Transportation Impact Assessment

Proposed Residential Development

Needham, Massachusetts

Prepared for:

Jefferson Apartment Group
Newton Massachusetts

Vanasse & Associates, Inc.
Transportation Engineers & Planners
35 New England Business Center Drive
Suite 140
Andover, MA 01810-1066

TRANSPORTATION IMPACT ASSESSMENT

PROPOSED RESIDENTIAL DEVELOPMENT
NEEDHAM, MASSACHUSETTS

Prepared for:

Jefferson Apartment Group
Newton, MA

January 2019

Prepared by:

VANASSE & ASSOCIATES, INC.
35 New England Business Center Drive
Suite 140
Andover, MA 01810

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EXECUTIVE SUMMARY

Vanasse & Associates, Inc. (VAI) has prepared this Transportation Impact Assessment (TIA) in order to evaluate the potential traffic impacts associated with the proposed residential development to be located at 433 Chestnut Street in Needham, Massachusetts (the "Project"). The Project will consist of the development of 150 housing units with a total of approximately 225 parking spaces. Access to the Project will be provided by way of one full access driveway onto Chestnut Street.

This study was prepared in consultation with the Town of Needham and in accordance with the Massachusetts Department of Transportation (MassDOT) Guidelines for *Transportation Impact Assessment (TIA) Guideline*; and was conducted pursuant to the standards of the Traffic Engineering and Transportation Planning Professions for the preparation of such reports. Based on the results of this study, the following can be concluded:

- Using trip-generation statistics published by the Institute of Transportation Engineers (ITE) [1], the Project is expected to generate approximately 23 new vehicle trips (7 entering and 16 exiting) during the weekday morning peak hour and 25 new vehicle trips (32 entering and -7 exiting) during the weekday evening peak hour.

- The removal of the existing business will result in a significant reduction in trucks on the local streets.

- Project-related traffic increases in the area are expected to be between 1.1 percent to 3.3 percent during the peak hours.

- The analysis has indicated that the Project will result in minimal impact on motorist delays at the study intersections, as compared to future No-Build conditions.

- The site driveway provides ample sight lines and will provide safe access and egress to the development.

- Accident data provided by the Needham Police Department indicates safe operation of the existing driveway.

In consideration of the above, we have concluded that the Project can be accommodated within the confines of the existing transportation infrastructure in a safe and efficient manner with the implementation of the following recommendations.

[1] *Trip Generation*, 10th Edition; Institute of Transportation Engineers; Washington, DC; 2017.

RECOMMENDATIONS

The following improvements have been recommended, as part of this evaluation, to provide safe and efficient access to the Project.

Project Access

Access to the Project is proposed by way of existing full access onto Chestnut Street. It is recommended that the site access driveway, be placed under STOP-sign control, with illumination provided. Signs and landscaping adjacent to the Project driveway and within the Project site should be designed and maintained so as not to restrict lines of sight. All signs and other pavement markings to be installed should conform to the specifications of the Manual on Uniform Traffic Devices (MUTCD).[2.]

Travel Demand Management (TDM) Plan

Reducing the amount of traffic generated by the Project is an important component of the development plan. The goal of the TDM plan is to reduce the use of Single Occupant Vehicles by encouraging car/vanpooling, bicycle commuting, the use of public transportation and pedestrian travel. The following measures will be implemented as part of the proposed project management team in an effort to reduce the number of vehicle trips generated:

- In order to encourage the use of public transportation, the property management team will make available public transportation schedules, which will be posted in a centralized location for residents.
- In order to encourage car/vanpooling, the property management team will identify car/vanpool resources that may be available to residents of the proposed project. This information will be posted in a centralized location for the residents.
- The property management team will provide information on available pedestrian and bicycle facilities in the vicinity of the project site. This information will be posted in a centralized location.
- Bicycle racks and a bicycle "Fix-it" station will be provided on-site.

The above strategies will encourage non-auto travel by the residents.

CONCLUSIONS

As documented in this study, project-related traffic increases will not result in significant increases in overall traffic volumes or traffic delays within the study area. The project-related traffic can be adequately accommodated within the existing infrastructure with minimal impact on the traffic operations. The site driveway will provide safe access and egress to the development, as planned.

[2] *Manual on Uniform Traffic Control Devices (MUTCD)*; Federal Highway Administration; Washington, D.C.; 2009.

INTRODUCTION

Vanasse & Associates, Inc. (VAI) has prepared this Transportation Impact Assessment (TIA) in order to evaluate the potential traffic impacts associated with the proposed residential development to be located at 433 Chestnut Street in Needham, Massachusetts (hereafter referred to as the "Project"). This study evaluates the following specific areas as they relate to the Project: i) access requirements; ii) potential off-site improvements; and iii) safety considerations; and identifies and analyzes existing traffic conditions and future traffic conditions, both with and without the Project.

PROJECT DESCRIPTION

The Project will consist of the development of 150 housing units with a total of approximately 225 parking spaces. Access to the Project will be provided by way of one full access driveway onto Chestnut Street.

STUDY METHODOLOGY

This study was prepared in consultation with the Town of Needham and in accordance with the Massachusetts Department of Transportation (MassDOT) Guidelines for *Transportation Impact Assessment (TIA) Guideline*; and the standards of the Traffic Engineering and Transportation Planning professions for the preparation of such reports; and was conducted in three distinct stages.

The first stage involved an assessment of existing conditions in the study area and included an inventory of roadway geometrics; pedestrian facilities; observations of traffic flow; review of safety characteristics along area roadways and collection of daily and peak period traffic counts.

In the second stage of the study, future traffic conditions were projected and analyzed. Specific travel demand forecasts for the Project were assessed along with future traffic demands due to expected traffic growth independent of the Project. A seven-year time horizon was selected for analyses consistent with state guidelines for the preparation of TIAs. The traffic analysis conducted in stage two identifies existing or projected future roadway capacity, traffic safety, and site access issues.

The third stage of the study presents and evaluates measures to address traffic and safety issues, if any, identified in stage two of the study.

EXISTING CONDITIONS

A comprehensive field inventory of existing conditions within the study area was conducted November 2018. The field investigation consisted of an inventory of existing roadway geometrics, pedestrian facilities, traffic volumes, and operating characteristics; as well as posted speed limits and land use information for the major roadways that provide access to the Project including Chestnut Street as well as the intersection which are expected to accommodate the majority of Project-related traffic. The study area for the project is listed below and graphically depicted in Figure 1.

1. Chestnut Street at School Street
2. Chestnut Street at Hospital emergency entrance
3. Chestnut Street at Oak Street
4. Chestnut Street at Junction Street
5. Chestnut Street at Carriage Lane
6. Chestnut Street at High Rock Lane

The following describes the study area roadway and intersections and is depicted in Figure 2, which summarizes existing lane use and travel lane widths at the study area intersections.

GEOMETRY

Roadways

Chestnut Street

Within the study area, Chestnut Street is a two-lane roadway under local jurisdiction that traverses the study area in a general north-south direction. Chestnut Street provides one 12-foot wide travel lane per direction separated by a double yellow centerline, within the study area. A sidewalk is provided along the both sides of Chestnut Street, north of the Site Drive, and along the east side of Chestnut Street, south of the Site Drive. Illumination provided by way of street lights mounted on wood poles. The posted speed limit along Chestnut Street within site area is 30 miles per hour (mph). Land use along Chestnut Street consisting primarily of the Hospital, commercial, and residential uses.

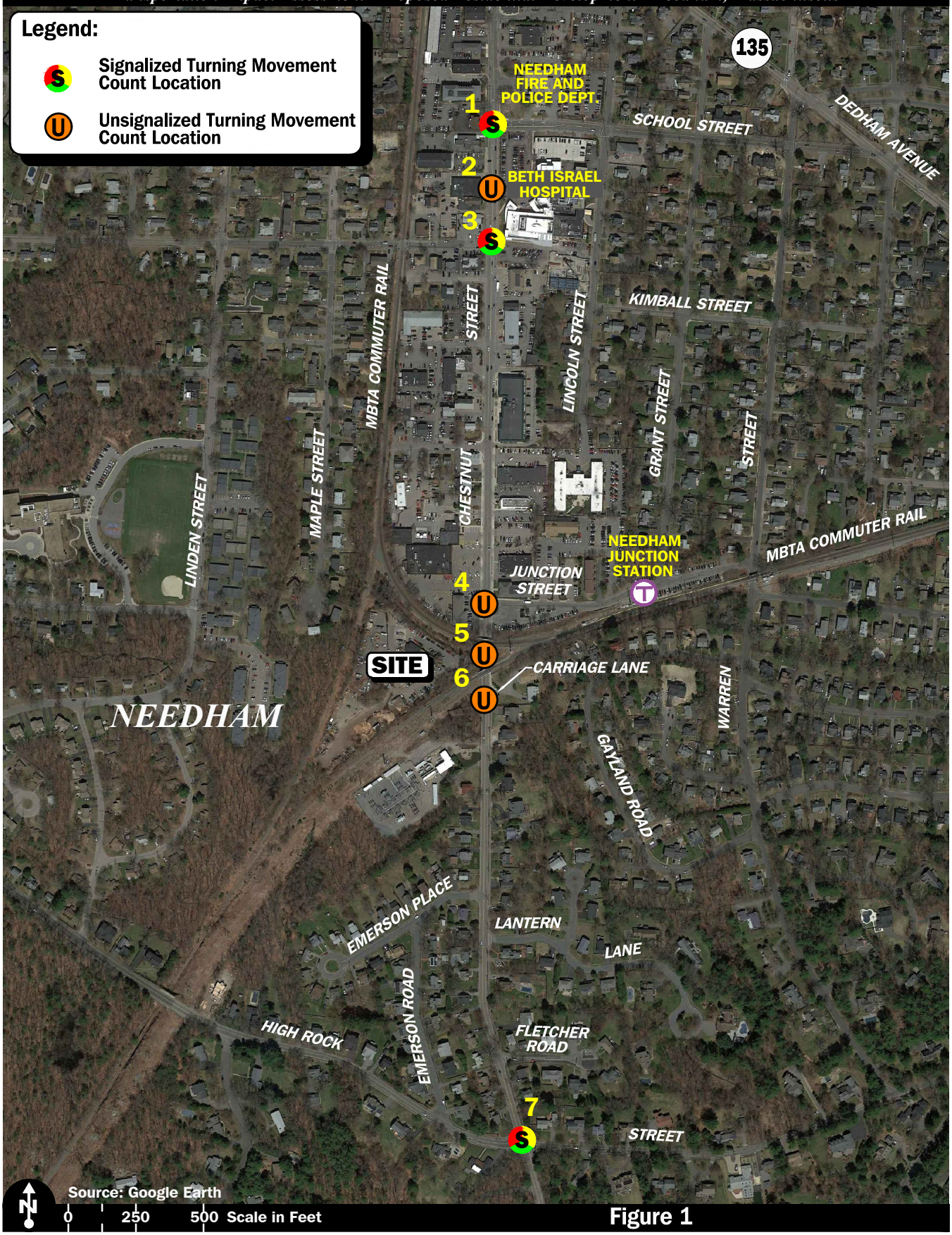

Figure 1

Study Area Map

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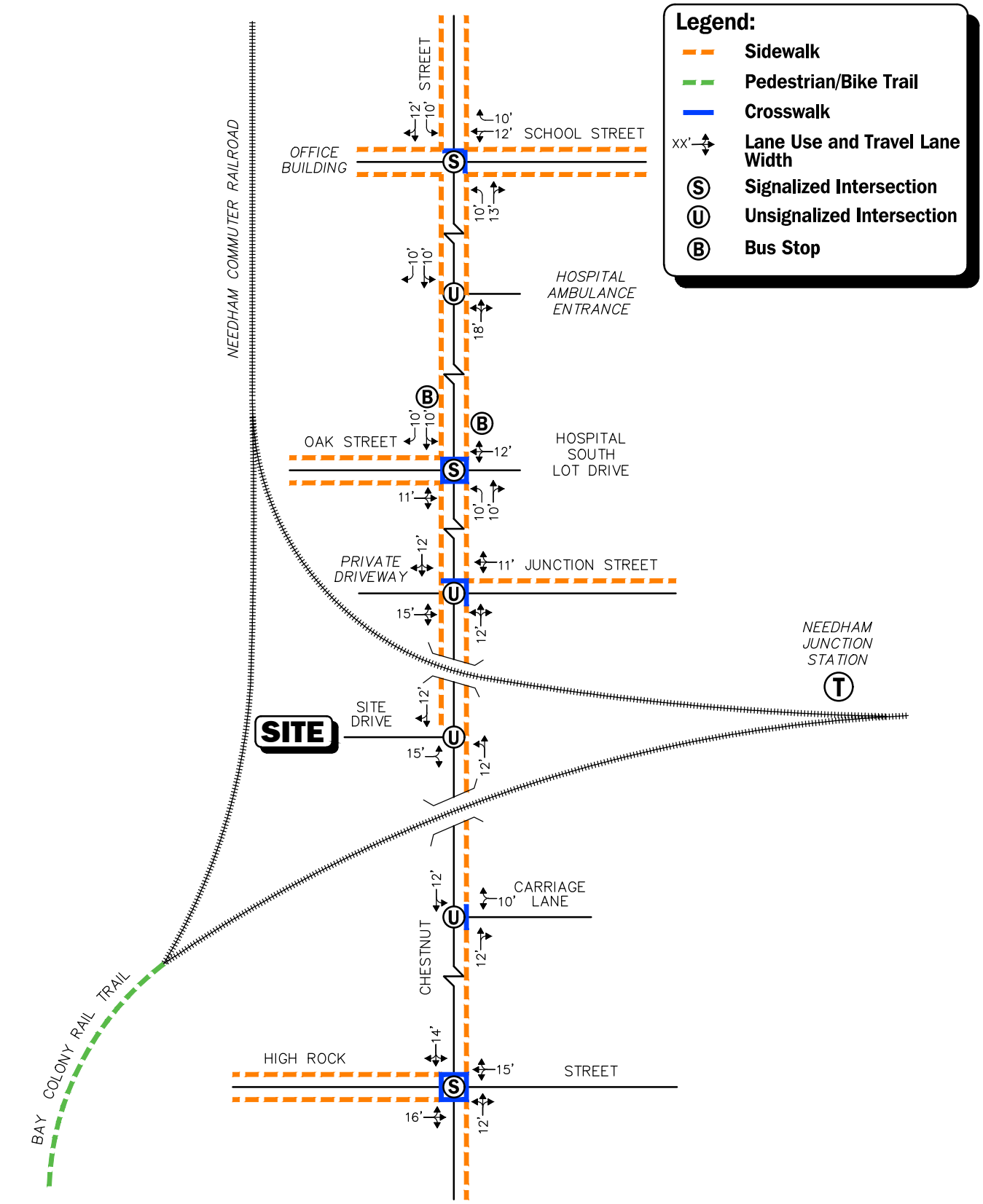

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Figure 2

Existing Intersection Lane Use, Travel Lane Width and Pedestrian Facilities

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EXISTING TRAFFIC VOLUMES

In order to determine existing traffic-volume demands and flow patterns within the study area, manual turning movement counts (TMCs) and vehicle classification counts were conducted on November 2018, when all schools were in session, during the weekday morning (7:00 to 9:00 AM), and weekday evening (4:00 to 6:00 PM) peak periods at each study area intersection. Traffic counts for the intersection of Chestnut Street with School Street during the weekday morning[3] and weekday evening [4] peak hour was obtained from recently traffic study completed by *VAI*.

Seasonal Adjustment

In order to determine whether traffic volumes collected in November are representative of average annual conditions, historical traffic data collected by MassDOT were examined. Based on a review of seasonal adjustment factors collected by MassDOT for urban arterials and collectors, November traffic volumes are approximately 1 percent above average-month conditions. As such, the raw traffic count data that forms the basis of the assessment was not adjusted downward in order to provide a conservative (above-average) analysis condition. In addition, traffic volumes obtained from recent traffic study were adjusted upward by an additional 1 percent to account for a one-year growth rate. The 2018 Existing traffic volumes are summarized in Table 1, with the weekday morning and evening peak-hour traffic volumes graphically depicted on Figure 3.

Table 1
EXISTING ROADWAY TRAFFIC-VOLUME SUMMARY

		Weekday Morning Peak Hour (7:45 – 8:45 AM)			Weekday Afternoon Peak Hour (4:30 – 5:30 PM)		
Location	Daily Volume (vpd)[a]	Volume (vph)[b]	Percent of Daily Traffic[c]	Predominant Flow	Volume (vph)	Percent of Daily Traffic	Predominant Flow
Chestnut Street North of Oak Street	10,120	904	8.9	63%NB	910	9.0	57%SB

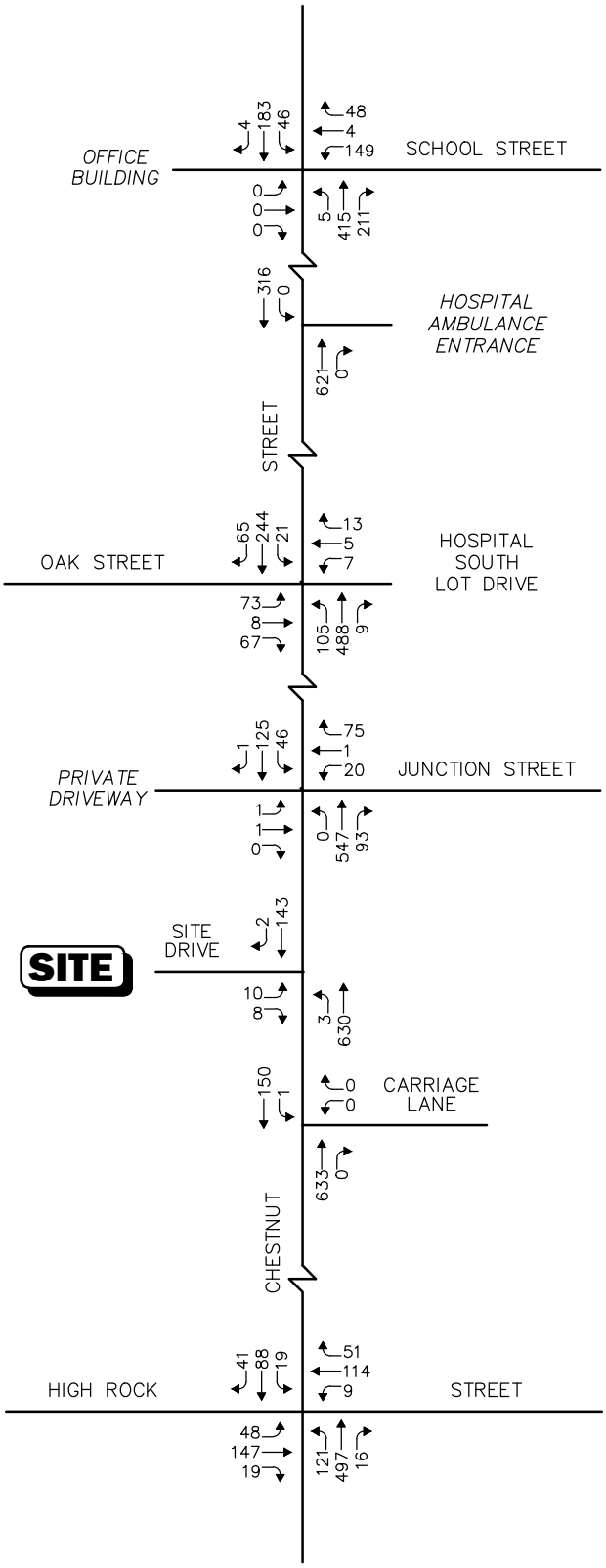
[a]Two-way daily traffic expressed in vehicles per day;
[b] Manual turning movement counts conducted in November 2018.
[c]The percent of daily traffic that occurs during the peak hour.
NB=northbound, SB= southbound

As can be seen in Table 1, Chestnut Street North of Oak Street, was found to accommodate approximately 10,120 vehicles per day (vpd) with 904 vehicles per hour (vph) during the weekday morning peak hour and 910 vph during the weekday evening peak hour. The predominance flow on Chestnut Street during the weekday morning is in the northbound direction and during the weekday evening is in the southbound direction.

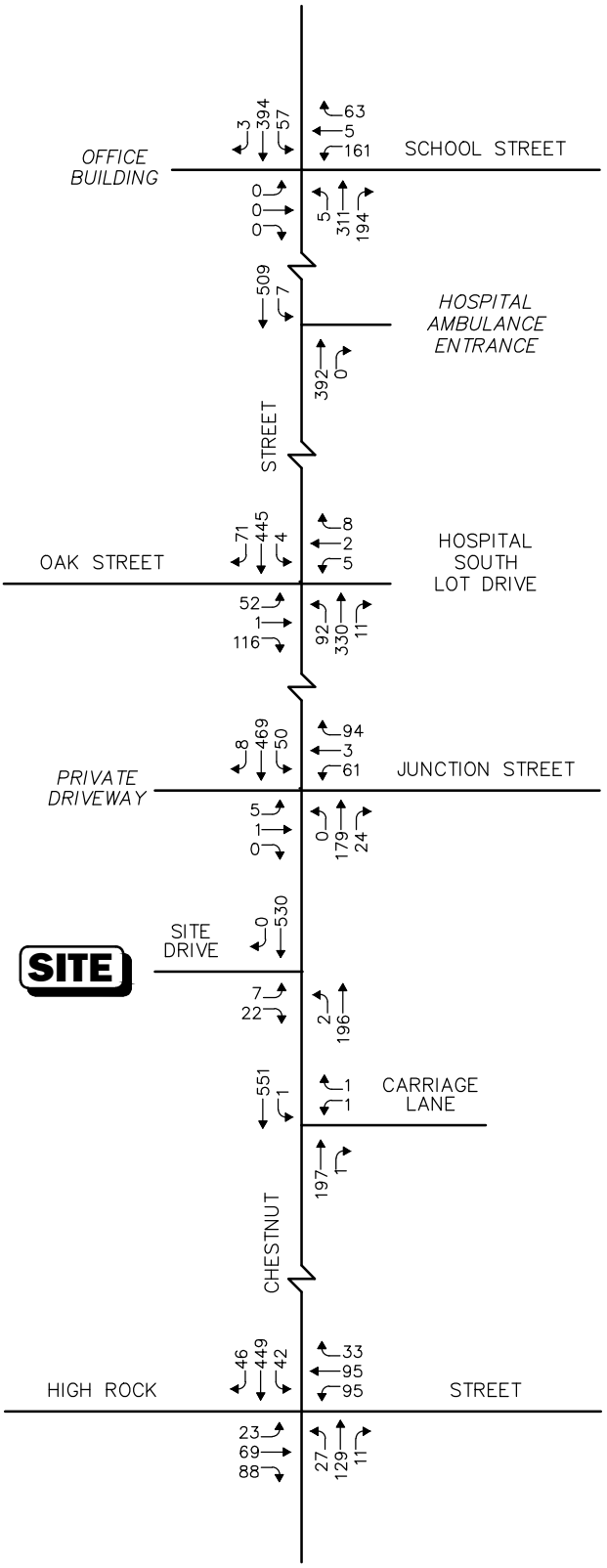
A review of the peak-period traffic counts indicate that the weekday morning peak hour generally occurs between 7:45 and 8:45 AM, with the weekday evening peak hour, generally occurring between 4:30 and 5:30 PM.

[3]*Transportation Impact Assessment*, Beth Israel Deaconess Hospital Expansion in Needham, Massachusetts; VAI; August 2017
[4]*Transportation Impact Assessment*, Needham Public Safety Facility in Needham, Massachusetts; VAI; April 2018

WEEKDAY MORNING PEAK HOUR (7:45 - 8:45 AM)



WEEKDAY EVENING PEAK HOUR (4:30 - 5:30 PM)



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Figure 3

2018 Existing Weekday Peak Hour Traffic Volumes

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PEDESTRIAN AND BICYCLE FACILITIES

A comprehensive field inventory of pedestrian and bicycle facilities within the study area was undertaken in November 2018. The field inventory consisted of a review of the location of sidewalks and pedestrian crossing locations along the study roadways and at the study intersections, as well as the location of existing bicycle facilities. In general, sidewalks are provided along the study area roadways. Crosswalks are provided at major intersection. At the signalized intersection crosswalk are provided along with pedestrian traffic signal equipment and phasing.

The Bay Colony Rail Trail is located 0.6 miles away from the project site. It provides a safe and natural facility for hiking, walking, running, biking, cross-country skiing, and other recreational activities. This trail is environmentally friendly transportation and provides a viable, safe and green transportation route. The trail extends for 7 miles through the towns of Needham, Dover and Medfield.

There are no formal existing bicycle facilities that were identified within the immediate study area; however, the traffic signal system at the signalized study intersections includes bicycle detection.

PUBLIC TRANSPORTATION

Public transportation services are provided within the study area by the Massachusetts Bay Transportation Authority (MBTA). The MBTA operates Bus Route 59, Needham Junction – Watertown Square via Newtonville, with bus stops located on Chestnut Street at the intersection of Oak Street and the intersection of Great Plain Avenue. The bus service inbound (Needham Junction to Watertown Square via Newtonville) is provided Monday through Friday from approximately 6:00 AM to 7:50 PM operating every 35 minutes, Saturday from approximately 7:05 AM to 7:05 PM and Sunday from 7:50 AM to 6:20 PM both operating every 1 hour and 30 minutes. The bus service outbound (Watertown Square via Newtonville to Needham Junction) is provided Monday through Friday from approximately 6:05 AM to 7:00 PM operating every 35 minutes, Saturday from approximately 6:20 AM to 6:20 PM and Sunday from 7:05 AM to 5:35 PM both operating every 1 hour and 30 minutes.

The MBTA provides Commuter Rail service to South Station in Boston on the Needham Line (Zone 2), with Needham Junction Station located across the street. The service is provided on weekday and Saturdays between approximately 6:00 AM to 8:00 PM.

MOTOR VEHICLE CRASH DATA

Motor vehicle crash information for the study area intersections was provided by the MassDOT Highway Division Safety Management/Traffic Operations Unit for the most recent five-year period available (2012 through 2016 inclusive) in order to examine motor vehicle crash trends occurring within the study area. The data is summarized by intersection, type, and severity, and is presented in Table 2.

Table 2
MOTOR VEHICLE CRASH DATA SUMMARY[a]

Scenario	Chestnut Street at School Street (Signalized) [e]	Chestnut Street at Oak Street (Signalized) [e]	Chestnut Street at Junction Street (Unsignalized) [d]	Chestnut Street at High Rock Street (Signalized) [e]
Year:				
2012	1	3	1	0
2013	1	2	0	0
2014	1	3	0	3
2015	1	1	1	1
2016	0	0	2	2
Total	4	9	4	6
Average[b]	0.80	1.80	0.80	1.20
Crash Rate[c]	0.15	0.35	0.20	0.24
Significant[d]	No	No	No	No
Type:				
Angle	3	4	2	0
Rear-End	1	3	0	1
Head-On	0	0	0	3
Sideswipe	0	1	0	1
Fixed Object/Animal	0	1	1	1
Unknown/Other	0	0	0	0
Total	4	9	4	6
Time of Day:				
Weekday (7:00-9:00 AM)	0	3	1	1
Weekday (4:00-6:00 PM)	2	0	0	2
Remainder of Day	2	6	3	3
Total	4	9	4	6
Lighting Conditions:				
Daylight	2	8	4	3
Dawn/Dusk	0	0	0	1
Dark (lit)	2	0	0	2
Dark (unlit)	0	0	0	0
Unknown	0	1	0	0
Total	4	9	4	6
Pavement Conditions				
Dry	2	9	3	5
Wet	2	0	1	1
Snow	0	0	0	0
Icy	0	0	0	0
Unknown (Other)	0	0	0	0
Total	4	9	4	6
Severity:				
Property Only	3	7	3	6
Injury Accident	0	2	1	0
Fatal Accident	0	0	0	0
Hit and Run	0	0	0	0
Other	1	0	0	0
Total	4	9	4	6

[a]Source: MassDOT, 2012 through 2016.
[b]Average crashes over five-year period.
[c]Crash rate per million entering vehicles (mev).
[d]Unsignalized intersections are significant if rate >0.52 crashes per million vehicles;
[e] Ssignalized intersections are significant if rate >0.71 crashes per million vehicles

As summarized in Table 2, the locations that experienced the highest number of reported collisions was at the Chestnut Street intersection with Oak Street. A total of 9 motor vehicle collisions were reported at this location over the five-year review period, averaging 1.8 accidents per year. The majority of accidents involved property damage only (7 out of 9) and occurred on dry pavement (9 out of 9) during the daylight (8 out of 9). The motor vehicle crash rate at all study area intersections fall significantly below the MassDOT average (0.52 for unsignalized and 0.71signalized intersections in District 6). These intersections were not listed on the Highway Safety Improvement Program (HSIP). No fatalities were reported at these intersections over the five-year review period.

The Motor vehicle crash records were also obtained from the Town of Needham Police Department in order to review motor vehicle crash frequencies that occurred at the site driveway. Based on review of this data, over the past five-year (2014-2018) the site driveway experienced only one (1) rear-end collisions in 2016, when a vehicle stopped to make a left turn onto the site drive. Additionally, in April of 2018, an incident at the Chestnut Street Railroad Bridge located 40-feet of the site driveway was reported. This accident involves a tractor trailer that got stuck under the bridge. Details are contained in the Technical Appendix of this report, including Needham Police reports.

SPOT SPEED MEASUREMENTS

Vehicle travel speed measurements were performed on Chestnut Street in the vicinity of the project site. Table 3 summarizes the vehicle travel speed measurements.

Table 3
VEHICLE TRAVEL SPEED MEASUREMENTS

	Chestnut Street Northbound	Chestnut Street Southbound
Mean Travel Speed (mph)	32	32
85th Percentile Speed (mph)	32	34
Posted Speed Limit (mph)	30	30

mph = miles per hour.

As can be seen in Table 3, the mean (average) vehicle travel speed at Chestnut Street, in the vicinity of the project site, was found to be approximately 32 mph in the northbound and southbound direction. The measured 85th percentile vehicle travel speed, or the speed at which 85 percent of the observed vehicles traveled above, and it was found to be approximately 32 mph in the northbound direction and 34 mph the southbound direction. The posted speed limit along Chestnut Street within site area is 30 miles per hour (mph).

FUTURE CONDITIONS

Traffic volumes in the study area were projected to the year 2025, which reflects a seven-year planning horizon consistent with State Traffic Study Guidelines. Independent of the Project, traffic volumes on the roadway network in the year 2025 under No-Build conditions include all existing traffic and new traffic resulting from background traffic growth. Anticipated Project-generated traffic volumes superimposed upon this 2025 No-Build traffic network reflect the 2025 Build conditions with the Project.

FUTURE TRAFFIC GROWTH

Future traffic growth is a function of the expected land development in the immediate area and the surrounding region. Several methods can be used to estimate this growth. A procedure frequently employed estimates an annual percentage increase in traffic growth and applies that percentage to all traffic volumes under study. The drawback to such a procedure is that some turning volumes may actually grow at either a higher or a lower rate at particular intersections.

An alternative procedure identifies the location and type of planned development, estimates the traffic to be generated, and assigns it to the area roadway network. This procedure produces a more realistic estimate of growth for local traffic. However, the drawback of this procedure is that the potential growth in population and development external to the study area would not be accounted for in the traffic projections.

To provide a conservative analysis framework, both procedures were used, the salient components of which are described below.

GENERAL BACKGROUND TRAFFIC GROWTH

Traffic-volume data compiled by MassDOT from permanent count stations and historical traffic counts in the area were reviewed in order to determine general background traffic growth trends. Based on a review of this data and other area traffic studies, it was determined that a 1.0 percent per year compounded annual background traffic growth rate was used to account for account for future traffic growth and presently unforeseen development within the study area.

SPECIFIC DEVELOPMENT BY OTHERS

The town of Needham was contacted in order to determine if there are any planned or approved specific development projects within the area that would have an impact on future traffic volumes at the study intersections. No other developments were identified that are expected to result in an increase in traffic within the study area beyond the general background traffic growth rate.

ROADWAY IMPROVEMENT PROJECTS

The Town of Needham Planning Department was contacted to identify any planned roadway improvement projects that would have an impact on the traffic operating conditions within the study area by the 2025 design year. Based on this discussion, the following roadway improvement projects were identified in the study area.

- ***Fire Department Signal Relocation*** **-** Relocation of the flashing signal and pre-emption from the existing fire station to the Chestnut Street intersection with the new fire station driveway intersection.

NO-BUILD TRAFFIC VOLUMES

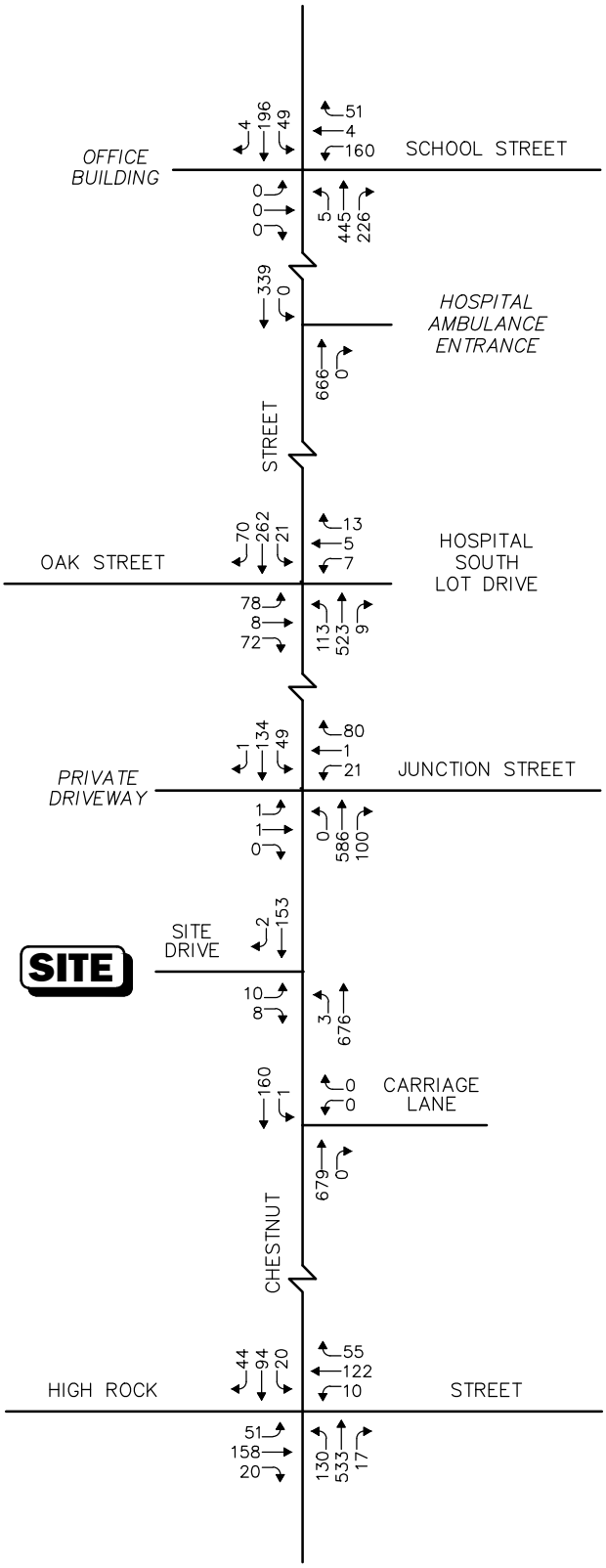
The 2025 No-Build peak-hour traffic-volume networks were developed by applying the 1.0 percent per year compounded annual background traffic growth rate to the 2018 Existing peak-hour traffic volumes. The resulting 2025 No-Build weekday morning and weekday evening peak-hour traffic volume networks are shown on Figure 4.

PROJECT-GENERATED TRAFFIC

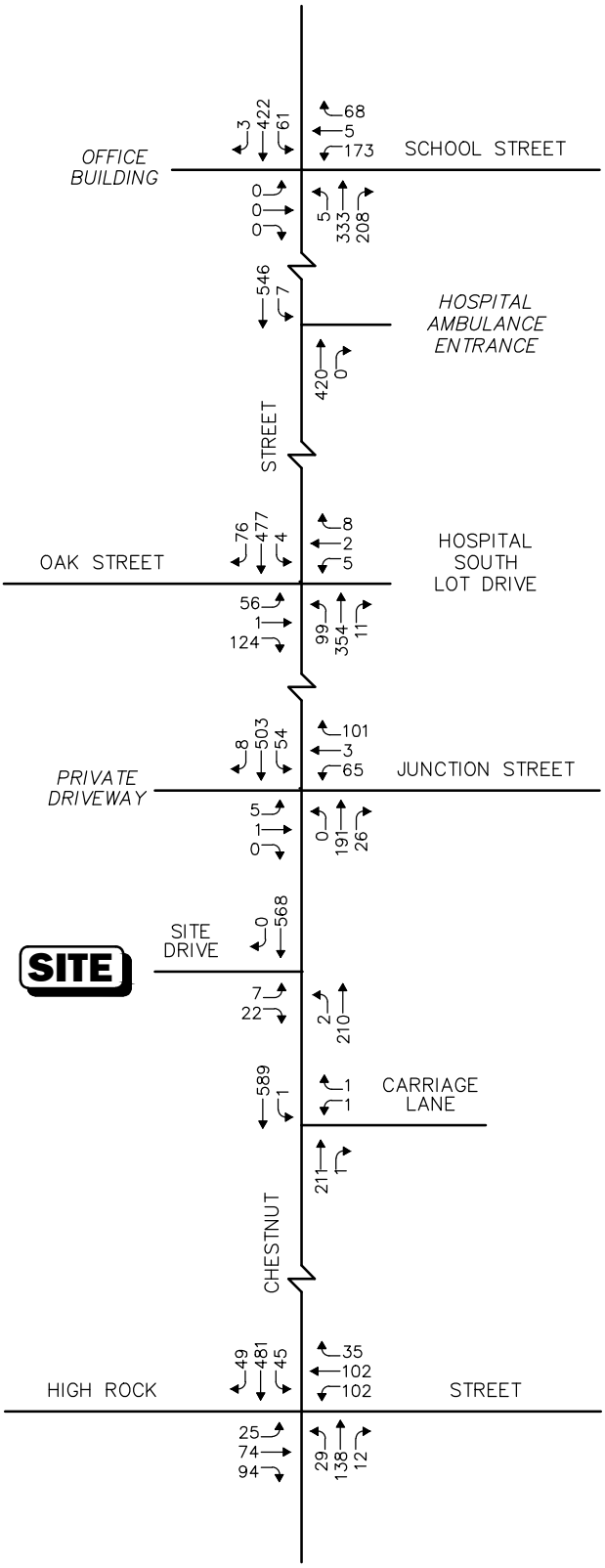
The Project will entail the construction of 150 housing units. In order to estimate the trip generation characteristics of the proposed development, the Institute of Transportation Engineers (ITE) *Trip Generation* manual[5] for a similar land use as that proposed were used. ITE Land Use Code (LUC) 220, *Multifamily Housing;* was used to develop the traffic characteristics of the Project. Trip generation calculations were performed for a typical weekday, as well as the weekday morning and weekday evening peak hours, the critical time periods for project-related traffic activity. In addition, due to the close proximity to transit services, a 15 percent transit usage was assumed based upon the US Censes Journey to Work data. A summary of the expected vehicle trip generation is summarized in Table 4.

[5]Ibid 1

WEEKDAY MORNING PEAK HOUR (7:45 - 8:45 AM)



WEEKDAY EVENING PEAK HOUR (4:30 - 5:30 PM)



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Figure 4

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2025 No-Build
Weekday
Peak Hour Traffic Volumes

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Table 4
TRIP GENERATION SUMMARY[a]

Time Period/ Directional Distribution	Vehicle Trips (150 Units)[a] (A)	Vehicle Occupancy Rate[b] (B)	Person Trips C=A x B	Transit/ Walk Trips[c] D=C x 15%	New Person Trips E=C -D	New Vehicle Trips F=E/B
Weekday Daily	816	1.03	840	126	714	694
Weekday Morning Peak Hour:						
Entering	14	1.03	14	2	12	12
Exiting	40	1.03	41	6	35	34
Total	54		55	8	47	46
Weekday Evening Peak Hour:						
Entering	40	1.03	41	6	35	34
Exiting	26	1.03	27	4	23	22
Total	66		68	10	58	56

[a]Based on ITE LUC 220, Apartments, 10th Edition.
[b]15% Non-Auto Usage – Source: US Census Journey to Work.

As shown in Table 4, the 150 housing units will approximately 693 new trips on an average weekday, with approximately 46 new vehicle trips (12 entering and 34 exiting) during the weekday morning peak hour and 56 new vehicle trips (34 entering and 22 exiting) during the weekday evening peak hour.

The proposed project will eliminate exiting trips. Table 5 depicts the net increase in traffic during the peak hours.

Table 5
PEAK HOUR TRAFFIC - NET INCREASE

Time Period/ Directional Distribution	Existing trips	New Vehicle Trips	Net Increase Over Existing Trips
Weekday Morning Peak Hour:			
Entering	5	12	7
Exiting	18	34	16
Total	23	46	23
Weekday Evening Peak Hour:			
Entering	2	34	32
Exiting	29	22	-7
Total	31	56	25

As shown in Table 5, the project will generate less than 30 vehicles trips during the peak hour or less than 1 new vehicle trip every 2 minutes.

TRIP DISTRIBUTION AND ASSIGNMENT

The directional distribution of generated trips to and from the Project site was determined based on a review of Journey-to-Work data obtained from the U.S. Census for persons residing in the Town of Needham, and then refined based on existing traffic patterns within the study area. The general trip distribution for the Project is summarized in Table 6 and graphically depicted on Figure 5. The weekday morning and weekday evening peak-hour traffic volumes expected to be generated by the Project were assigned on the study area roadway network as shown on Figure 6.

Table 6
TRIP-DISTRIBUTION SUMMARY

Roadway	Direction (To/From)	Percent
Chestnut Street	North	70%
Chestnut Street	South	5%
High Rock Street	East	20%
High Rock Street	West	5%
TOTAL		**100%**

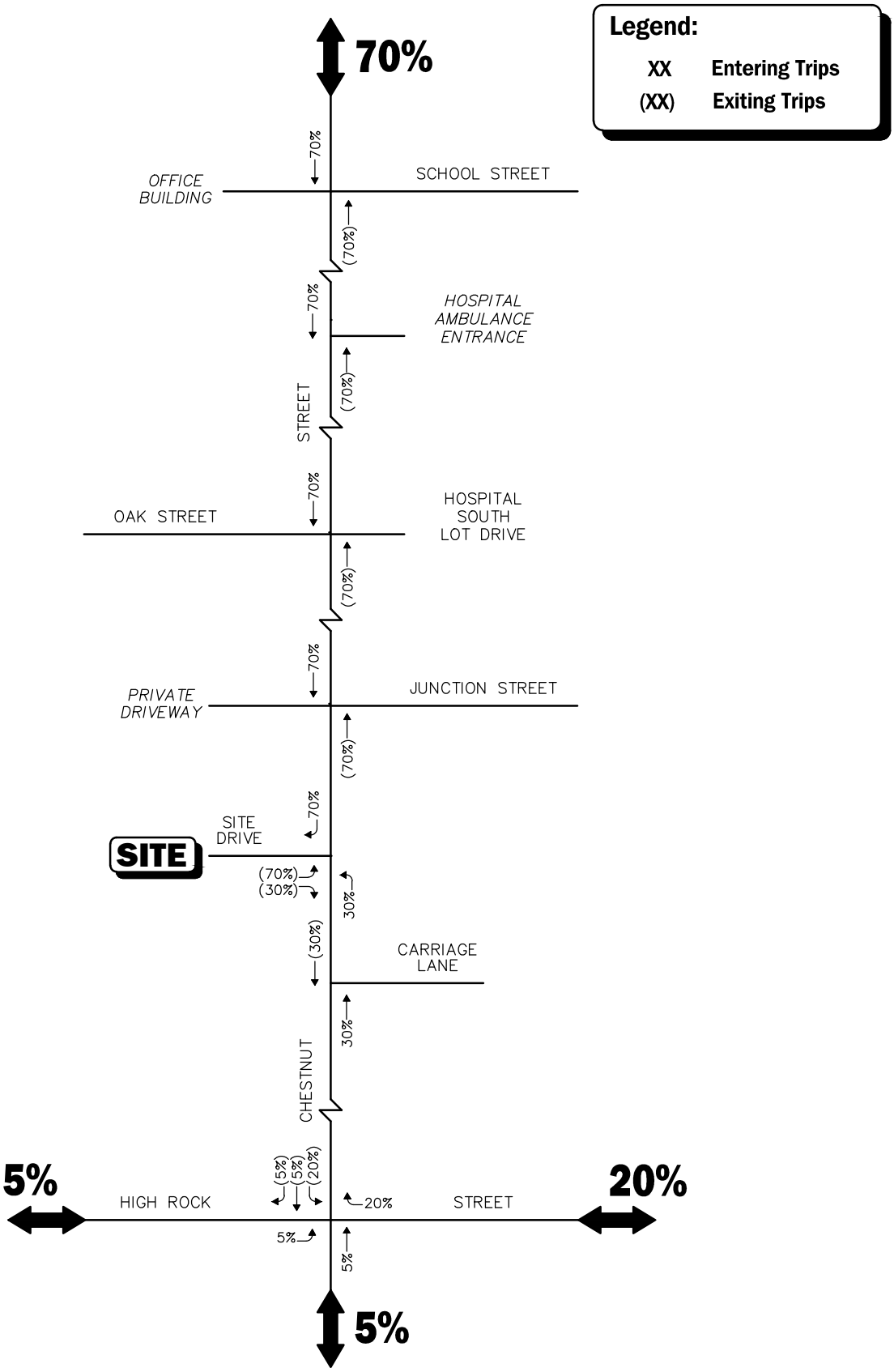
FUTURE TRAFFIC VOLUMES - BUILD CONDITION

The 2025 Build condition networks consist of the 2025 No-Build traffic volumes with the anticipated Project-generated traffic added to them. The 2025 Build weekday morning and weekday evening peak-hour traffic volume networks are graphically depicted on Figure 7.

A summary of peak-hour projected traffic-volume increases external to the study area that is the subject of this assessment is shown in Table 7. These volumes are based on the expected increases from the Project.

Table 7
PEAK HOUR TRAFFIC-VOLUME INCREASES

Location/Peak Hour	2025 No-Build	2025 Build	Traffic Volume Increase Over No-Build	Percent (Increase) Decrease
Chestnut Street North Oak Street:				
Weekday Morning	967	988	21	(2.2)
Weekday Evening	975	1,007	32	(3.3)
Chestnut Street South of Carriage Lane:				
Weekday Morning	839	841	2	(1.0)
Weekday Evening	802	795	-7	0.9



Not To Scale

Figure 5

Trip Distribution Map

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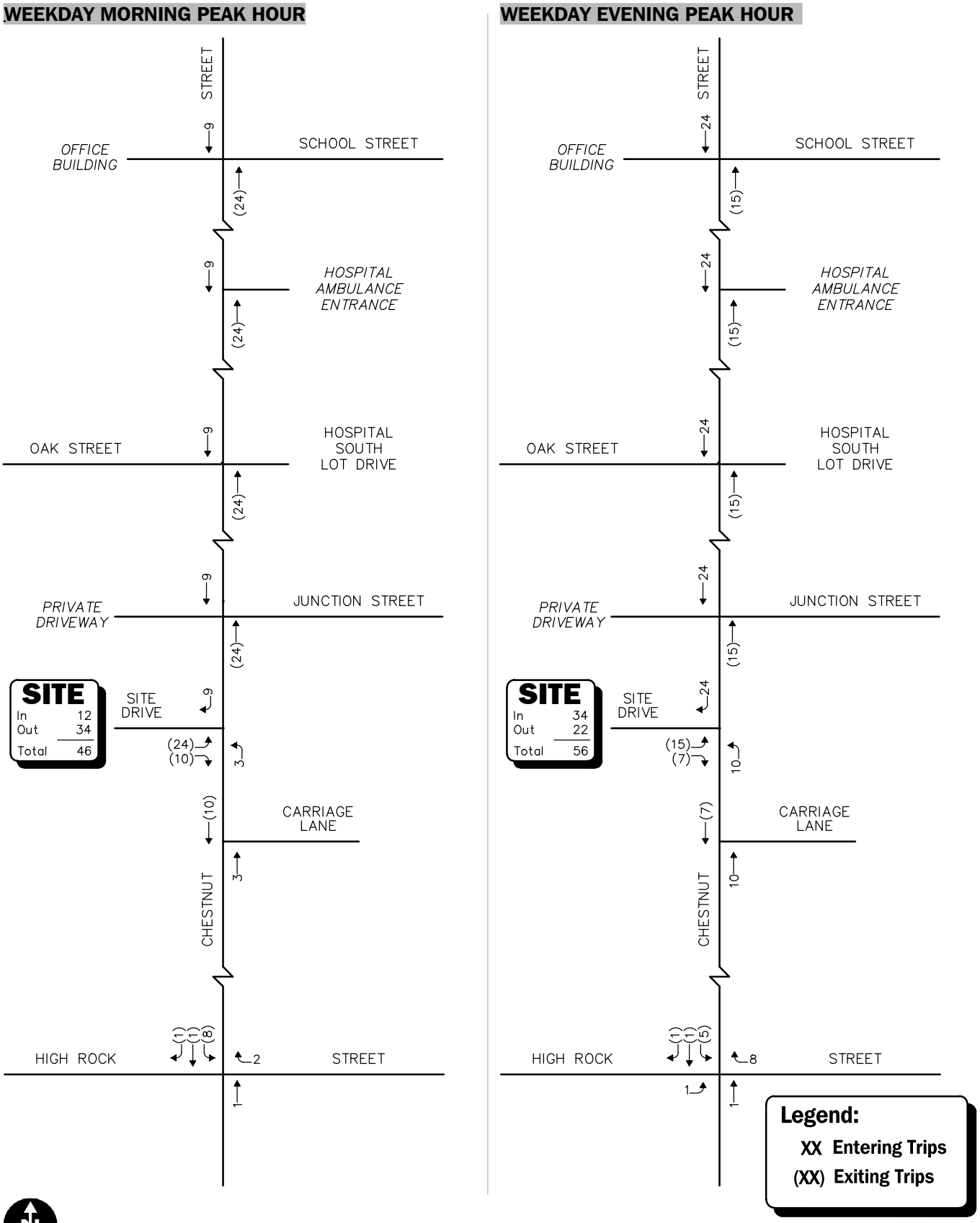

Not To Scale

Figure 6

Project-Generated Weekday Peak Hour Traffic Volumes

Vanasse & Associates, Inc.
Transportation Engineers & Planners

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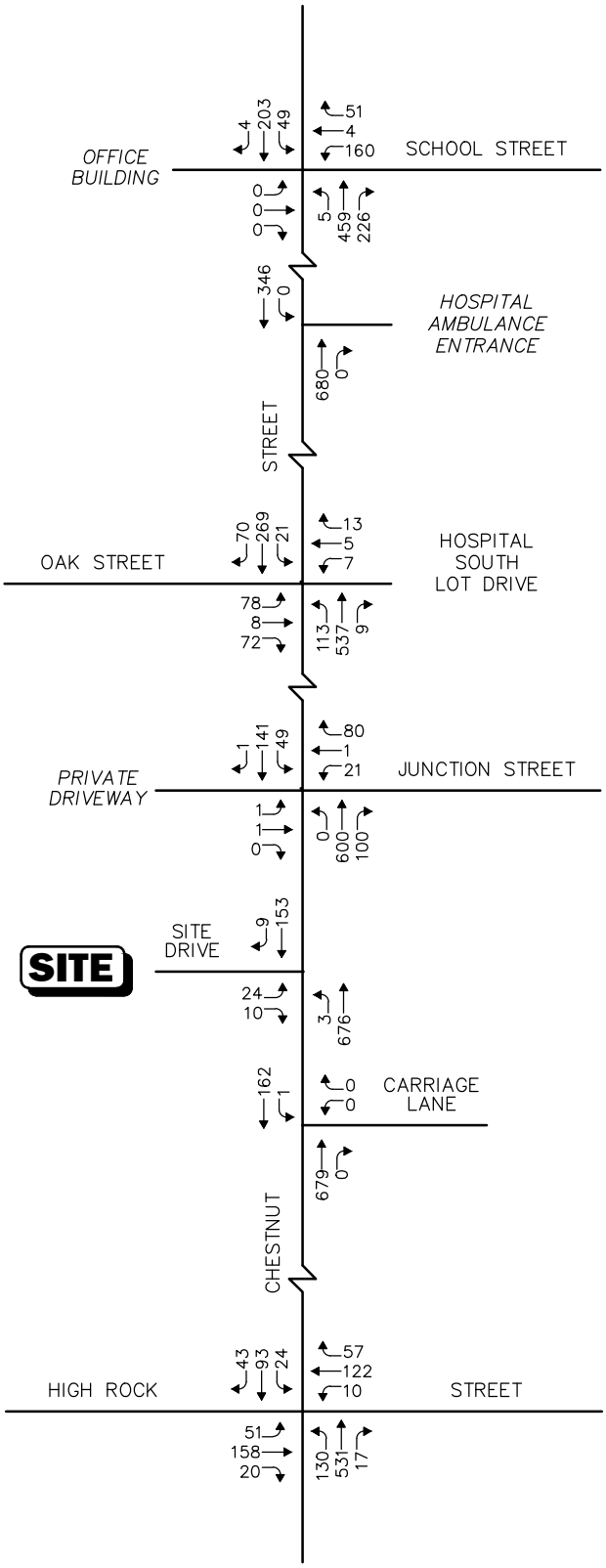
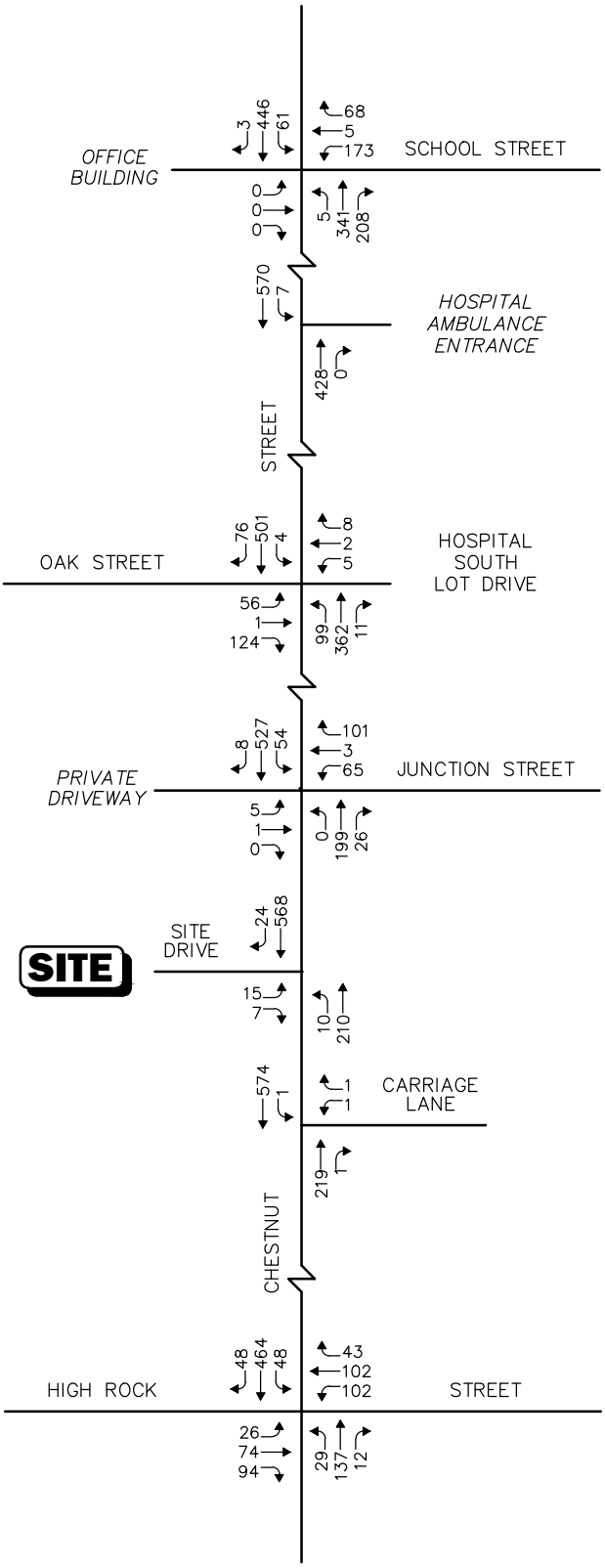
WEEKDAY MORNING PEAK HOUR (7:45 - 8:45 AM)



WEEKDAY EVENING PEAK HOUR (4:30 - 5:30 PM)



Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 7

Vanasse & Associates, Inc.
Transportation Engineers & Planners

2025 Build
Weekday
Peak Hour Traffic Volumes

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As shown in Table 6, in comparison to future No-Build conditions, project-related traffic increases are minimal, projected to range between 2 to 21 vehicles during peak hours, with traffic percent increases ranging from 1.1 percent to 3.3 percent.

SIGHT DISTANCE EVALUATION

Sight distance measurements were performed at the existing site driveway intersection with Chestnut Street in accordance with MassDOT and American Association of State Highway and Transportation Officials (AASHTO)[6] standards. In brief, SSD is the distance required by a vehicle traveling at the design speed of a roadway, on wet pavement, to stop prior to striking an object in its travel path. In accordance with AASHTO and MassDOT standards, at a minimum, sufficient stopping sight distances must be provided at an intersection. While the posted speed limit is 30 mph, the observed 85th percentile speeds were 32 mph in the northbound direction and 34 mph in the southbound direction. Table 8 presents the measured sight distances at the proposed site driveway intersecting with Chestnut Street.

Table 8
SIGHT DISTANCE MEASUREMENTS

Intersection/Sight Distance	Required Minimum (Feet) [a] 30 mph	Required Minimum (Feet) [a] 35 mph	Measured (Feet)
Chestnut Street at Site Driveway			
Exiting Sight Distance:			
Looking North	200	250	500+
Looking South	200	250	377

[a]Recommended minimum values obtained from *A Policy on Geometric Design of Highways and Streets*, Fifth Edition; American Association of State Highway and Transportation Officials (AASHTO); 2011.

As can be seen in Table 8, the available lines of sight for motorists exiting onto Chestnut Street exceeds the recommended minimum sight distance to function in a safe manner based on the appropriate approach speeds. The posted speed limit in the vicinity of the site is 30 miles per hour (mph). As shown above, a clear line of sight can be provided onto Chestnut Street from the Project site driveway. It is important to note that the existing vegetation along the site frontage must be cleared to maintain acceptable sight distances.

[6]*A Policy on Geometric Design of Highway and Streets*, 6th Edition; American Association of State Highway and Transportation Officials (AASHTO); 2011.

TRAFFIC OPERATIONS ANALYSIS

Measuring existing and future traffic volumes quantify traffic flow within the study area. To assess the quality of flow, roadway capacity and vehicle queue analyses were conducted under Existing, No-Build and Build traffic-volume conditions. Capacity analyses provide an indication of how well the roadway facilities serve the traffic demands placed upon them, with vehicle queue analyses providing a secondary measure of the operational characteristics of an intersection or section of roadway under study.

METHODOLOGY

Levels of Service

A primary result of capacity analyses is the assignment of the level of service to traffic facilities under various traffic-flow conditions. The concept of level of service is defined as a qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers. A level-of-service definition provides an index to the quality of traffic flow in terms of such factors as speed, travel time, freedom to maneuver, traffic interruptions, comfort, convenience, and safety.

Six levels of service are defined for each type of facility. They are given letter designations from A to F, with LOS A representing the best operating conditions and LOS F representing the worst.

Since the level of service of a traffic facility is a function of the traffic flows placed upon it, such a facility may operate at a wide range of levels of service, depending on the time of day, day of week, or period of year.

Signalized Intersections

The six levels of service for signalized intersections may be described as follows:

- *LOS A* describes operations with very low control delay; most vehicles do not stop at all.
- *LOS B* describes operations with relatively low control delay. However, more vehicles stop than LOS A.
- *LOS C* describes operations with higher control delays. Individual cycle failures may begin to appear. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping.
- *LOS D* describes operations with control delay in the range where the influence of congestion becomes more noticeable. Many vehicles stop and individual cycle failures are noticeable.
- *LOS E* describes operations with high control delay values. Individual cycle failures are frequent occurrences.
- *LOS F* describes operations with high control delay values that often occur with over-saturation. Poor progression and long cycle lengths may also be major contributing causes to such delay levels.

Levels of service for signalized intersections are calculated using the operational analysis methodology of the 2000 Highway Capacity Manual and implemented as a part of the Synchro® 10 software. This method assesses the effects of signal type, timing, phasing, and progression; vehicle mix; and geometrics on delay. Level-of-service designations are based on the criterion of control or signal delay per vehicle. Control or signal delay is a measure of driver discomfort, frustration, and fuel consumption, and includes initial deceleration delay approaching the traffic signal, queue move-up time, stopped delay and final acceleration delay. Table 9 summarizes the relationship between level of service and control delay. The tabulated control delay criterion may be applied in assigning level-of-service designations to individual lane groups, to individual intersection approaches, or to entire intersections.

Table 9
LEVEL-OF-SERVICE CRITERIA FOR SIGNALIZED INTERSECTIONS[a]

Level of Service	Control (Signal) Delay Per Vehicle (Seconds)
A	≤10.0
B	10.1 to 20.0
C	20.1 to 35.0
D	35.1 to 55.0
E	55.1 to 80.0
F	>80.0

[a]Source: *Highway Capacity Manual*, Transportation Research Board; Washington, DC; 2010; page 16-2.

Unsignalized Intersections

The six levels of service for unsignalized intersections may be described as follows:

- *LOS A* represents a condition with little or no control delay to minor street traffic.
- *LOS B* represents a condition with short control delays to minor street traffic.
- *LOS C* represents a condition with average control delays to minor street traffic.
- *LOS D* represents a condition with long control delays to minor street traffic.
- *LOS E* represents operating conditions at or near capacity level, with very long control delays to minor street traffic.
- *LOS F* represents a condition where minor street demand volume exceeds the capacity of an approach lane, with extreme control delays resulting.

The levels of service of unsignalized intersections are determined by application of a procedure described in the 2010 *Highway Capacity Manual*.[7] Level of service is measured in terms of average control delay. Mathematically, control delay is a function of the capacity and degree of saturation of the lane group and/or approach under study and is a quantification of motorist delay associated with traffic control devices such as traffic signals and STOP signs. Control delay includes the effects of the initial deceleration delay approaching a STOP sign, stopped delay, queue move-up time, and final acceleration delay from a stopped condition. Definitions for level of service at unsignalized intersections are also given in the 2010 *Highway Capacity Manual*. Table 10 summarizes the relationship between level of service and average control delay for two-way stop controlled and all-way stop controlled intersections.

Table 10
LEVEL-OF-SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS[a]

Level-of-Service by Volume-to-Capacity Ratio		Average Control Delay (Seconds Per Vehicle)
v/c ≤ 1.0	v/c > 1.0	
A	F	≤10.0
B	F	10.1 to 15.0
C	F	15.1 to 25.0
D	F	25.1 to 35.0
E	F	35.1 to 50.0
F	F	>50.0

[a]Source: *Highway Capacity Manual*; Transportation Research Board; Washington, DC; 2010; page 19-2.

[7]*Highway Capacity Manual*; Transportation Research Board; Washington, DC; 2010.

ANALYSIS RESULTS

Level-of-service and vehicle queue analyses were conducted for 2018 Existing, 2025 No-Build and 2025 Build conditions for the intersections within the study area. The results of the intersection capacity and vehicle queue analyses are summarized for signalized intersections in Table 11 and for unsignalized intersections in Table 12, with the detailed analysis results presented in the Appendix. The following is a summary of the level-of-service and delay analyses for the intersections within the study area:

Signalized Intersections

Chestnut Street at School Street

Under all conditions, the critical movements at this signalized intersection operates at LOS C during the weekday morning and evening peak hours peak hour. The project impact on queues and delays will be minimal.

Chestnut Street at Oak Street

Under all conditions, the critical movements at this signalized intersection operates at LOS B during the weekday morning and evening peak hours peak hour. The project impact on queues and delays will be minimal.

Chestnut Street at High Rock Street

Under all conditions, the critical movements at this signalized intersection operates at LOS C during the weekday morning and evening peak hours peak hour. The project impact on queues and delays will be minimal.

Unsignalized Intersections

Chestnut Street at Hospital emergency entrance

Under all conditions, the critical movements at this unsignalized intersection operates at LOS A during the weekday morning and evening peak hours peak hour. The project impact on queues and delays will be minimal.

Chestnut Street at Junction Street

Under existing condition, the critical movements at this unsignalized intersection operates at LOS C during the weekday morning and evening peak hours. Under future conditions, the critical movements at this unsignalized intersection (Left-Turns onto Chestnut Street) operates at LOS D during the weekday morning and evening peak hours. This is typical of a Main Street unsignalized location. It is noteworthy that the LOS remains the same under the future no-build and build conditions. The project impact on queues and delays will be minimal.

Chestnut Street at Site Drive

Under existing condition, the critical movements at this unsignalized intersection operates at LOS B during the weekday morning and evening peak hours. Under no-build condition, the critical movements at this unsignalized intersection operates at LOS B during the weekday morning and at LOS C during the weekday evening peak hours. Under build conditions, the critical movements at this unsignalized intersection operates at LOS C during the weekday morning and evening peak hours. This is acceptable for a driveway with delays exiting the property.

Chestnut Street at Carriage Lane

Under existing condition, the critical movements at this unsignalized intersection operates at LOS A during the weekday morning and evening peak hours. Under future conditions, the critical movements at this unsignalized intersection (Left-Turns onto Chestnut Street) operates at LOS A during the weekday morning and at LOS A during weekday evening peak hours. It is noteworthy that the LOS remains the same under the future no-build and build conditions. The project impact on queues and delays will be minimal.

Table 11
SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

Signalized Intersection/Peak-hour/Movement	2018 Existing V/C[a]	2018 Existing Delay[b]	2018 Existing LOS[c]	2018 Existing Queue[d] 50th/95th	2025 No-Build V/C	2025 No-Build Delay	2025 No-Build LOS	2025 No-Build Queue 50th/95th	2025 Build V/C	2025 Build Delay	2025 Build LOS	2025 Build Queue 50th/95th
Chestnut Street at School Street												
Weekday Morning:												
School Street WB TH LT	0.86	68.2	E	105/212	0.90	75.0	E	114/231	0.90	75.0	E	114/231
School Street WB RT	0.13	28.6	C	25/52	0.14	28.4	C	26/55	0.14	28.4	C	26/55
Chestnut Street NB RT	0.01	7.4	A	1/3	0.01	7.4	A	1/3	0.01	7.2	A	1/3
Chestnut Street NB TH LT	0.83	25.3	C	282/653	0.89	30.5	C	320/710	0.91	32.3	C	334/726
Chestnut Street SB LT	0.20	27.4	C	6/36	0.25	32.4	C	6/37	0.27	34.0	C	6/37
Chestnut Street SB TH RT	0.19	8.0	A	25/115	0.21	8.2	A	27/123	0.21	8.3	A	28/127
Overall	**0.69**	**28.5**	**C**	--	**0.74**	**32.9**	**C**	--	**0.75**	**33.9**	**C**	--
Weekday Evening:												
School Street WB TH LT	0.85	58.0	E	100/203	0.88	64.2	E	108/221	0.88	64.2	E	108/221
School Street WB RT	0.15	24.2	C	27/56	0.16	24.0	C	30/60	0.16	24.0	C	30/60
Chestnut Street NB RT	0.02	8.1	A	1/4	0.02	8.2	A	1/4	0.02	8.2	A	1/4
Chestnut Street NB TH LT	0.67	16.6	B	197/504	0.73	18.5	B	218/554	0.74	18.8	B	223/565
Chestnut Street SB LT	0.17	17.4	B	7/44	0.20	19.8	B	8/46	0.21	20.3	C	8/46
Chestnut Street SB TH RT	0.40	8.3	A	62/269	0.43	8.7	A	68/293	0.46	8.9	A	73/315
Overall	**0.65**	**20.0**	C	--	**0.70**	**21.9**	C	--	**0.71**	**21.9**	C	--
Chestnut Street at Oak Street and Hospital South Parking Lot												
Weekday Morning												
Oak Street EB LT/TH/RT	0.63	39.6	D	97/147	0.66	40.4	D	104/154	0.66	40.4	D	104/157
Hospital Parking Lot WB LT/TH/RT	0.09	31.6	C	14/36	0.09	31.1	C	14/36	0.09	31.1	C	14/36
Chestnut Street NB LT	0.19	7.6	A	16/72	0.21	8.0	A	18/76	0.21	8.1	A	18/76
Chestnut Street NB TH/RT	0.50	11.1	B	103/369	0.54	12.0	B	118/407	0.55	12.2	B	123/423
Chestnut Street SB LT/TH	0.33	11.1	B	38/159	0.36	11.7	B	41/167	0.37	11.7	B	43/169
Chestnut Street SB RT	0.09	10.2	B	9/48	0.10	10.7	B	10/51	0.10	10.8	B	10/50
Overall	**0.51**	**15.3**	**B**	--	**0.55**	**15.9**	**B**	--	**0.56**	**16.0**	**B**	--
Weekday Evening												
Oak Street EB LT/TH/RT	0.66	36.5	D	98/156	0.69	37.3	D	104/167	0.69	37.3	D	104/167
Hospital Parking Lot WB LT/TH/RT	0.05	27.4	C	7/23	0.05	27.0	C	7/23	0.05	27.0	C	7/23
Chestnut Street NB LT	0.22	15.3	B	14/60	0.26	17.2	B	16/64	0.27	18.2	B	16/64
Chestnut Street NB TH/RT	0.36	9.6	A	61/213	0.39	10.2	B	69/231	0.39	10.3	B	72/237
Chestnut Street SB LT/TH	0.59	18.8	B	82/419	0.64	19.9	B	107/453	0.67	20.6	C	122/490
Chestnut Street SB RT	0.11	15.2	B	12/77	0.12	15.4	B	13/81	0.12	15.5	B	14/82
Overall	**0.54**	**18.5**	**B**	--	**0.58**	**19.4**	**B**	--	**0.60**	**19.7**	**B**	--

See Table Below

Table 11 (continued)
SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

	2018 Existing				2025 No-Build				2025 Build			
Signalized Intersection/Peak-hour/Movement	V/C[a]	Delay[b]	LOS[c]	Queue[d] 50th/95th	V/C	Delay	LOS	Queue 50th/95th	V/C	Delay	LOS	Queue 50th/95th
Chestnut Street at High Rock Street												
Weekday Morning:												
High Rock Street EB LT TH RT	0.67	29.3	C	96/182	0.71	30.5	C	105/196	0.71	30.7	C	105/192
High Rock Street WB LT TH RT	0.42	23.9	C	61/137	0.44	23.8	C	67/148	0.44	23.9	C	67/145
Chestnut Street NB LT TH RT	0.67	14.3	B	130/590	0.73	16.9	B	156/666	0.72	16.4	B	156/642
Chestnut Street SB LT TH RT	0.32	23.5	C	42/137	0.36	24.6	C	47/146	0.37	24.9	C	48/147
Overall	**0.70**	**20.1**	**C**	--	**0.76**	**21.8**	**C**	--	**0.71**	**21.7**	**C**	--
Weekday Evening:												
High Rock Street WB LT TH RT	0.41	23.2	C	60/125	0.42	22.8	C	66/133	0.42	22.7	C	68/137
High Rock Street EB LT TH RT	0.73	32.6	C	95/205	0.74	32.3	C	104/217	0.74	31.8	C	108/229
Chestnut Street NB LT TH RT	0.43	26.8	C	59/165	0.48	29.0	C	69/174	0.48	29.3	C	70/176
Chestnut Street SB LT TH RT	0.54	12.7	B	117/391	0.59	14.8	B	150/419	0.58	14.9	B	150/417
Overall	**0.63**	**21.0**	C	--	**0.67**	**22.1**	C	--	**0.66**	**22.2**	C	--

[a]Volume-to-capacity.ratio
[b]Delay in seconds per vehicle.
[c]Level of service.
[d]Queue length, in feet.
NB = northbound; SB = southbound; EB = eastbound; WB = westbound; LT = left-turning movements; TH = through movements; RT = right-turning movements.

Table 12
UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

	2018 Existing				2025 No-Build				2025 Build			
Unsignalized Intersection/ Peak Hour/Movement	Demand[a]	Delay[b]	LOS[c]	Queue 95th Percentile[d]	Demand	Delay	LOS	Queue 95th Percentile[d]	Demand	Delay	LOS	Queue 95th Percentile[d]
Chestnut Street at Hospital Emergency Drive												
Weekday Morning:												
Chestnut Street SB TH LT	0	0	A	0	0	0	A	0	0	0	A	0
Weekday Evening:												
Maple Street WB LT RT	7	0.2	A	1	7	0.2	A	1	7	0.2	A	1
Chestnut Street at Junction Street and Private Drive												
Weekday Morning:												
Private Driveway EB LT TH RT	2	22.8	C	1	2	25.3	D	1	2	26.0	D	1
Junction Street WB LT TH RT	86	17.8	C	30	102	19.6	C	36	102	20.2	C	37
Chestnut Street SB LT TH RT	162	2.9	A	5	184	3.0	A	5	191	3.0	A	5
Weekday Evening:												
Private Driveway EB LT TH RT	6	24.4	C	3	6	31.4	D	4	6	34.0	D	5
Junction Street WB LT TH RT	158	18.7	C	51	198	29.7	D	104	198	33.4	D	116
Chestnut Street SB LT TH RT	527	1.2	A	3	565	1.3	A	4	589	1.2	A	4
Chestnut Street at Site Driveway												
Weekday Morning:												
Site Driveway WB LT RT	18	13.9	B	4	18	14.9	B	5	34	15.3	C	10
Weekday Evening:												
Site Driveway WB LT RT	29	14.4	B	7	29	15.1	C	8	22	16.3	C	7
Chestnut Street at Carriage Lane												
Weekday Morning:												
Carriage Lane LT RT	0	0	A	0	0	0	A	0	0	0	A	0
Chestnut Street SB LT	1	0.1	A	0	1	0.1	A	0	1	0.1	A	0
Weekday Evening:												
Carriage Lane LT RT	2	12.3	A	0	2	12.8	B	0	2	12.7	B	0
Chestnut Street SB LT	1	0	A	0	1	0	A	0	1	0	A	0

[a] Demand in vehicles per hour.
[b] Control delay per vehicle in seconds.
[c] Level-of-Service.
[d] Queue 95th Percentile(Vehicle)
NB = northbound; SB = southbound; EB = eastbound; WB = westbound;
LT = left-turning movements; TH = through movements; RT = right-turning movements.

CONCLUSIONS AND RECOMMENDATIONS

Vanasse & Associates, Inc. (VAI) has prepared this Transportation Impact Assessment (TIA) in order to evaluate the potential traffic impacts associated with the proposed residential development to be located at 433 Chestnut Street in Needham, Massachusetts (the "Project"). The Project will consist of the development of 150 housing units with a total of approximately 225 parking spaces. Access to the Project will be provided by way of one full access driveway onto Chestnut Street.

This study was prepared in consultation with the Town of Needham and in accordance with the Massachusetts Department of Transportation (MassDOT) Guidelines for *Transportation Impact Assessment (TIA) Guideline;* and was conducted pursuant to the standards of the Traffic Engineering and Transportation Planning Professions for the preparation of such reports. Based on the results of this study, the following can be concluded:

- Using trip-generation statistics published by the Institute of Transportation Engineers (ITE) [8], the Project is expected to generate approximately 23 new vehicle trips (7 entering and 16 exiting) during the weekday morning peak hour and 25 new vehicle trips (32 entering and -7 exiting) during the weekday evening peak hour.

- The removal of the existing business will result in a significant reduction in trucks on the local streets.

- Project-related traffic increases in the area are expected to be between 1.1 percent to 3.3 percent during the peak hours.

- The analysis has indicated that the Project will result in minimal impact on motorist delays at the study intersections, as compared to future No-Build conditions.

- The site driveway provides ample sight lines and will provide safe access and egress to the development.

- Accident data provided by the Needham Police Department indicates safe operation of the existing driveway.

In consideration of the above, we have concluded that the Project can be accommodated within the confines of the existing transportation infrastructure in a safe and efficient manner with the implementation of the following recommendations.

[8] *Ibid 1*

RECOMMENDATIONS

The following improvements have been recommended, as part of this evaluation, to provide safe and efficient access to the Project.

Project Access

Access to the Project is proposed by way of existing full access onto Chestnut Street. It is recommended that the site access driveway, be placed under STOP-sign control, with illumination provided. Signs and landscaping adjacent to the Project driveway and within the Project site should be designed and maintained so as not to restrict lines of sight. All signs and other pavement markings to be installed should conform to the specifications of the Manual on Uniform Traffic Devices (MUTCD).[9.]

Travel Demand Management (TDM) Plan

Reducing the amount of traffic generated by the Project is an important component of the development plan. The goal of the TDM plan is to reduce the use of Single Occupant Vehicles by encouraging car/vanpooling, bicycle commuting, the use of public transportation and pedestrian travel. The following measures will be implemented as part of the proposed project management team in an effort to reduce the number of vehicle trips generated:

- In order to encourage the use of public transportation, the property management team will make available public transportation schedules, which will be posted in a centralized location for residents.

- In order to encourage car/vanpooling, the property management team will identify car/vanpool resources that may be available to residents of the proposed project. This information will be posted in a centralized location for the residents.

- The property management team will provide information on available pedestrian and bicycle facilities in the vicinity of the project site. This information will be posted in a centralized location.

- Bicycle racks and a bicycle "Fix-it" station will be provided on-site.

The above strategies will encourage non-auto travel by the residents.

CONCLUSIONS

As documented in this study, project-related traffic increases will not result in significant increases in overall traffic volumes or traffic delays within the study area. The project-related traffic can be adequately accommodated within the existing infrastructure with minimal impact on the traffic operations. The site driveway will provide safe access and egress to the development, as planned.

[9] *Ibid 2*