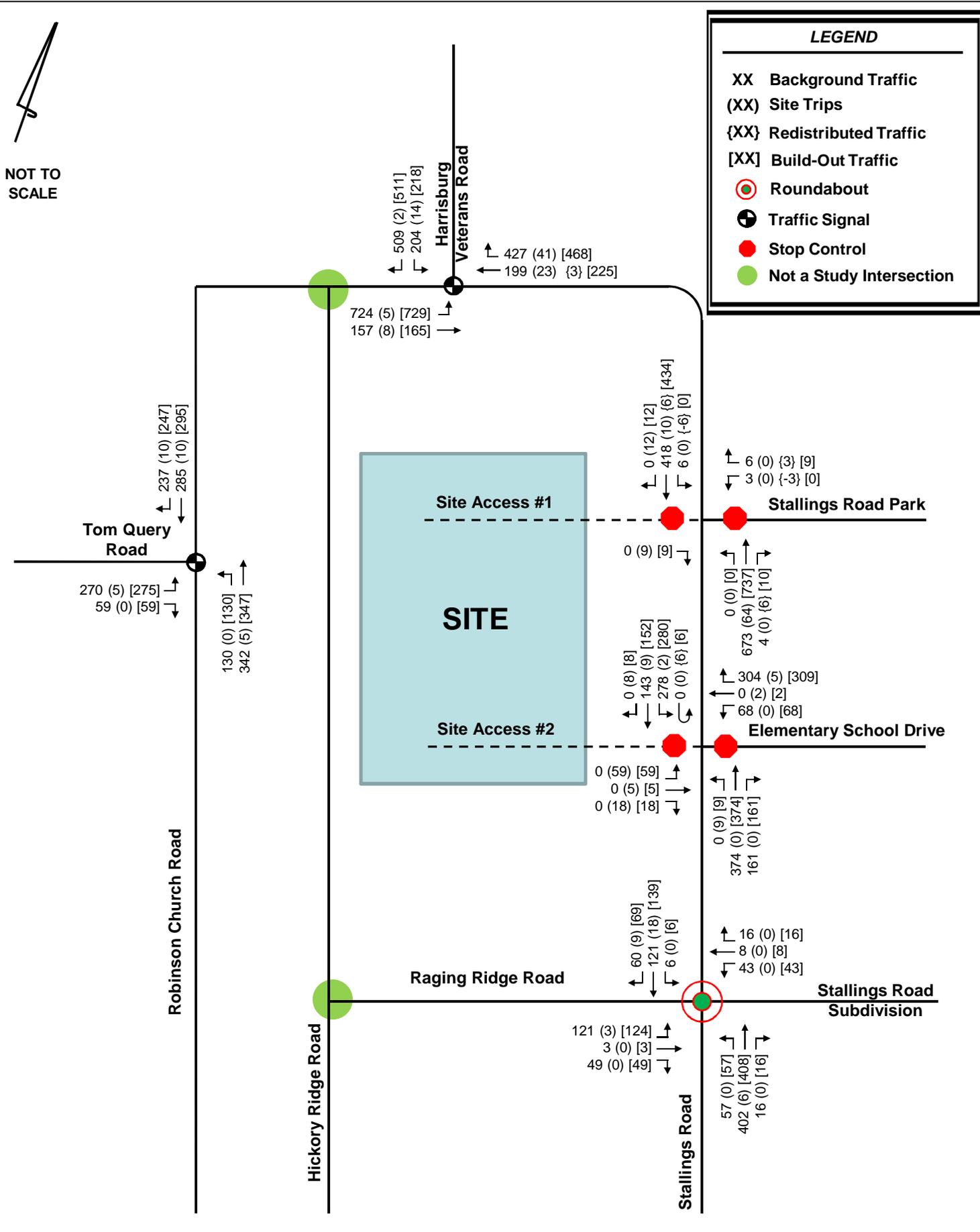
The 2023 build-out traffic volumes include the assignment of the projected site traffic generation added to the 2023 background traffic volumes. **Figures 5.2** and **5.3** show the projected 2023 build-out traffic volumes for the AM and PM peak hours, respectively. Intersection volume development worksheets for all intersections and driveways within the study network are provided in the **Appendix**.



NOT TO SCALE

LEGEND

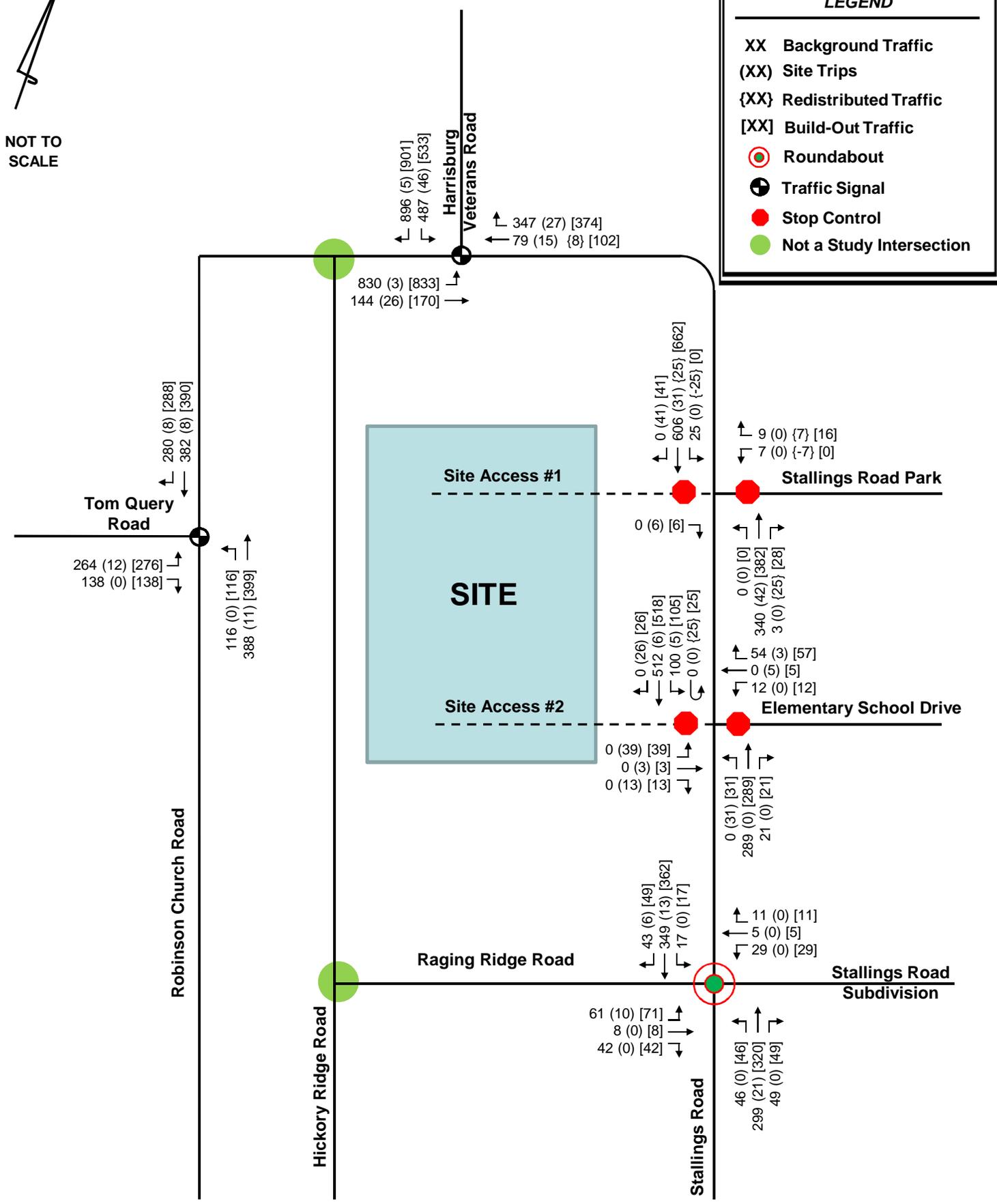
- XX Background Traffic
- (XX) Site Trips
- {XX} Redistributed Traffic
- [XX] Build-Out Traffic
- ⊙ Roundabout
- ⊙ Traffic Signal
- Stop Control
- Not a Study Intersection



NOT TO SCALE

LEGEND

- XX Background Traffic
- (XX) Site Trips
- {XX} Redistributed Traffic
- [XX] Build-Out Traffic
- ⊙ Roundabout
- ⊙ Traffic Signal
- Stop Control
- Not a Study Intersection



6.0 Capacity Analysis

Based on the requirements set forth by the *Town of Harrisburg Unified Development Ordinance – Appendix F* and in accordance with the traffic study guidelines in the *NCDOT Policy on Street and Driveway Access to North Carolina Highways*, capacity analyses were performed at the study area intersections for each of the following AM and PM peak-hour scenarios:

- 2018 Existing Conditions
- 2023 Background Conditions
- 2023 Build-out Conditions

Capacity analyses were performed for the AM and PM peak hours using the Synchro Version 9 software to determine the operating characteristics at the signalized and stop-controlled intersections of the adjacent street network and to evaluate the impacts of the proposed development. Capacity is defined as the maximum number of vehicles that can pass over a particular road segment, or through a particular intersection, within a specified period of time under prevailing operational, geometric and controlling conditions within a set time duration. This software program uses methodologies contained in the *Highway Capacity Manual (HCM)* to determine the operating characteristics of an intersection.

The *Highway Capacity Manual (HCM)* defines LOS as a “quantitative stratification of a performance measure or measures representing quality of service”, and is used to “translate complex numerical performance results into a simple A-F system representative of travelers’ perceptions of the quality of service provided by a facility or service”. The HCM defines six levels of service, LOS A through LOS F, with A having the best operating conditions from the traveler’s perspective and F having the worst. However, it must be understood that “the LOS letter result hides much of the complexity of facility performance”, and that “the appropriate LOS for a given system element in the community is a decision for local policy makers”. According to the HCM, “for cost, environmental impact, and other reasons, roadways are typically designed not to provide LOS A conditions during peak periods but instead to provide some lower LOS that balances individual travelers’ desires against society’s desires and financial resources. Nevertheless, during low-volume periods of the day, a system element may operate at LOS A.”

LOS for a two-way stop-controlled (TWSC) intersection is determined by the control delay at the side-street approaches, typically during the highest volume periods of the day, the AM and PM peak periods. Control delay includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. With respect to field measurements, control delay is defined as the total elapsed time from the time a vehicle stops at the end of the queue to the time the vehicle departs from the stop line. It is typical for stop sign-controlled side streets and driveways intersecting major streets to experience long delays during peak hours, particularly for left-turn movements. The majority of the traffic moving through the intersection on the major street experiences little or no delay.

LOS for signalized intersections is reported for the intersection as a whole, and typically during the highest volume periods of the day, the AM and PM peak periods. One or more movements at an intersection may experience a low level-of-service, while the intersection as a whole may operate acceptably.

Table 6.0-A and **6.0-B** list the LOS control delay thresholds published in the HCM for unsignalized and signalized intersections, respectively, as well as the unsignalized operational descriptions assumed herein.

Table 6.0-A Vehicular LOS Control Delay Thresholds for Unsignalized Intersections		
Level-of-Service	Average Control Delay per Vehicle [sec/veh]	
A	≤ 10	Short Delays
B	> 10 – 15	
C	> 15 – 25	
D	> 25 – 35	Moderate Delays
E	> 35 – 50	
F	> 50	Long Delays

Table 6.0-B Vehicular LOS Control Delay Thresholds for Signalized Intersections	
Level-of-Service	Average Control Delay per Vehicle [sec/veh]
A	≤ 10
B	> 10 – 20
C	> 20 – 35
D	> 35 – 55
E	> 55 – 80
F	> 80

Using the signal timing plans, cycle lengths, offsets, and splits were optimized for the existing conditions analyses and carried through all scenarios. The Congestion Management (CM) minimum cycle of 90 seconds based on the phasing of the signalized intersections was also utilized. A lost time of 5 seconds was used in all scenarios and no right turn on red (RTOR) were utilized in all scenarios as well. Permitted-protected phasing was allowed in all scenarios at existing signals to reflect field conditions.

In the existing condition, the observed peak hour factor (PHF) was used in the analysis. A weighted PHF was used for all future year conditions in the AM peak hour to account for the impacts of school traffic. A 0.9 PHF was used for all conditions in the PM peak hour.

Capacity analysis reports generated by Synchro Version 9 software are included in the **Appendix**.

6.1 ROBINSON CHURCH ROAD AND TOM QUERY ROAD

Table 6.1 summarizes the LOS, control delay and 95th percentile queue lengths at the signalized intersection of Robinson Church Road and Tom Query Road.

Table 6.1 - Robinson Road and Tom Query Road					
Condition	Measure	EB	NB	SB	Intersection
		EBLR	NBLT	SBTR	
AM Peak Hour					
2018 Existing	LOS (Delay)	E (56.6)	B (15.4)	A (9.9)	C (23.4)
	Synchro 95th Q	245'	224'	249'	
2023 Background	LOS (Delay)	E (65.4)	D (35.5)	B (11.3)	C (32.8)
	Synchro 95th Q	#317'	#409'	289'	
2023 Build	LOS (Delay)	E (66.9)	D (40.5)	B (11.9)	D (35.0)
	Synchro 95th Q	#325'	#431'	316'	
PM Peak Hour					
2018 Existing	LOS (Delay)	E (56.8)	B (16.2)	B (12.7)	C (25.3)
	Synchro 95th Q	#368'	280'	303'	
2023 Background	LOS (Delay)	E (65.5)	D (35.7)	B (15.3)	C (34.7)
	Synchro 95th Q	#432'	#496'	378'	
2023 Build	LOS (Delay)	E (68.2)	D (46.9)	B (16.0)	D (39.4)
	Synchro 95th Q	#451'	#526'	396'	

95th percentile volume exceeds capacity, queue may be longer

As shown in **Table 6.1**, the eastbound approach is expected to operate with long delays in both peak hours both with and without site traffic. The overall intersection is expected to drop from LOS C to LOS D with the addition of site traffic, with an overall intersection delay increase of 2.2 seconds and 4.7 seconds in the AM and PM peak hours, respectively.

Because the site is not expected to significantly impact delay at this intersection, it is not recommended that the site constructs improvements at this intersection. However, it is recommended that the proposed site contribute 25% to the overall cost of the planned Town improvements (not to exceed \$100,000) at this intersection to mitigate the drop in LOS.

6.2 STALLINGS ROAD AND HARRISBURG VETERANS ROAD

Table 6.2 summarizes the LOS, control delay and 95th percentile queue lengths at the signalized intersection of Stallings Road and Harrisburg Veterans Road.

Condition	Measure	EB		WB		SB		Intersection
		EBL	EBT	WBT	WBR	SBL	SBR	
AM Peak Hour								
2018 Existing	LOS (Delay)	B (14.9)		B (15.9)		C (27.5)		B (18.7)
	Synchro 95th Q	m#373'	57'	134'	183'	151'	208'	
2023 Background	LOS (Delay)	F (81.8)		C (29.0)		C (21.1)		D (48.8)
	Synchro 95th Q	m#833'	65'	146'	206'	180'	284'	
2023 Build	LOS (Delay)	F (108.3)		C (28.3)		C (22.0)		E (59.0)
	Synchro 95th Q	m#826'	65'	163'	236'	196'	299'	
2023 Build IMP - Dual Lefts	LOS (Delay)	C (29.9)		B (19.6)		C (25.7)		C (25.5)
	Synchro 95th Q	m#297'	67'	163'	228'	193'	299'	
2023 Build IMP - Split Phasing	LOS (Delay)	C (34.8)		E (58.3)		C (34.5)		D (42.0)
	Synchro 95th Q	656'	274'	288'	527'	316'	325'	
PM Peak Hour								
2018 Existing	LOS (Delay)	D (50.8)		C (20.7)		B (19.6)		C (30.6)
	Synchro 95th Q	#651'	72'	84'	151'	329'	340'	
2023 Background	LOS (Delay)	F (280.7)		B (19.5)		C (20.7)		F (111.5)
	Synchro 95th Q	#1115'	93'	100'	189'	416'	530'	
2023 Build	LOS (Delay)	F (430.1)		B (17.9)		B (19.7)		F (160.8)
	Synchro 95th Q	#1200'	121'	m117'	159'	429'	605'	
2023 Build IMP - Dual Lefts	LOS (Delay)	D (41.3)		C (25.8)		C (26.2)		C (31.3)
	Synchro 95th Q	#504'	139'	m148'	m250'	558'	611'	
2023 Build IMP - Split Phasing	LOS (Delay)	E (57.6)		C (34.1)		C (25.5)		D (38.0)
	Synchro 95th Q	#846'	#844'	m166'	m303'	647'	646'	

95th percentile volume exceeds capacity, queue may be longer

m Volume for 95th percentile queue is metered by upstream signal

As shown in **Table 6.2**, the eastbound approach is expected to operate with long delays in both peak hours both with and without site traffic. The overall intersection is expected to operate at LOS F in the PM peak hours in 2023 background and build-out conditions. This is due to the high volume of eastbound left-turning vehicles at the signalized intersection.

With the addition of dual eastbound left-turn lanes with 325 feet of storage, as shown in the Build Improved row in the table, the overall intersection and all of its approaches are expected to operate at LOS D or better. However, it should be noted that improvements to the eastbound approach are limited by available intersection spacing and right-of-way.

Due to this limited right-of-way, the following improvements are recommended at this intersection:

- Restriping of the eastbound through lane to provide a shared through-left lane
- Implementation of split phasing on the eastbound and westbound approaches

With improvements made at this intersection, it is also recommended that the proposed development install a signal at the intersection of Stallings Road and Hickory Ridge Road. This signal should be connected to the existing signal cabinet at the intersection of Stallings Road and Harrisburg Veterans Road.

6.3 STALLINGS ROAD AND STALLINGS ROAD PARK DRIVE/SITE ACCESS #1

Table 6.3 summarizes the LOS, control delay and 95th percentile queue lengths at the unsignalized intersection of Stallings Road and Stallings Road Park Drive/Site Access #1.

Table 6.3 - Stallings Road and Stallings Road Park Drive / Site Access #1					
Condition	Measure	EB	WB	SB	NB
		EBL	WBL	SBL	NBL
AM Peak Hour					
2018 Existing	LOS (Delay)	A (0.2)	A (0.0)	C (22.5)	-
	Synchro 95th Q	1'	0'	6'	-
2023 Background	LOS (Delay)	A (0.2)	A (0.0)	D (27.9)	-
	Synchro 95th Q	2'	0'	8'	-
2023 Build	LOS (Delay)	A (0.0)	A (0.0)	C (18.8)	B (12.3)
	Synchro 95th Q	0'	0'	4'	2'
PM Peak Hour					
2018 Existing	LOS (Delay)	A (0.5)	A (0.0)	B (14.8)	-
	Synchro 95th Q	2'	0'	5'	-
2023 Background	LOS (Delay)	A (0.3)	A (0.0)	C (15.6)	-
	Synchro 95th Q	2'	0'	4'	-
2023 Build	LOS (Delay)	A (0.0)	A (0.0)	B (11.0)	B (14.0)
	Synchro 95th Q	0'	0'	2'	1'

It should be noted that this intersection will be converted to right-in/right-out in the build-out condition. As shown in **Table 6.3**, in both peak hours, the proposed site access is expected to operate with short delays in build-out with a single lane ingress/egress. Therefore, no improvements are recommended at this intersection for capacity purposes.

To convert this intersection to right-in/right-out, an 8' concrete median should be constructed to serve as a refuge for pedestrian crossing.

6.4 STALLINGS ROAD AND HARRISBURG ELEMENTARY SCHOOL DRIVE/SITE ACCESS #2

Table 6.4 summarizes the LOS, control delay and 95th percentile queue lengths at the unsignalized intersection of Stallings Road and Harrisburg Elementary School Drive/Site Access #2.

Table 6.4 - Stallings Road and Harrisburg Elementary School Drive / Site Access #2										
Condition	Measure	EB		WB		SB		NB		Intersection
		EBL	EBTR	WBTL	WBR	SBTL	SBR	NBL	NBTR	
AM Peak Hour										
2018 Existing	LOS (Delay)	A (7.9)		A (0.0)		F (94.1)		-		-
	Synchro 95th Q	50'	0'	0'		235'	253'			
2023 Background	LOS (Delay)	A (8.8)		A (0.0)		F (237.7)		-		-
	Synchro 95th Q	69'	0'	0'		345'	460'			
2023 Build	LOS (Delay)	A (8.6)		A (0.2)		F (2021.4)		F (Err)		-
	Synchro 95th Q	70'	0'	1'		Err	455'	Err		
2023 Build IMP - Signal	LOS (Delay)	E (65.0)		E (66.7)		E (77.8)		F (85.4)		E (70.6)
	Synchro 95th Q	#268'	37'	#419'	138'	53'	#566'	#113'	27'	
2023 Build IMP - Roundabout	LOS (Delay)	A (7.1)		A (6.1)		B (10.8)		B (11.7)		A (8.2)
	SIDRA 95th Q	229'		125'	67'	46'	228'	32'		
PM Peak Hour										
2018 Existing	LOS (Delay)	A (1.9)		A (0.0)		B (13.9)		-		-
	Synchro 95th Q	10'	0'	0'		9'	8'			
2023 Background	LOS (Delay)	A (1.3)		A (0.0)		B (12.9)		-		-
	Synchro 95th Q	8'	0'	0'		5'	7'			
2023 Build	LOS (Delay)	A (1.3)		A (1.1)		C (16.2)		E (49.3)		-
	Synchro 95th Q	8'	0'	3'		11'	7'	48'		
2023 Build IMP - Signal	LOS (Delay)	B (11.5)		B (14.1)		D (38.8)		D (37.3)		B (15.3)
	Synchro 95th Q	126'	174'	212'	21'	23'	74'	52'	27'	
2023 Build IMP - Roundabout	LOS (Delay)	A (2.6)		A (2.2)		A (4.6)		B (10.1)		A (3.0)
	SIDRA 95th Q	207'		51'	5'	4'	10'	17'		

95th percentile volume exceeds capacity, queue may be longer

As shown in **Table 6.4**, the southbound approach currently operates at LOS F in the AM peak hour and is expected to continue to operate at LOS F in future years both with and without site traffic. Additionally, the proposed northbound site access is expected to operate at LOS F in the AM peak hour. While it is not uncommon for a stop controlled, side-street approach to experience long delays in peak hours, due to the AM elementary school drop-off, significant delays are expected on the northbound and southbound approaches.

To improve capacity and delays at this intersection, a traffic signal or roundabout should be considered at this intersection. Should a signal be installed at this intersection, the following laneage improvements are recommended:

- Extension of the eastbound left-turn lane from Stallings Road into the Elementary School Drive with 275 feet of storage
- Installation of protected phasing on the eastbound approach
- Construction of a westbound right-turn lane from Stallings Road into the Elementary School Drive with 150 feet of storage
- Striping of the existing pavement on the southbound approach (Elementary School Drive) to provide a dedicated left-turn lane and a shared through-right lane
- Construction of a left-turn lane with 125 feet of storage and a shared through-right lane on the northbound approach

With these improvements in place, the overall intersection is expected to operate at LOS E in the AM peak hour and LOS B in the PM peak hour. However, it should be noted that peak-hour signal warrants are not met at this intersection.

Should a roundabout be installed at this intersection to better mitigate the AM peak hour, a single lane roundabout is expected to operate at LOS D. But the roundabout would be expected to operate with a volume to capacity ratio (v/c) of 1.11 in the AM peak hour; indicating that a single lane roundabout would be over capacity at this intersection at the build-out of the site. With a right-turn lane on the westbound and southbound approaches, as shown in the Build IMP row of **Table 6.4**, the overall intersection is expected to operate at LOS A in the AM peak hour with a v/c of 0.72.

Therefore, the following improvements are recommended at this intersection for capacity purposes:

- Installation of a roundabout
- Construction of a single lane northbound approach
- Construction of a southbound right-turn lane from the Elementary School Drive onto Stallings Road with a minimum of 250 feet of storage (accomplished via restriping of the existing turn lanes)
- Construction of a single lane eastbound approach
- Construction of a westbound right-turn lane from Stallings Road into the Elementary School Drive with 100 feet of storage

Per coordination with the Town, the roundabout should be constructed in conjunction with the Town's planned second receiving lane on the Elementary School Drive. This lane will be constructed by the developer at the cost of the Town.

6.5 STALLINGS ROAD AND RAGING RIDGE ROAD/STALLINGS ROAD SUBDIVISION

Table 6.5 summarizes the LOS, control delay and 95th percentile queue lengths at the signalized intersection of Stallings Road and Raging Ridge Road/Stallings Road Subdivision.

Table 6.5 - Stallings Road and Raging Ridge Road/ Stallings Road Subdivision									
Condition	Measure	EB		WB		SB	NB		Intersection
		EBLT	EBR	WBL	WBTR	SBTLR	NBL	NBTR	
AM Peak Hour									
2018 Existing	LOS (Delay)	A (0.0)		A (2.5)		-	F (65.0)		-
	Synchro 95th Q	0'	0'	11'	0'	-	307'		
2023 Background - Roundabout	LOS (Delay)	B (12.8)		A (3.2)		B (13.7)	A (6.4)		A (8.7)
	SIDRA 95th Q	340'		75'		33'	98'		
2023 Build - Roundabout	LOS (Delay)	B (13.3)		A (3.2)		B (13.8)	A (6.6)		A (9.0)
	SIDRA 95th Q	356'		75'		34'	100'		
PM Peak Hour									
2018 Existing	LOS (Delay)	A (0.0)		A (1.2)		-	C (15.5)		-
	Synchro 95th Q	0'	0'	4'	0'	-	26'		
2023 Background - Roundabout	LOS (Delay)	A (2.1)		A (1.7)		A (7.0)	A (6.8)		A (2.7)
	SIDRA 95th Q	81'		80'		9'	23'		
2023 Build - Roundabout	LOS (Delay)	A (2.2)		A (1.7)		A (7.2)	A (7.1)		A (2.8)
	SIDRA 95th Q	89'		86'		10'	26'		

As shown in **Table 6.5**, under 2023 background conditions with the installation of a single lane roundabout by the Stallings Road Subdivision development, the overall intersection is expected to operate at LOS A in the AM and PM peak hours. The overall intersection and its approaches are expected to continue to operate at the same, acceptable levels of service with the addition of site traffic. Therefore, no capacity improvements are recommended at this intersection due to the proposed site.

7.0 Auxiliary Turn Lane Warrants

Warrants for additional turn-lane improvements for unsignalized intersection beyond those necessary for capacity were determined based on a review of the figure titled 'Warrant for Left and Right-Turn Lanes' found on page 80 in the *NCDOT Policy On Street And Driveway Access to North Carolina Highways*. The results of the warrants for left and right-turn lanes under 2023 build-out conditions are summarized by intersection below and included in the **Appendix**.

2018 Build-out Conditions

Stallings Road and Stallings Road Park Drive/Site Access #1

- Eastbound right-turn lane along Stallings Road with a minimum storage length of 50 feet

Stallings Road and Harrisburg Elementary School Drive/Site Access #2

- Westbound left-turn lane along Stallings Road with a minimum storage length of 50 feet

Auxiliary turn lanes are warranted at both Stallings Road and Stallings Road Park Drive/Site Access #1 and Stallings Road and Harrisburg Elementary School Drive/Site Access #2. Given the proposed roundabout at Site Access #2, it is recommended that the proposed site construct the warranted turn-lane at Site Access #1.

Although 50 feet of storage is warranted per the graphic (included in the **Appendix**), per NCDOT guidelines, a minimum of 100 feet of storage will be required for the warranted turn lane.

8.0 Traffic Signal Warrant Analysis

Based on the approved MOU, a peak hour traffic signal warrant analysis was performed for the 2023 build-out year for unsignalized study intersections, based on the guidelines published by the Federal Highway Administration (FHWA) in the *Manual on Uniform Traffic Control Devices (MUTCD), 2009 Edition*.

For signal warrant analysis, the MUTCD provides the following standards:

- An engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed to determine whether installation of a traffic control signal is justified at a particular location.
- The investigation of the need for a traffic control signal shall include an analysis of factors related to the existing operation and safety at the study location and the potential to improve these conditions, and the applicable factors contained in the following signal warrants:
 - Warrant 1, Eight-Hour Vehicular Volume
 - Warrant 2, Four-Hour Vehicular Volume
 - Warrant 3, Peak Hour
 - Warrant 4, Pedestrian Volume
 - Warrant 5, School Crossing
 - Warrant 6, Coordinated Signal System
 - Warrant 7, Crash Experience
 - Warrant 8, Roadway Network
 - Warrant 9, Intersection Near a Grade Crossing

Warrant 1 Condition A is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic signal. Warrant 1 Condition B is intended for application where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street. If a combination of Condition A and Condition B are not satisfied, Warrant 1 may be satisfied by Condition C.

Warrant 2 is intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic signal.

Warrant 3 is intended for use at a location where traffic conditions are such that for a minimum of one hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street.

A traffic control signal should not be installed unless one or more of the above warrants are met. However, the satisfaction of a traffic signal warrant or warrants should not in itself require the installation of a traffic control signal.

Table 8.1 shows the results of the signal warrant analyses for the unsignalized study area intersections under both 2023 background and build-out conditions, along with number of hours satisfied against the number of hours required. It should be noted that this analysis only reflects peak hour traffic volumes (Warrant 3). A full 13-hour count and traffic signal warrant analysis would be required at each of these locations before a signal is installed.

Table 8.1 – Traffic Signal Warrant Analysis Results		
Criteria satisfied/not satisfied (hours satisfied/required)		
Intersection	2023 Background	2023 Build-Out
Stallings Road and Stallings Road Park Drive/Site Access #1	0/2	0/2
Stallings Road and Harrisburg Elementary School Drive/Site Access #2	0/2	0/2

Based on results shown in **Table 8.1**, peak hour signal warrants (Warrant 3) are not met in either background or build conditions at the following intersections:

- Stallings Road and Stallings Road Park Drive/Site Access #1
- Stallings Road and Harrisburg Elementary School Drive/Site Access #2

Signal warrant calculations are included in the **Appendix**.

9.0 Crash Data Analysis

Crash data was obtained at study intersections for crashes that occurred between November 1, 2015, and October 31, 2018. Over this three-year period, 37 total crashes were reported at the five existing study intersections. The breakdown of crashes at these five study intersections by severity, frequency and accident type can be seen the tables below.

Table 9.1 – Crash Severity Summary

Crash Type	Number of Crashes
Fatal Crashes	0
Class A	0
Class B	2
Class C	8
Property Damage Only	27
Total	37

Table 9.1 above displays the total number of crashes by severity type from most to least severe. As shown, there were no fatal or Class A crashes reported in the study area intersections over the past three years. ‘Class A’ incidents are crashes in which serious injury is suspected, which can include significant loss of blood or broken bones. ‘Class B’ incidents are crashes in which minor injury is suspected, such as bruises or minor cuts. There were two of these crash types within the study area reported over the three years. There were 8 ‘Class C’ crashes reported, which are defined as crashes wherein possible injuries occur. Possible injuries are injuries reported by the person or indicated by his/her behavior, but no wounds or injuries are physically present, such as limping or complaint of neck pain. There were 27 crashes in which only property damage occurred, meaning no injury was reported in 73% of the recorded crashes at the study intersections.

Table 9.2 – Accident Frequency Summary

Location	Crashes/100 MEV
Robinson Church Road and Tom Query Road	13.48
Stallings Road and Harrisburg Veterans Road	9.54
Stallings Road and Stallings Road Park Drive	0.00
Stallings Road and Harrisburg Elementary School Drive	8.99
Stallings Road and Raging Ridge Road	8.99
Average	8.2

Shown in **Table 9.2** are the accident frequency rates for each study intersection, reported in crashes per 100 million entering vehicles (MEV). Their rates resulted in a weighted average crash rate of 8.2 crashes per 100 MEV, with the highest rate occurring at the intersection of Robinson Church Road and Tom Query Road.

Table 9.3 – Accident Type Summary

Accident Type	Robinson Church Road and Tom Query Road	Stallings Road and Harrisburg Veterans Road	Stallings Road and Stallings Road Park Drive	Stallings Road and Harrisburg Elementary School Drive	Stallings Road and Raging Ridge Road
Angle	1	0	0	0	0
Fixed Object	4	0	0	0	0
Left-Turn, Different Roadways	1	1	0	0	4
Left-Turn, Same Roadway	0	4	0	0	1
Other Collision with Vehicle	0	1	0	0	1
Overturn/Rollover	0	1	0	0	0
Ran off Road - Right	0	1	0	0	0
Rear End, Slow or Stop	6	5	0	1	0
Rear End, Turn	1	2	0	0	0
Right-Turn, Different Roadways	0	1	0	0	0
Sideswipe Same Direction	0	1	0	0	0
Total	13	17	0	1	6

As seen in **Table 9.3**, at the five study intersections, the most common crash type was a rear end collision due to slow or stop, with over 30% of crashes. This crash type is often associated with mainline traffic along a corridor with unsignalized turning movements with the lack of turn lanes onto side-streets. The second most common crash type was a left-turn collision. This crash type is often associated with lack of adequate gaps or poor sight distance.

10.0 Mitigation Improvements

Based on the capacity analyses performed at each of the identified study intersections, along with the review of auxiliary turn-lane warrants contained herein, the following improvements are identified to mitigate the impact of the proposed development on the adjacent street network:

Robinson Church Road and Tom Query Road

- Contribution of 25% of the overall cost of planned Town improvements to this intersection, not to exceed \$100,000

Stallings Road and Harrisburg Veterans Road

- Restriping of the eastbound through lane to provide a shared through-left lane
- Implementation of split phasing on the eastbound and westbound approaches
- Installation of a traffic signal at the intersection of Stallings Road and Hickory Ridge Road to be connected to the signal cabinet at Stallings Road and Harrisburg Veterans Road

Stallings Road and Stallings Road Park Drive/Site Access #1

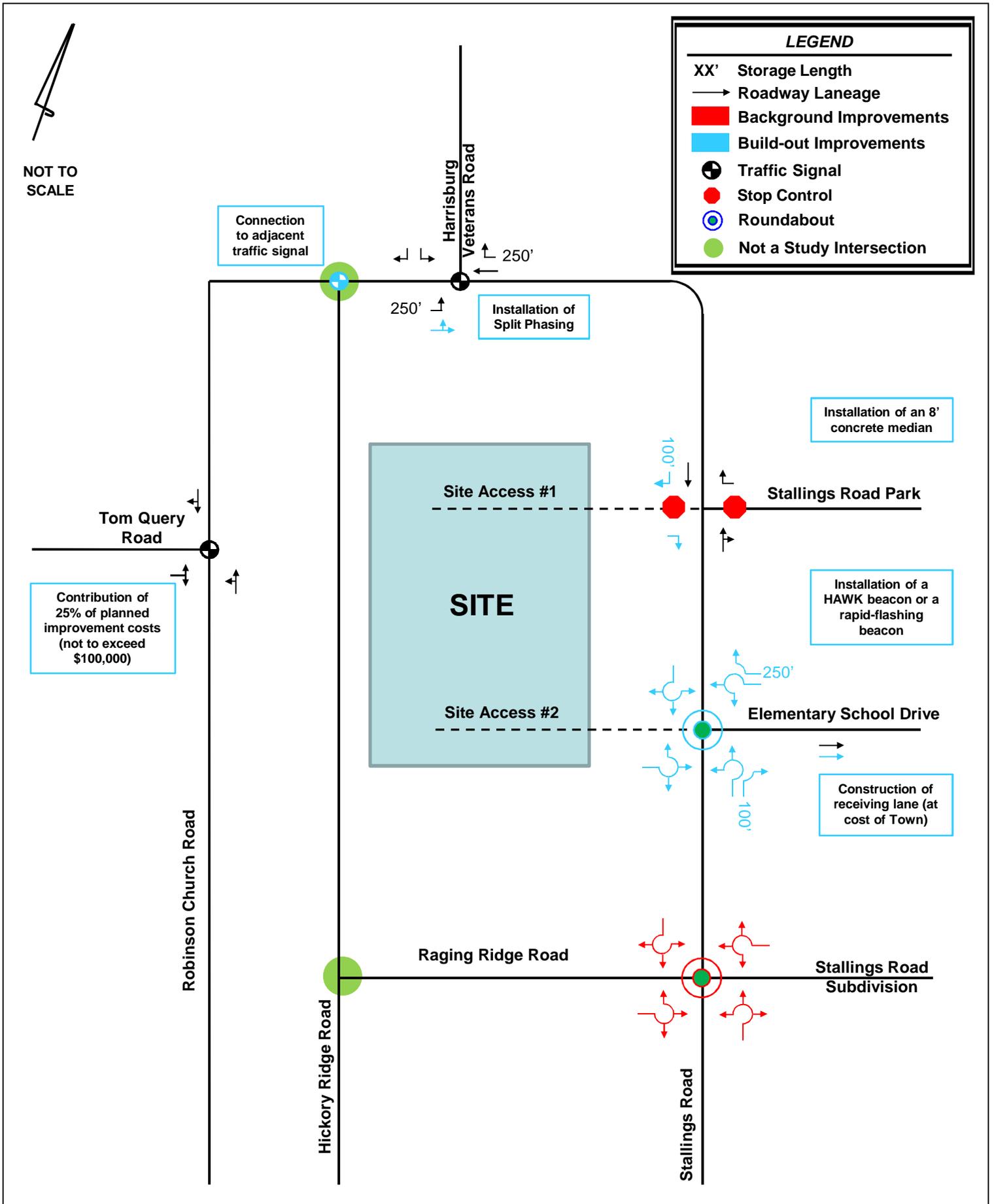
- Installation of an eastbound right-turn lane from Stallings Road into Site Access #1 with 100 feet of storage
- Installation of an 8' concrete median to serve as a refuge for pedestrian crossing and to convert the intersection to a right-in/right-out

Stallings Road and Harrisburg Elementary School Drive/Site Access #2

- Installation of a roundabout
- Construction of a single lane northbound approach
- Construction of a southbound right-turn lane from the Elementary School Drive onto Stallings Road with a minimum of 250 feet of storage (accomplished via restriping of the existing turn lanes)
- Construction of a single lane eastbound approach
- Construction of a westbound right-turn lane from Stallings Road into the Elementary School Drive with 100 feet of storage
- Construction of second receiving lane on the Elementary School Drive (this lane will be constructed by the developer at the cost of the Town)

Per the Town, installation of a High-Intensity Activated Crosswalk (HAWK) beacon or rapid-flashing beacon will be required to provide a connection from the proposed development to Stallings Road Park.

The mitigation identified within the study area is shown in **Figure 10.1**. The improvements shown on this figure are subject to approval by NCDOT and the Town of Harrisburg. All additions and attachments to the State and Town roadway system shall be properly permitted, designed and constructed in conformance to standards maintained by the agencies.



APPENDIX