Randolph, Massachusetts

Town Wide Traffic Evaluation

Phase 1: Northwest Quadrant

September 2017

TRAFFIC EVALUATION STUDY

DRAFT

BETA

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Prepared by: BETA GROUP, INC.
Prepared for: Town of Randolph

September 2017

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1.0 INTRODUCTION

The Town of Randolph engaged BETA Group, Inc. to assist the Town in methodically addressing various traffic operational issues. Of particular concern are issues of speeding, cut-through traffic, and congestion at traffic signals. While issues are spread throughout the Town, the approach is to phase services in order to meet budget constraints, as well as to implement measures and test results.

Phase One will focus on the area east of Route 24 as shown in Figure 1 and the remaining areas of Town will be evaluated by future phases of work. The project limits for Phase One consist of the High Street/Lafayette Street corridor between Scanlon Drive and West Street, and the Route 28 corridor between Russ Street and West Street. There are two schools located within the study area. The Randolph Community Middle School located at #225 High Street and the Donavan Elementary School at #123 Reed Street. The York Industrial Park and Adams Farm are also located in the vicinity of the High Street corridor.

The primary focus of the traffic evaluations will be on vehicular operational issues, particularly speeding and cut-through traffic on High Street due to congestion on Route 28 with traffic destined to Interstate 93. The pedestrian and bicycle components will not be part of the scope of services, however, for analysis purposes, observed activities will be noted.

The intent of this Traffic Evaluation Study is also to evaluate existing traffic volumes, crash history, and transportation conditions and amenities, as well as to recommend improvements in an effort to alleviate deficiencies. Traffic counts were collected to understand current multi-modal travel, speeds, and patterns along the High Street corridor. With the goal of improving transportation efficiency, measures have been developed to minimize conflict, enhance connectivity, and reduce vehicular speeds along the corridor.

2.0 PROJECT LOCATION

The Phase 1 project location focuses on the High Street corridor between Lafayette Street and Scanlon Drive, and is shown in Figure 1. High Street is under Town of Randolph jurisdiction and is functionally classified as an Urban Collector between Lafayette Street and Chestnut Street, and an Urban Minor Arterial between Chestnut Street and Scanlon Drive. Although the High Street corridor is not on the National Highway System (NHS), the roadway is eligible for State Transportation Program (STP) Federal Aid Funding. The corridor extends approximately 1.9 miles from the southern limit at the Lafayette Street intersection to the northern limit at the Scanlon Drive intersection.

The section of Route 28 shown within the project limits between Interstate 93 and Depot Street is under MassDOT jurisdiction. There are three signals located along this section of Route 28. Any recommended signal timing adjustments to these signals will require MassDOT's coordination and approval.

3.0 EXISTING CONDITIONS

A traffic-volume baseline along the corridor has been developed to provide a foundation for assessing the transportation system to support existing and future traffic volumes. Base year traffic conditions within the study area were developed by collecting manual turning movement counts (TMCs), vehicle classification counts (i.e., separation of passenger vehicles, heavy vehicles, pedestrians, and cyclists), and automatic traffic recorder (ATR) counts in April 2017.

LEGEND:

STUDY AREA INTERSECTION

AUTOMATIC TRAFFIC RECORDER LOCATION

9/20/2017 11:50 AM O:\5600\5608 - RANDOLPH TRAFFIC EVALUATION\DRAWING FILES\PLAN SETS\5608 LAYOUT.DWG (BETA STB BW.STB)

PREPARED BY

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REGISTERED PROFESSIONAL

RANDOLPH TOWN COUNCIL

PROJECT

Randolph Traffic Evaluation

Randolph, MA

TITLE

LOCUS MAP

STUDY AREA & CONCEPT LOCATIONS

NO.	REVISIONS	DATE

DRAWN BY:

DESIGNED BY:

CHECKED BY:

ISSUE DATE:

BETA JOB NO.:

SCALE

NOT TO SCALE

UNLESS OTHERWISE NOTED OR CHANGED BY REPRODUCTION

Not for Construction

SHEET NO.

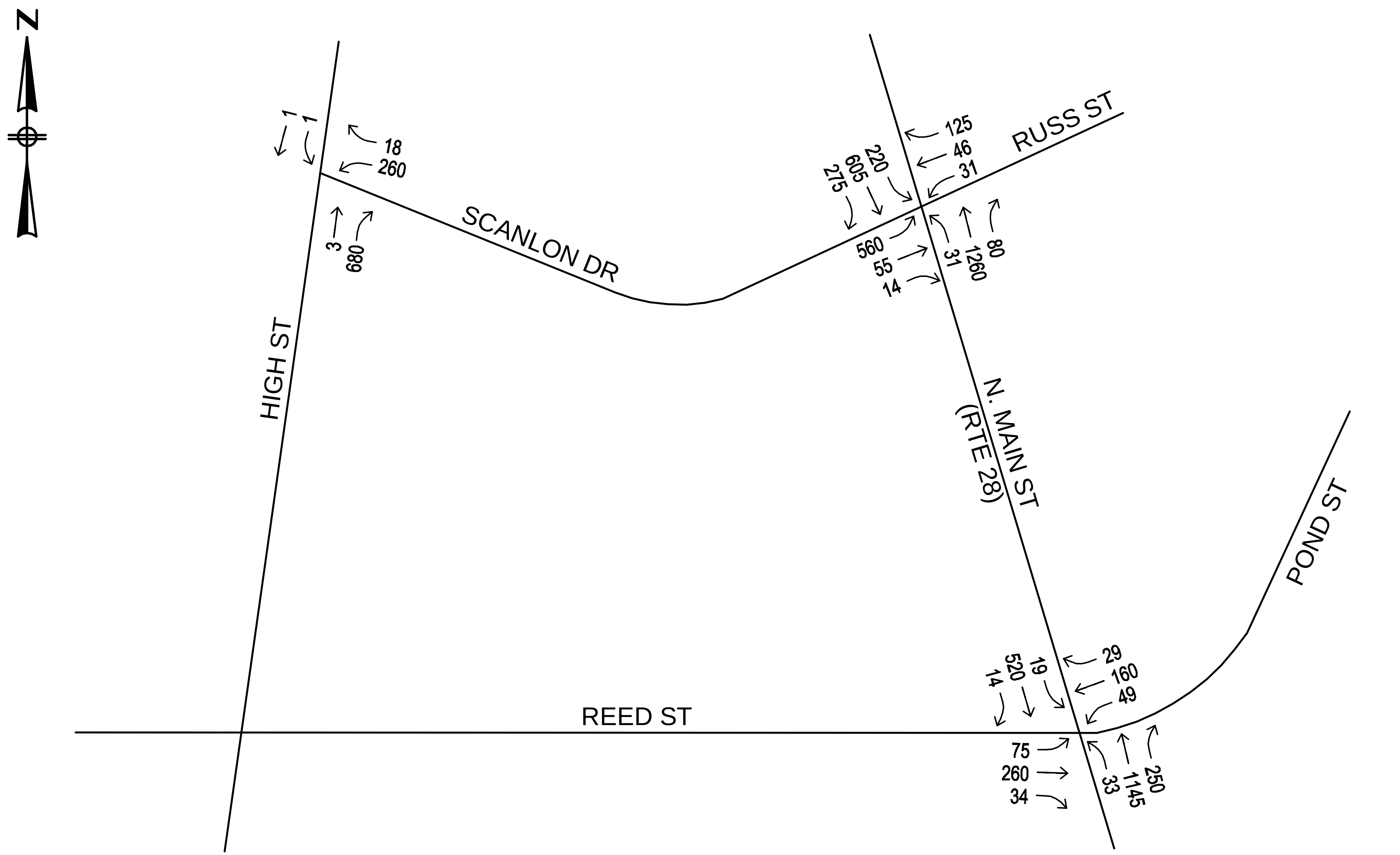
FIGURE 1

3.1 TRAFFIC VOLUMES

Manual TMC data were collected on Wednesday, April 5, 2017, during the Weekday AM peak period (7:00 to 9:00 AM) and during the Weekday PM peak period (4:00 to 6:00 PM). Along the High Street corridor, the peak hours were generally found to be 7:00-8:00 AM and 4:45-5:45 PM. Along Route 28, the peak hours were generally found to be 7:30-8:30 AM and 4:45-5:45 PM. Based on discussions with Town of Randolph officials, these traffic counts were collected at the following locations to provide an understanding of the traffic volumes along and within the vicinity of the High Street corridor:

- High Street at Scanlon Drive
- High Street and Canton Street
- High Street and Chestnut Street
- Lafayette Street at Grove Street
- Lafayette Street at West Street
- West Street and West Street Connector (to Route 139)
- Route 139 (Mazzeo Drive/Warren Street) and West Street Connector
- Route 28, Chestnut Street, and Oak Street
- Route 28, Reed Street, and Pond Street
- Route 28, Scanlon Drive, and Russ Street

Once the peak hours were determined, the traffic volumes were examined to evaluate the need for seasonal adjustment. A review of the historical traffic growth data maintained by the Massachusetts Department of Transportation (MassDOT) Highway Division at a nearby Permanent Count Station indicated that traffic volumes in April are approximately 9% higher than average-month traffic volumes. To provide a more conservative analysis, the April traffic counts were used as collected and not reduced. The peak hour turning movements are shown in Figures 2 through 7. Full traffic-volume summaries are shown in the Appendix.



AM PEAK HOUR: 7:30 - 8:30 AM

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Figure 2
2017 Existing Weekday AM Peak Hour Traffic Volumes
NOT TO SCALE

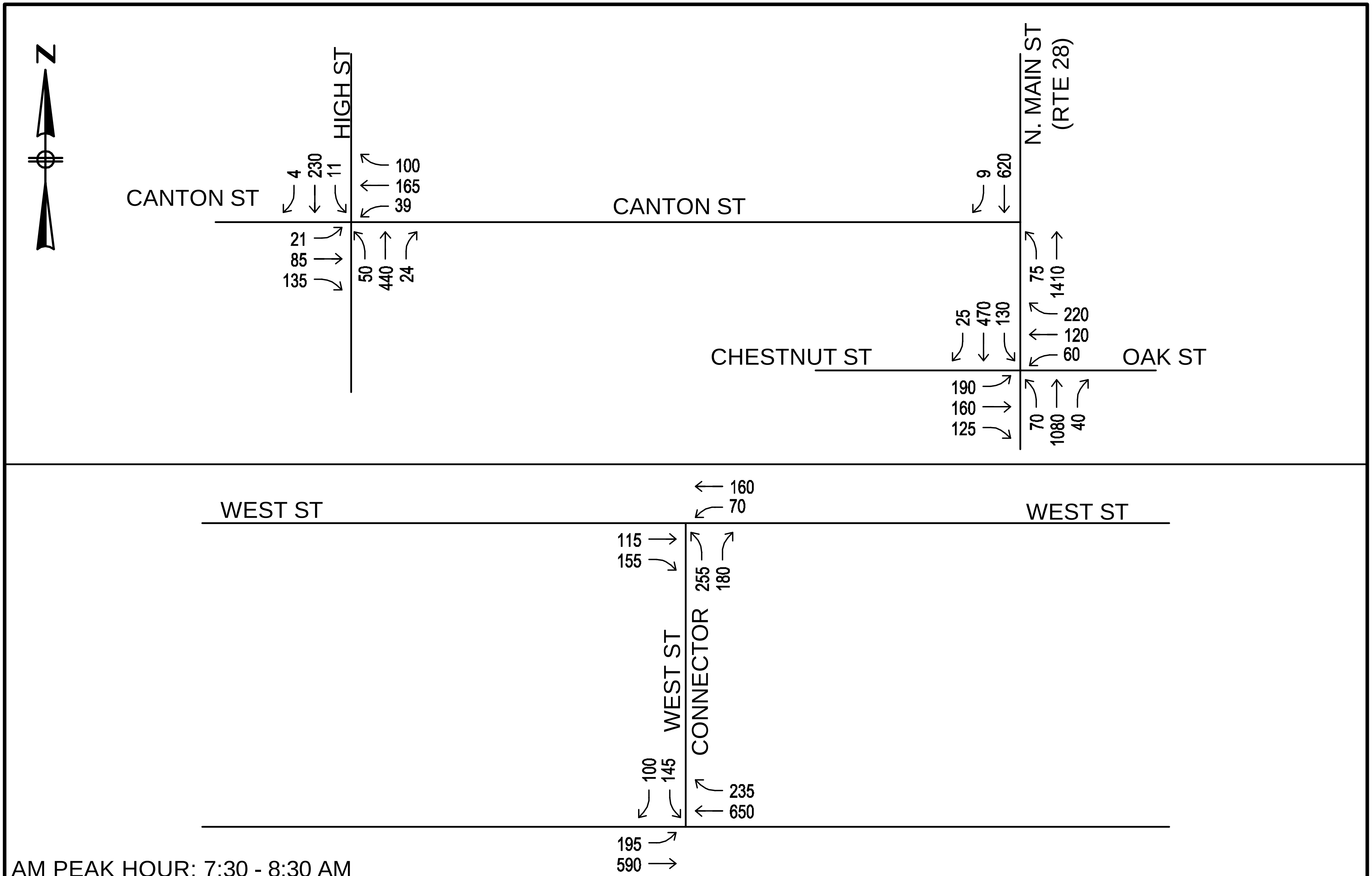

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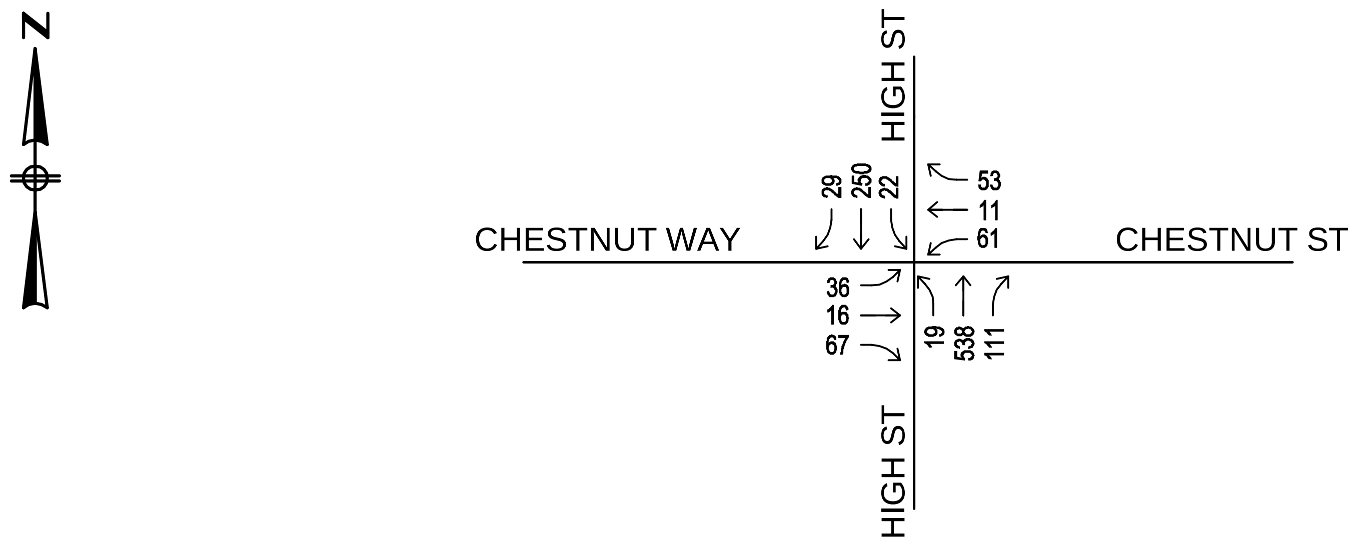
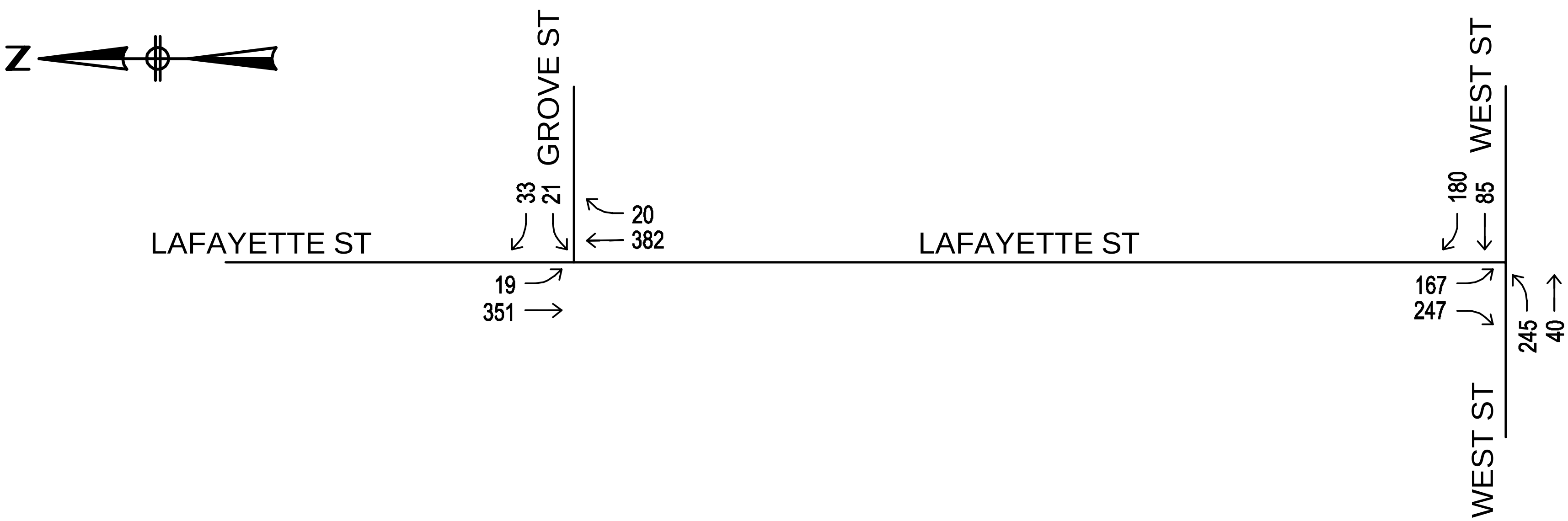
Figure 3

2017 Existing Weekday AM Peak Hour Traffic Volumes

NOT TO SCALE



AM PEAK HOUR: 7:45 - 8:45 AM



AM PEAK HOUR: 8:00 - 9:00 AM

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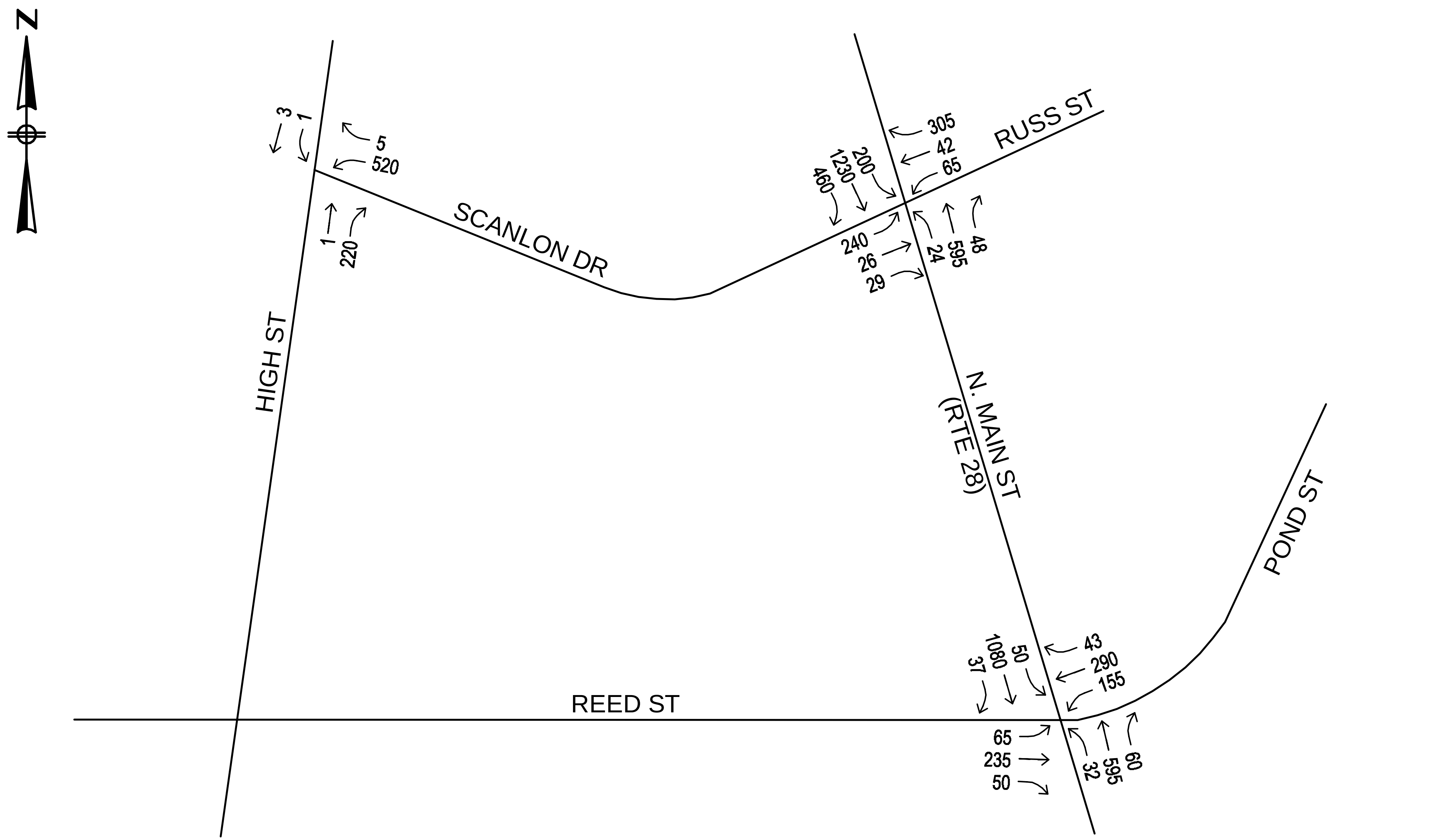
Figure 4
2017 Existing Weekday AM Peak Hour Traffic Volumes
NOT TO SCALE



PM PEAK HOUR: 4:45 - 5:45 PM

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Figure 5
2017 Existing Weekday PM Peak
Hour Traffic Volumes
NOT TO SCALE

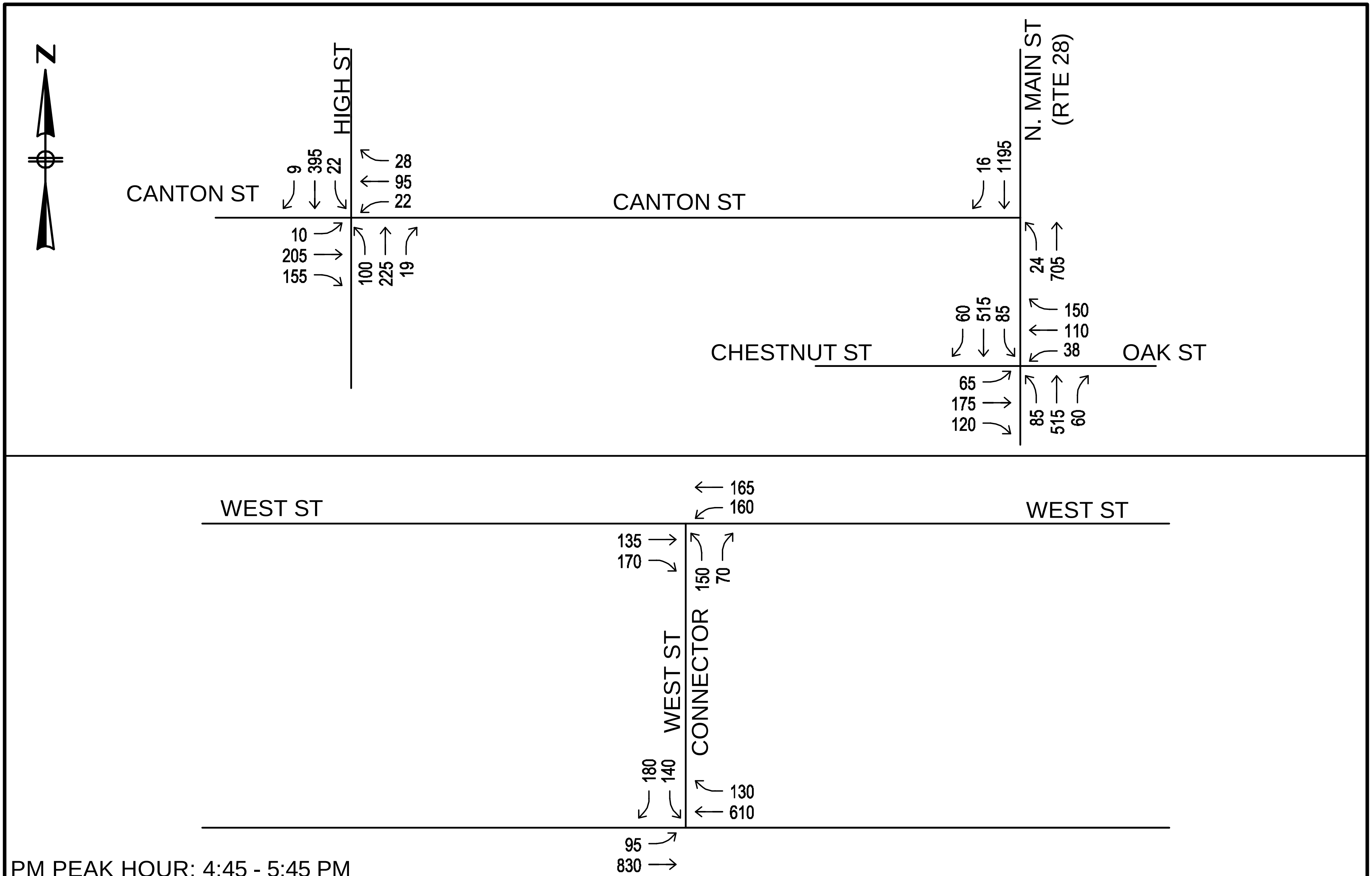

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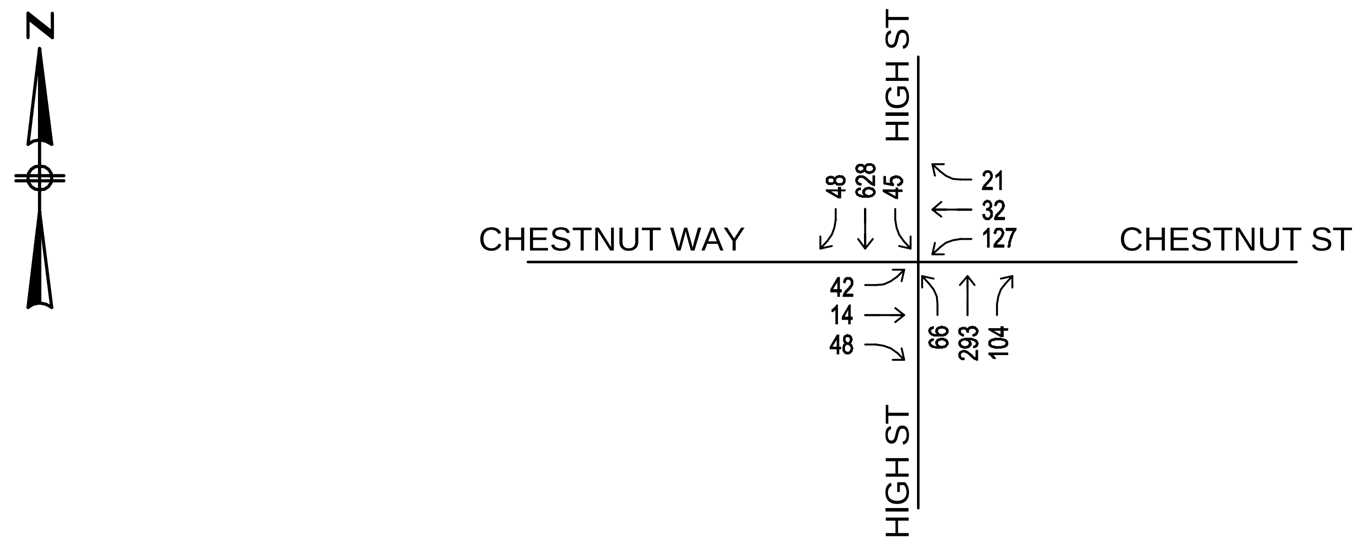
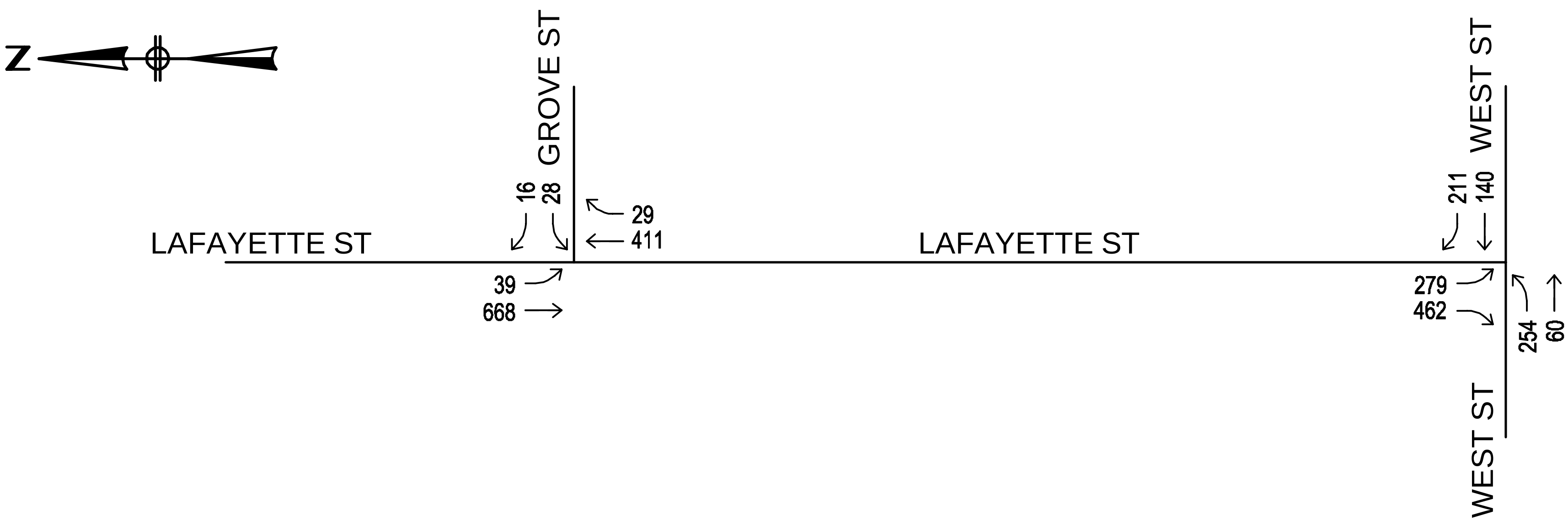
Figure 6
2017 Existing Weekday PM Peak Hour Traffic Volumes
NOT TO SCALE

O:\5600s\5608 - Randolph Traffic Evaluation\Engineering\Reports\Figures\TMC's_8.5x11.dwg Plot Date: 8/15/2017 9:15 AM



PM PEAK HOUR: 4:45 - 5:45 PM



PM PEAK HOUR: 4:45 - 5:45 PM

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Figure 7
2017 Existing Weekday PM Peak Hour Traffic Volumes
NOT TO SCALE

In addition, ATR counts were collected for a 48-hour period between Wednesday, April 5, 2017, and Thursday, April 6, 2017, at seven locations along and within the vicinity of the High Street corridor. ATR traffic counts were collected at the following locations and are also shown as black bars in Figure 1.

- High Street south of the Randolph Community Middle School
- High Street north of Reed Street
- Lafayette Street south of High Street
- Route 28 south of Chestnut Street
- Route 28 north of Pond Street
- Route 28 between the I-93 ramps
- Webster Street north of Oak Street

The data collected included volume, classification, and speed and complete ATR data are included in the Appendix. The traffic-volume data are summarized in Table 1.

Table 1 – Existing Traffic-Volume Summary

Location/Direction	Vehicles Per Day [a]	Weekday AM Peak Hour [b]	Weekday PM Peak Hour [b]	Percent Heavy Vehicles [c]
High Street South of Randolph Community Middle School				
Northbound	6,453	740	448	3%
Southbound	6,711	441	679	3%
High Street North of Reed Street				
Northbound	5,324	696	324	14%
Southbound	5,392	284	551	7%
Lafayette Street South of High Street				
Northbound	6,133	683	396	7%
Southbound	5,989	362	708	7%
Route 28 South of Chestnut Street				
Northbound	12,870	1,066	730	11%
Southbound	12,531	669	1,006	8%
Route 28 North of Pond Street				
Northbound	13,610	1,200	774	15%
Southbound	12,706	620	932	12%
Route 28 Between I-93 Ramps				
Northbound	14,466	1,557	895	9%
Southbound	13,985	673	1,282	18%
Webster Street North of Oak Street				
Northbound	541	70	47	11%
Southbound	455	26	58	5%

[a] Average vehicles per day on April 5, 2017 (Wednesday) and April 6, 2017 (Thursday).
[b] Average vehicles per hour on April 5, 2017 (Wednesday) and April 6, 2017 (Thursday).
[c] Percent of daily vehicles that include ≥2 axles and ≥6 tires (no buses or cars with trailers).

3.2 Vehicular Speeds

Vehicle speed is a basic measure of transportation performance that is defined as the rate of movement of a vehicle in distance per unit of time. Speed limits on roadways are typically established based on sound traffic engineering principles that consider actual motorist travel speeds in ideal driving conditions (i.e., free-flowing). Vehicle speeds are important as motorists relate travel speeds to safety, convenience, time, comfort, and economics. The intent for limiting vehicle speeds is to reduce traffic collisions, improve safety for non-motorized traffic, and alleviate environmental impacts (e.g., vehicle noise, vibration, emissions).

The travel time was recorded using automatic traffic recorders (ATRs) over 24-hour periods, thereby also recording travel speeds during non-peak hours when vehicle speeds are not affected by platooning. The speeds were determined by dividing the elapsed time by the measured distance between two checkpoints. In April 2017, speed measurements were conducted at the following locations. The speed measurement data are summarized in Table 2 and provided in the Appendix.

- High Street south of the Randolph Community Middle School
- High Street north of Reed Street
- Lafayette Street south of High Street
- Route 28 south of Chestnut Street
- Route 28 north of Pond Street
- Route 28 between the I-93 ramps
- Webster Street north of Oak Street

Traffic speed data are summarized with average (median) speed and 85^{th} percentile speeds. The 85^{th} percentile speed represents the speed at which 85% of vehicles are traveling at or below. Since this speed more accurately represents the overall travel speed, 85^{th} percentile speeds are typically used to verify speeding concerns. In addition, the pace was noted of the vehicles traveling in each of the specific sections. The pace is the 10 mph range containing the largest number of sample vehicles.

Based on discussions with Randolph Police Department staff, the Town-wide enforced speed limit was recently regulated to be 25 mph unless otherwise posted. This enforced speed limit is not imposed along Route 28 or Route 139.

Table 2 – Speed Data Summary

Location/Direction	Regulated Speed Limit	Average Speed	85th Percentile Speed [a]	Pace [b]
High Street South of Randolph Community Middle School				
Northbound	25/30 [c]	33	39	31-40
Southbound	25/30 [c]	33	39	31-40
High Street North of Reed Street				
Northbound	25/30 [c]	36	41	31-40
Southbound	25/30 [d]	36	42	31-40
Lafayette Street South of High Street				
Northbound	25/30 [c]	33	40	31-40
Southbound	25/30 [c]	34	39	31-40
Route 28 South of Chestnut Street				
Northbound	40	33	41	31-40
Southbound	40	40	46	36-45
Route 28 North of Pond Street				
Northbound	30	31	40	31-40
Southbound	30	30	38	26-35
Route 28 Between I-93 Ramps				
Northbound	45	41	51	41-50
Southbound	45	50	60	46-55
Webster Street North of Oak Street				
Northbound	25/30 [c]	25	32	21-30
Southbound	25/30 [c]	26	32	21-30

[a] Speed at, or below which, 85% of observed vehicles travel.
[b] The 10 mph speed range containing the greatest number of vehicles.
[c] Town-wide enforced speed limit recently set to 25 mph unless otherwise posted. At the time of speed observations, the enforced speed limit was 30 mph.

Average vehicular speeds along the study roadways were found to be consistent with the regulated speed limits, with the 85^{th} percentile speeds higher than the regulated speed limit. The average speeds were found to be generally consistent with the posted speed limit and are not excessive. The 10 mph pace ranges were found to be generally higher than the posted speed limits which suggests that many of the observed motorists ignored the regulatory signs. The higher speeds are representative of the roadway classification, width, and alignment, suggesting that physical traffic calming measures could be considered to help reduce travel speeds.

3.3 Cut-Through Analysis

An Origin-Destination (OD) study was conducted along the High Street corridor to help understand the vehicular patterns along the corridor. The OD study included the collection of vehicular license plates and arrival times at two checkpoints. For the purpose of this evaluation, the origin is the place where a vehicle is first observed and the destination is where that vehicle is last observed. The license plates were then matched at the checkpoints to determine the number of vehicles that continuously travel along the route without diverting to a different path (driveway or side street).

The intent of this evaluation is to track vehicles along the corridor and determine the number of vehicles that avoid the Route 28 corridor and cut-through High Street destined for Interstate 93 (I-93). The OD study was conducted between the Lafayette Street/West Street intersection (Origin) and the High Street/Scanlon Drive intersection (Destination). The following summarizes the results of the OD study:

- 20% of the vehicles departing the Origin were determined to be cut-through traffic.
- 24% of the vehicles arriving at the Destination were determined to be cut-through traffic.

3.4 Safety Analysis

Crash data for the study area intersections were obtained from MassDOT for the most recent three-year period available (between 2012 and 2014). In addition, collision data were requested from the Randolph Police Department but have not been received at the time of this study. A summary of the MassDOT crash data at the study area intersections is provided in Table 3.

Table 3 – Crash Data Summary

Year	Collision Type								Severity Type				Ambient Light					Weather Condition					Total Crashes
	Angle	Rear-End	Head On	Sideswipe, Same Dir	Sideswipe, Opp. Dir	Pedestrian/Bike	Single Vehicle Crash	Unknown	Property Damage	Non-Fatal Injury	Fatal Injury	Not Reported	Daylight	Dawn/Dusk	Dark Lighted Roadway	Dark Non-Lighted Roadway	Unknown	Clear	Cloudy	Rain	Snow	Unknown	
High Street at Scanlon Drive (Unsignalized)																							
2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
2013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
2014	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
High Street at Reed Street (Signalized)																							
2012	2	--	--	--	--	--	--	--	2	--	--	--	2	--	--	--	--	2	--	--	--	--	2
2013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
2014	2	1	1	--	--	--	--	--	2	2	--	--	2	--	2	--	--	3	1	--	--	--	4
Total	4	1	1	0	0	0	0	0	4	2	0	0	4	0	2	0	0	5	1	0	0	0	6
High Street at Canton Street (Unsignalized)																							
2012	2	--	--	--	--	--	--	--	--	1	--	1	--	--	2	--	--	1	1	--	--	--	2
2013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
2014	3	3	--	1	--	--	--	--	4	3	--	--	2	1	3	--	1	4	1	1	--	1	7
Total	5	3	0	1	0	0	0	0	4	4	0	1	2	1	5	0	1	5	2	1	0	1	9
High Street at Chestnut Street/Chestnut West (Unsignalized)																							
2012	--	1	--	--	--	--	--	--	1	--	--	--	1	--	--	--	--	1	--	--	--	--	1
2013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
2014	3	--	--	--	--	--	--	--	1	1	--	1	2	--	1	--	--	2	--	--	1	--	3
Total	3	1	0	0	0	0	0	0	2	1	0	1	3	0	1	0	0	3	0	0	1	0	4

Table 3 (continued) – Crash Data Summary

Year	Collision Type								Severity Type				Ambient Light					Weather Condition					Total Crashes
	Angle	Rear-End	Head On	Sideswipe, Same Dir	Sideswipe, Opp. Dir	Pedestrian/Bike	Single Vehicle Crash	Unknown	Property Damage	Non-Fatal Injury	Fatal Injury	Not Reported	Daylight	Dawn/Dusk	Dark Lighted Roadway	Dark Non-Lighted Roadway	Unknown	Clear	Cloudy	Rain	Snow	Unknown	
Lafayette Street at Grove Street (Unsignalized)																							
2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
2013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
2014	--	1	--	--	--	--	1	--	2	--	--	--	2	--	--	--	--	1	--	--	1	--	2
Total	0	1	0	0	0	0	1	0	2	0	0	0	2	0	0	0	0	1	0	0	1	0	2
Lafayette Street at West Street (Unsignalized)																							
2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
2013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
2014	--	1	1	1	--	--	2	--	4	1	--	--	3	1	1	--	--	4	1	--	--	--	5
Total	0	1	1	1	0	0	2	0	4	1	0	0	3	1	1	0	0	4	1	0	0	0	5
West Street at West Street Connector (Unsignalized)																							
2012	1	--	--	--	--	--	--	--	1	--	--	--	--	1	--	--	--	1	--	--	--	--	1
2013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
2014	2	1	--	--	--	--	--	--	3	--	--	--	3	--	--	--	--	2	--	1	--	--	3
Total	3	1	0	0	0	0	0	0	4	0	0	0	3	1	0	0	0	3	0	1	0	0	4
Route 139 at West Street Connector (Unsignalized)																							
2012	2	1	--	--	--	--	--	--	3	--	--	--	3	--	--	--	--	2	1	--	--	--	3
2013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
2014	2	1	--	1	--	1	--	--	2	3	--	--	4	--	1	--	--	4	--	1	--	--	5
Total	4	2	0	1	0	1	0	0	5	3	0	0	7	0	1	0	0	6	1	1	0	0	8

Table 3 (continued) – Crash Data Summary

Year	Collision Type								Severity Type				Ambient Light					Weather Condition					Total Crashes
	Angle	Rear-End	Head On	Sideswipe, Same Dir	Sideswipe, Opp. Dir	Pedestrian/Bike	Single Vehicle Crash	Unknown	Property Damage	Non-Fatal Injury	Fatal Injury	Not Reported	Daylight	Dawn/Dusk	Dark Lighted Roadway	Dark Non-Lighted Roadway	Unknown	Clear	Cloudy	Rain	Snow	Unknown	
Route 28 at Chestnut Street/Oak Street (Signalized)																							
2012	--	3	--	--	--	--	--	--	2	1	--	--	3	--	--	--	--	3	--	--	--	--	3
2013	--	--	--	1	--	--	--	--	1	--	--	--	1	--	--	--	--	1	--	--	--	--	1
2014	2	8	1	--	--	--	--	--	5	6	--	--	4	--	7	--	--	10	--	1	--	--	11
Total	2	11	1	1	0	0	0	0	8	7	0	0	8	0	7	0	0	14	0	1	0	0	15
Route 28 at Reed Street/Pond Street (Signalized)																							
2012	2	--	--	--	--	--	--	--	1	1	--	--	2	--	--	--	--	2	--	--	--	--	2
2013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
2014	3	3	2	--	--	1	5	--	9	5	--	--	11	--	3	--	--	9	3	1	1	--	14
Total	5	3	2	0	0	1	5	0	10	6	0	0	13	0	3	0	0	11	3	1	1	0	16
Route 28 at Scanlon Drive/Russ Street (Signalized)																							
2012	--	4	--	--	--	--	--	--	2	2	--	--	1	--	3	--	--	2	--	--	2	--	4
2013	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0
2014	4	7	2	3	--	--	1	--	10	7	--	--	13	2	2	--	--	10	2	4	1	--	17
Total	4	11	2	3	0	0	1	0	12	9	0	0	14	2	5	0	0	12	2	4	3	0	21

3.4.1 *HIGH STREET AND SCANLON DRIVE*

Based on the MassDOT crash records, no incidents were reported at the High Street and Scanlon Drive unsignalized intersection between 2012 and 2014.

3.4.2 *HIGH STREET AND REED STREET*

The MassDOT crash data indicate that the High Street and Reed Street signalized intersection has experienced an average of 2 reported collisions per year over the three-year period. Approximately 67% (4 of 6) of the incidents resulted in property damage only and approximately 67% (4 of 6) were identified as angle-type collisions.

3.4.3 *HIGH STREET AND CANTON STREET*

The MassDOT crash data indicate that the High Street and Canton Street unsignalized intersection has experienced an average of 3 reported collisions per year over the three-year period. Approximately 44% (4 of 9) of the incidents resulted in personal injury and approximately 56% (5 of 9) were identified as angle-type collisions.

3.4.4 *HIGH STREET, CHESTNUT STREET, AND CHESTNUT WEST*

The MassDOT crash data indicate that the High Street unsignalized intersection with Chestnut Street and Chestnut West has experienced an average of over 1 reported collision per year over the three-year period. Approximately 50% (2 of 4) of the incidents resulted in property damage only and approximately 75% (3 of 4) were identified as angle-type collisions.

3.4.5 *LAFAYETTE STREET AND GROVE STREET*

The MassDOT crash data indicate that the High Street and Grove Street unsignalized intersection has experienced an average of less than 1 reported collision per year over the three-year period. Both incidents resulted in property damage only, with one identified as a rear-end-type collision and the other as a single vehicle collision.

3.4.6 *LAFAYETTE STREET AND WEST STREET*

The MassDOT crash data indicate that the High Street and West Street unsignalized intersection has experienced an average of less than 2 reported collisions per year over the three-year period. Approximately 80% (4 of 5) of the incidents resulted in property damage only and approximately 40% (2 of 5) were identified as single vehicle collisions.

3.4.7 *WEST STREET AND WEST STREET CONNECTOR*

The MassDOT crash data indicate that the West Street and West Street Connector unsignalized intersection has experienced an average of over 1 reported collision per year over the three-year period. The 4 reported incidents resulted in property damage only and approximately 75% (3 of 4) were identified as angle-type collisions.

3.4.8 *ROUTE 139 AND WEST STREET CONNECTOR*

The MassDOT crash data indicate that the Route 139 and West Street Connector unsignalized intersection has experienced an average of less than 3 reported collisions per year over the three-year period. Approximately 62% (5 of 8) of the incidents resulted in property damage only and approximately 50% (4 of 8) were identified as angle-type collisions.

3.4.9 Route 28, Chestnut Street, and Oak Street

The MassDOT crash data indicate that the Route 28 signalized intersection with Chestnut Street and Oak Street has experienced an average of 5 reported collisions per year over the three-year period. Approximately 47% (7 of 15) of the incidents resulted in personal injury and approximately 73% (11 of 15) were identified as rear-end-type collisions.

3.4.10 Route 28, Reed Street, and Pond Street

The MassDOT crash data indicate that the Route 28 signalized intersection with Reed Street and Pond Street has experienced an average of over 5 reported collisions per year over the three-year period. Approximately 62% (10 of 16) of the incidents resulted in property damage only and approximately 31% (5 of 16) were identified as angle-type collisions.

3.4.11 Route 28, Scanlon Drive, and Russ Street

The MassDOT crash data indicate that the Route 28 signalized intersection with Scanlon Drive and Russ Street has experienced an average of 7 reported collisions per year over the three-year period. Approximately 57% (12 of 21) of the incidents resulted in property damage only and approximately 52% (11 of 21) were identified as rear-end-type collisions.

4.0 Recommendations

In order to discourage motorists from using High Street as a cut-through roadway between Route 139 and I-93 and instead be encouraged to utilize the major roadway system (i.e., Route 28), a holistic approach was used in developing measures to improve vehicular flow along the Route 28 corridor and measures to improve safety by slowing vehicular travel along the High Street corridor. These recommendations are conceptual in nature and that further engineering design is required prior to construction and implementation (e.g., truck and bus turn accommodations, precise location of traffic calming devices, grading and drainage, rights-of-way, on-street parking analysis, full signal warrant analysis, utilities, and intersection analyses). For reference, conceptual sketches for each of the study area locations are provided in the Appendix. Preliminary construction costs were estimated for each of the study area locations as shown in the conceptual sketches. A table summarizing these preliminary cost estimates is provided in the Appendix.

4.1 Route 28 Traffic Signal Upgrades

4.1.1 Loop Detectors

Traffic signal systems that are traffic responsive depend on the ability to sense vehicles for local intersection traffic control and management. The traffic signals along Route 28 at the intersections with Chestnut Street/Oak Street, Reed Street/Pond Street, and Scanlon Drive/Russ Street utilize inductive loop detectors consisting of insulated loop wire installed in the roadway surface. The loop detectors sense the presence of conductive metal objects (e.g., motor vehicles) passing over the wire loops.

Based on field reconnaissance, it was noted that the loop detectors along Route 28 are not functioning properly at the Chestnut Street/Oak Street intersection and at the Scanlon Drive/Russ Street intersection. As a result, the traffic signal operations wil not be working efficiently as the loop detectors are providing the maximum amount of green time for the Route 28 approaches even when vehicles are not present.

Recommendation:

- *Since the Route 28 traffic signals within the project limits are under State jurisdiction, on August 8th, the City and BETA met with the District 6 Traffic Engineer to discuss the malfunction loop detectors. The District Engineers agreed to field check the loops at these two intersections and will make proper repair accordingly.*

4.1.2 Traffic Signal Timing Plans

To provide efficiency and safety of the transportation network, traffic signal assign the right of way at intersections by providing for orderly movement of people, effectively maximizing the volume movements, reducing the severity of certain types of collisions, and supplying appropriate levels of accessibility for pedestrians and side street traffic. Timing traffic signals should accommodate fluctuations in approaching motorized and non-motorized demands at an intersection. Some of the traffic signal timing parameters that impact intersection efficiency include the cycle length, green time, and clearance intervals.

Based on traffic counts collected in the field and intersection observations and analysis, it is recommended that modifications be made to the traffic signal parameters at the three Route 28 signalized intersections within the study area. For example, the traffic signal timings could be optimized at the Route 28 intersections with Chestnut Street/Oak Street, with Reed Street/Pond Street, and with Scanlon Drive/Russ Street. In addition, the phasing at the Route 28 signalized intersection with Reed Street and Pond Street could be modified to include a Route 28 southbound lead phase to help process the Route 28 left-turning vehicles.

Recommendation:

- *On August 8th, the City and BETA met with the District 6 Traffic Engineer to discuss the signal timing and phasing improvements for the three signalized intersection. The District Traffic Engineers agreed to review and implement the proposed signal timing and phasing accordingly.*
    - *A table summarizing the existing and proposed intersection timings is provided in the Appendix. Traffic analysis results with respect to this table are also provided in the Appendix.*

4.1.3 Traffic Signal Coordinated System

Traffic signal coordination provides the ability to synchronize multiple signalized intersections in an effort to improve the progression of traffic along a corridor by reducing travel times, stops, and delays. In general, coordinated operations often improve progression along arterial streets between signals with signal spacing between 500 Feet and 0.5 miles (2,640 feet). On arterials with faster travel speeds, progression benefits can be found with coordinated signals and/or peer to peer signal interface spaced 1 mile (5,280 feet) apart or longer. For closely spaced signalized intersections (i.e., less than 500 feet), coordination can help better manage vehicular queues between the intersections. In effect, a welltimed coordinated traffic signal system can reduce fuel consumption and improve air quality by providing continuous vehicular movement along a corridor with minimal delays and stops.[1]

Based on traffic counts collected in the field and intersection observations, installing a coordinated traffic signal system may benefit vehicle progression along Route 28 corridor that includes the Chestnut Street/Oak Street intersection, the Reed Street/Pond Street intersection, and the Scanlon Drive/Russ Street intersection. From preliminary measurements, the distance between these intersections would generally satisfy the guidelines for coordinated traffic signal systems (between Chestnut Street/Oak Street and Reed Street/Pond Street = ±2,500 feet [0.5 miles], and between Reed Street/Pond Street and Scanlon Drive/Russ Street = ±3,500 feet [0.7 miles]).

Recommendation:

- *On August 8th, the City and BETA met with the District 6 Traffic Engineer to discuss future signal coordination with these three signals. Since these signals currently do not have interconnect nor communication between them, BETA recommended that GPS devices be installed at these signal locations in order to establish signal coordination. The District 6 Engineers agreed to the signal coordination approach and will consider it in the future.*

- *For future long term improvements, an adaptive signal system was also discussed for these locations. The District Engineers agreed to explore Adaptive Signal System for this corridor.*

4.2 TRAFFIC SIGNAL WARRANT ANALYSIS

Traffic signal warrant analyses are conducted to determine if signal control is or will be warranted in accordance with Manual on Uniform Traffic Control Devices (MUTCD) guidelines. Since traffic typically fluctuates throughout the year depending on the area and the type of roadway, the counted volumes were downwardly adjusted to annual average conditions, consistent with MUTCD and MassDOT guidelines. Although other warrants should be considered, MassDOT prefers that the Warrant 1 (Eight Hour Vehicular Volume) is satisfied to confirm consideration of installing a traffic signal.

The available traffic data are generally compared with the requirements established in the MUTCD for the following volume-related warrants:

- Warrant 1 – Eight Hour Vehicular Volume
  - Condition A – Minimum Vehicular Volume
  - Condition B – Interruption of Continuous Traffic
  - Combination of Conditions A and B
- Warrant 2 – Four-Hour Vehicular Volume; and
- Warrant 3 – One-Hour Vehicular Volume.

[1] Koonce, Peter, et al. *Traffic Signal Timing Manual*, FHWA-HOP-08-024. U.S. Department of Transportation and Federal Highway Administration, 2008.

Typically, at least one of the eight-hour warrants (Warrant 1, Condition A or B) should be met before signal control is considered. The peak-hour volume warrant (Warrant 3) is generally applied only in unusual cases such as driveways serving large office/industrial complexes, manufacturing plants, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short period of time. In addition, the combination of Conditions A and B under Warrant 1 should only be applied after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.

4.2.1 High Street and Canton Street

The following MUTCD Traffic Signal Warrants are satisfied for the High Street and Canton Street intersection:

- Warrant 2 (Four-Hour Warrant)
- Warrant 3 (One-Hour Warrant)

Although the High Street and Canton Street intersection meets the four-hour warrant (Warrant 2) and the one-hour warrant (Warrant 3), the average-month traffic volumes do not currently meet any of the eight-hour warrants (Warrant 1) for signalization.

Recommendations:

- *A full traffic signal is proposed at this location. As part of the final design, we recommend that an eight-hour warrant be conducted to further validate the installation of a full traffic signal system.*
- *A traffic signal coordination system with the High Street and Reed Street intersection should be included in the final design and a smart signal or Adaptive Signal System should also be considered.*

4.2.2 Lafayette Street and West Street

A full traffic signal system is proposed for the Lafayette Street and West Street intersection. As part of the final design, a full traffic signal warrant analysis should be conducted.

Recommendations:

- *Collect traffic counts and conduct a full traffic signal warrant evaluation to determine if traffic volumes meet the eight-hour warrants for the installation of a traffic signal.*
- *In the interim, it is recommended that this intersection be considered to incorporate an All-Way Stop-Control design. Based on the commuting peak hour periods traffic volume, a four-way stop control is warranted.*

4.2.3 West Street and West Street Connector

Based on traffic analysis, field observations, and discussions with local officials, a full traffic signal system is proposed at the West Street and West Street Connector intersection. As part of the final design, a full traffic signal warrant analysis should be conducted.

Recommendations:

- *Collect traffic counts and conduct a full traffic signal warrant evaluation to determine if traffic volumes meet the eight-hour warrants for the installation of a traffic signal.*

- *Due to its close proximity to the Route 139 intersection, it is recommended that this intersection be integrated with the proposed signal at the Route 139 and West Street Connector intersection as one coordinated signal system. An adaptive signal system should also be considered for these two locations.*

- *In the interim, it is recommended that this intersection be considered to incorporate an All-Way Stop-Control design. Based on the commuting peak hour periods traffic volumes, a four-way stop control is warranted.*

4.2.4 Route 139 and West Street Connector

The following MUTCD Traffic Signal Warrants are satisfied for the Route 139 and West Street Connector intersection:

- Warrant 1B (Interruption of Continuous Traffic Warrant)

- Warrant 2 (Four-Hour Warrant)

- Warrant 3 (One-Hour Warrant)

Based on this analysis, a traffic signal is warranted at the Route 139 and West Street Connector intersection by meeting an eight-hour warrant (Warrant 1B) as well as the four-hour and peak-hour warrants.

Recommendations:

- *Install a full traffic signal system at the Route 139 and West Street Connector intersection.*
  - *Due to its close proximity to the West Street intersection, it is recommended that this intersection be integrated with proposed signal at the West Street at West Street Connector intersection as one coordinated signal system. An adaptive signal system or peer to peer signal operation interface should also be considered for these two locations.*
- *Implement geometric improvements with the new traffic control device, including:*
  - *An exclusive left-turn lane on the Route 139 eastbound approach,*
  - *An exclusive right-turn lane on the Route 139 westbound approach, and*
  - *A raised median island on the Route 139 east leg to align movements through the intersection.*

4.3 All-Way Stop-Control Analysis

In accordance with MUTCD guidelines, an evaluation was conducted to determine if multi-way stop control is currently warranted at different locations within the study area. In accordance with MUTCD and MassDOT guidelines, the April 2017 traffic counts were downwardly adjusted to represent annual average conditions. Based on this assessment, the following MUTCD conditions would need to be satisfied:

- The traffic volumes along the major street approaches combine to average at least 300 vehicles per hour for any 8 hours.
- The traffic volumes along the minor street approaches combine to average at least 200 vehicles per hour for the same 8 hours.

4.3.1 High Street and Canton Street

The average-month traffic volumes at the High Street and Canton Street intersection currently meet the MUTCD warrants for All-Way Stop-Control design. Prior to installing a traffic signal at this location, the following measures are recommended:

Recommendations:

- *Construct raised center islands along the centerlines of the High Street north and south legs to narrow the travel lane widths.*
- *Realign the crosswalks at the intersection to provide more direct and shorter pedestrian crossing distances.*
- *Implement access management techniques on the northeast corner of the intersection to better define Corner Store access on Canton Street (east leg) and NO PARKING HERE TO CORNER signs be posted along the north side of Canton Street (east leg) between the Corner Store driveway and High Street.*
- *Install stamped concrete at the islands to further alert approaching motorists of a change in setting (i.e., a traffic calmed area) that encourages slower travel speeds.*

4.3.2 Lafayette Street and West Street

The available average-month traffic volumes at the Lafayette Street and West Street intersection currently meet the MUTCD warrants for All-Way Stop-Control design. Prior to installing a traffic signal at the Lafayette Street and West Street intersection, the following measures are recommended:

Recommendations:

- *Collect additional traffic counts at the Lafayette Street and West Street intersection and conduct a full All-Way Stop-Control warrant analysis.*
- *Place the West Street eastbound and westbound approaches, the Lafayette Street southbound approach, and the northbound approach for the 358 West Street driveway under All-Way Stop-Control traffic control.*
- *Modify the curb radii on the northeast and northwest corners of the intersection.*
  - *This design would better align Lafayette Street southbound approaching vehicles to intersect West Street at more of a 90-degree angle.*

  - *This design would help slow West Street westbound right turns onto Lafayette Street as these vehicles would need to slow and turn more at a 90-degree angle than a continuous sweeping movement.*
- *Construct a raised center islands along the centerline of Lafayette Street to narrow the travel lane widths, better align approaching and departing vehicles along Lafayette Street.*
  - *Install stamped concrete at the island to further alert approaching motorists of a change in setting (i.e., a traffic calmed area) that encourages slower travel speeds.*
- *Relocate the STOP bar on the Lafayette Street southbound approach closer to West Street in an effort to enable better sight lines to and from Lafayette Street.*
- *Restripe the crosswalk across Lafayette Street to be more in line with the modified intersection.*

4.3.3 West Street and West Street Connector

The available average-month traffic volumes at the West Street and West Street Connector intersection currently meet the MUTCD warrants for All-Way Stop-Control design. Prior to installing a traffic signal at the West Street and West Street Connector intersection, the following measures are recommended:

Recommendations:

- *Collect additional traffic counts at the Lafayette Street and West Street intersection and conduct a full All-Way Stop-Control warrant analysis.*

4.4 Traffic Calming Evaluation

Based on discussions with local officials and our data collection efforts, there are safety concerns with vehicles traveling at higher speeds along High Street. In an effort to improve safety and livability in the area, different traffic calming measures have been evaluated to reduce vehicle speeds along High Street.

Traffic volumes along arterials, collectors, and local roadways can provide guidance on the type or types of traffic calming measures to be considered in reducing vehicle speeds or traffic volumes. For a roadway similar to High Street (i.e., a local roadway with a posted speed limit ≤35 mph and that carries between 10,000 and 14,000 vehicles per day), roadway narrowing measures and a single-lane roundabout are generally considered.[2]

As is the case with implementing different traffic calming techniques, it is important to monitor and evaluate the effects of each measure to determine if the desired results were achieved. Minimum or low impact monitoring includes vehicle operating speed observations before and after implementation along different sections of the roadway to determine if the desired results were achieved, communication with the residents, and an evaluation of any unexpected impacts that may be created (e.g., drainage concerns, increased speeding along other sections of the roadway, significant travel time delays to emergency vehicles, etc.).

[2] Brown, Steve J., and Reid Ewing. *U.S. Traffic Calming Manual*. Chicago: American Planning Association, 2009.

4.4.1 Center Island Narrowings

Raised islands placed along the centerline of a roadway can narrow the width of travel lanes. Center islands can help provide a pedestrian refuge area at a midpoint of the crossing to allow pedestrians to cross the roadway in two stages (i.e., one direction of traffic at a time). These types of traffic calming measures are effective in speed reductions when located sporadically along an open section of the major roadway to provide short interruptions, rather than a long median to continuously separate directional flow.

4.4.1.1 Pedestrian Refuge Areas

A pedestrian refuge area should be designed in conformance with American Association of State Highway and Transportation Officials (AASHTO) guidelines to provide space for pedestrian passage, turning, or platooning while allowing for the placement of detectable warnings. In addition, the refuge island should be sized to accommodate bicyclists and people pushing strollers without being hindered by poles, sign posts, or other obstructions. Pavement markings should be striped based on MUTCD guidelines, with edge line striping delineated around the pedestrian refuge area and tapered lines extending from the existing double yellow centerlines to the raised obstruction.

Recommendations:

- *Construct a pedestrian refuge island along High Street at Edwin Street and the crosswalk across High Street be realigned.*
- *Locate a raised island (aka, midblock median, median slow point, median choker) along High Street north of Walter Seyfert Way to slow vehicular speeds by narrowing the travel lanes.*
  - *This traffic calming device can include landscaping to provide a visual amenity that should be planted such as not to limit sight lines from nearby side streets and driveways.*

4.4.1.2 High Street, Chestnut Street, and Chestnut West

Based on existing traffic volumes and the alignment of the High Street, Chestnut Street, and Chestnut West unsignalized intersection, it is recommended that traffic calming measures and geometric modification be considered.

Recommendations:

- *Reconfigure the High Street southbound approach from a shared left-turn/through lane and an exclusive right-turn lane to an exclusive left-turn lane and a shared through/right-turn lane.*
- *Construct a raised island on the High Street south leg opposite the High Street southbound left-turn lane.*
- *Install a raised island on the Chestnut Street leg.*
  - *The island would better align Chestnut Street westbound approaching vehicles to intersect High Street at more of a 90-degree angle.*
  - *The island could be designed to provide a pedestrian refuge area.*

- *Modify the curb radius on the southeast corner of the intersection.*
  - *The Chestnut Street leg would intersect High Street at more of a perpendicular angle.*
  - *The design change would help to slow High Street northbound right turns onto Chestnut Street as these vehicles would need to turn more at a 90-degree angle than a continuous sweeping movement.*

4.4.2 Bicycle Facilities

Cycling and walking share common needs and are faced with similar problems, however, they are distinct modes of transportation that require individual thought and consideration. For example, these non-motorized modes of transportation travel at slower speeds than vehicles, but cyclists can travel at faster speeds than pedestrians and pedestrians can change directions and stop quicker.

A bicycle lane is a portion of the roadway that has been designated by striping, signage, and pavement markings for bicycle use. Bicycle lanes allow cyclists to ride at their desired speed without conflict from vehicular travel. Typical bicycle lanes are provided along the curbside of a roadway, without the presence of on-street parking, and flow in the same direction of vehicular traffic.

The Town of Randolph has been developing a Bicycle Connectivity Master Plan. In November 2016, an existing conditions assessment was conducted to be used as a baseline for identifying and prioritizing the need for bicycle facilities within the Town. As documented, the High Street corridor was noted to show cycling activity that could necessitate the need for an on-street bike lane between Route 139 and Route 28 at Scanlon Drive.

Recommendation:

- *As part of the final design, coordinate with the Town Planning Department to discuss bike accommodations along the High Street corridor.*

4.4.3 Roundabouts

Large, raised, circular islands in the middle of major intersections can create a slow steady flow of traffic, reduce conflict points, and narrow roadway approaches to the intersection that can slow vehicular speeds and enhance safety for pedestrians. Based on field observations, analysis and discussions with local officials, the following measures are recommended:

Recommendations:

- *A mini-roundabout is proposed at the Niles Road intersections with Althea Road and with Smith Road. As part of the final design, additional data should be collected to analyze these two intersections.*

4.4.4 Driver Speed Feedback Signs

Driver speed feedback signs are an effective tool in slowing vehicular speeds along specific sections of a roadway corridor. These devices operate using the feedback loop theory in which people generally notice and improve their actions when presented with information regarding their performance. The speed indicator sign would display the speed of approaching vehicles and bring attention to motorists (and those in proximity) that vehicles may be exceeding the regulated speed limit. Many options are available with these speed control signs, including flashing lights or displayed messages (e.g., SLOW DOWN) that are triggered when a vehicle travels above a preset speed. These devices can be portable or permanent and are intended to alert motorists of their actual travel speeds and create a feeling that motorists are being monitored.

Recommendations:

- *Due to the fast travel speeds recorded along the High Street/Lafayette Street corridor (Section 3.2: Vehicular Speeds), it is recommended that consideration be given to installing driver speed feedback signs at but not limited to the following locations:*
  - *High Street at Hill Street*
  - *Lafayette Street south of High Street.*

4.4.5 Increased Law Enforcement

In addition to traffic calming measures, increased levels of law enforcement may encourage motorists to maintain an enforced/posted speed limit and would penalize those who do not. For enforcement to be effective, a strong presence should be maintained.

4.5 Sight Distance Evaluation

To identify potential safety concerns associated with vehicles entering and exiting the High Street/ Lafayette Street corridor, sight distances have been evaluated within the study area to determine if the available sight distances for vehicles exiting minor street approaches meet or exceed the minimum distances required for approaching vehicles to safely stop. Minimum sight distance requirements have been established by the American Association of State Highway and Transportation Officials (AASHTO).[3] AASHTO is the national standard by which vehicle sight distance is calculated, measured, and reported.

Required sight distances are developed for various design speeds based on driver reaction time, braking ability of vehicles under wet pavement conditions, and the friction provided by pavement surfaces. Adequate sight lines provide motorists with sufficient time to identify and react appropriately to the roadway environment. Insufficient sight lines, however, can increase the risk of collision as a motorist's reaction time and stopping distance are reduced. Sight distances are influenced by the roadway's vertical and horizontal alignment. For example, sight distances are subject to the vertical alignment of a roadway can be impacted at crest vertical curves, headlight sight distance at sag vertical curves, and at bridge undercrossings. In the area of horizontal curves, sight distances can be limited by physical obstructions such as barriers, walls, backslopes, and vegetation.

4.5.1 High Street and Lafayette Street

Based on field investigations, the layout of the High Street and Lafayette Street intersection and the lack of directional signage have resulted in limited sight lines and driver confusion.

[3] *A Policy on Geometric Design of Highways and Streets*, 6th Edition. Washington, D.C.: American Association of State Highway and Transportation Officials (AASHTO), 2011.

- The High Street north leg and the Lafayette Street leg represent the mainline of vehicular travel, with the High Street south leg as the minor street approach.

- A raised delta island is located on the High Street south leg that allows High Street northbound right turns onto Lafayette Street and left turns from Lafayette Street onto High Street southbound to utilize the area south of the raised island.
  - High Street southbound movements that continue onto the High Street leg and High Street northbound movements that continue onto the High Street north leg utilize the area south of the raised island.
  - There is a STOP sign located on the High Street northbound approach for continued access onto the High Street north leg, but no STOP sign for the High Street northbound right turns onto Lafayette Street and no signs to direct Lafayette Street vehicles destined for the High Street south leg to which side of the raised island to use.
  - Motorists on the High Street northbound approach may be confused as to which direction approach High Street southbound vehicles are destined if those drivers do not use their directional.

To improve sight lines, improve safety, and alleviate driver confusion, the following measures are recommended:

Recommendations:

- *Remove the delta island on the High Street south leg.*
- *Realign the High Street south leg to intersect the High Street/Lafayette Street mainline at a more traditional intersection (90-degree angle).*
- *Place the High Street northbound approach (south leg) under STOP sign control.*

4.5.2 Lafayette Street and Grove Street

Based on field visits, there appear to be limited sight lines at the Lafayette Street and Grove Street intersection. To improve sight lines and improve safety, the following measures are recommended:

- *Modify the curb radii on northeast and southeast corners of the intersection to better align Grove Street westbound approaching vehicles to be more at a 90-degree angle with Lafayette Street.*

- *Construct a raised island on the Grove Street leg to better align Grove Street westbound approaching vehicles to intersect Lafayette Street at more of a 90-degree angle.*

- *Relocate the STOP bar on the Grove Street westbound approach closer to Lafayette Street to enable better sight lines to and from Grove Street.*

4.5.3 Lafayette Street and Grove Street

Based on field visits, there appear to be limited sight lines at the Lafayette Street and Grove Street intersection. To improve sight lines and improve safety, the following measures are recommended:

- *Modify the curb radii on northeast and southeast corners of the intersection to better align Grove Street westbound approaching vehicles to be more at a 90-degree angle with Lafayette Street.*

- *Construct a raised island on the Grove Street leg to better align Grove Street westbound approaching vehicles to intersect Lafayette Street at more of a 90-degree angle.*

- *Relocate the STOP bar on the Grove Street westbound approach closer to Lafayette Street to enable better sight lines to and from Grove Street.*

4.5.4 West Street and West Street Connector

As noted in the field, there appear to be limited sight lines at the West Street and West Street Connector intersection. To improve sight lines and improve safety, the following measures are recommended:

- *Modify the curb radii on southeast and southwest corners of the intersection to better align West Street Connector.*

- *Stripe a painted island on the West Street Connector leg to better align approaching and departing vehicles.*

- *Relocate the STOP bar on the West Street Connector approach closer to West Street to enable better sight lines to and from West Street Connector.*