Transportation Impact Assessment

Proposed Residential Development

Milton, Massachusetts

Prepared for:

Northland Residential Corporation
Concord, Massachusetts

Vanasse & Associates, Inc.
Transportation Engineers & Planners
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TRANSPORTATION IMPACT ASSESSMENT

PROPOSED RESIDENTIAL DEVELOPMENT
MILTON, MASSACHUSETTS

Prepared for:

Northland Residential Corporation
Concord, Massachusetts

September 2018

Prepared by:

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EXECUTIVE SUMMARY

Vanasse & Associates, Inc. (VAI) has conducted a Transportation Impact Assessment (TIA) to determine the potential traffic impacts associated with the development of a 54-unit age-restricted residential townhouse project located at 1672 Canton Avenue, in Milton Massachusetts. As part of this report, existing traffic operating parameters on key roadways and intersections are reported within the study area, the anticipated traffic-volume increases and traffic-related impacts are computed and analyzed, and site access and egress requirements are also evaluated.

The analyzed proposal entails the construction of 54 age-restricted homes, located at 1672 Canton Avenue, north of Brush Hill Road. Access to the project site will be located on Canton Avenue approximately 1,600 feet north of the Blue Hill Avenue intersection. Based upon the analysis, the following is concluded:

- The anticipated development will not have a significant increase on motorist delays or vehicle queuing along the study area roadways.

- No apparent safety deficiencies are expected at the study intersections.

- The project is expected to generate 386 new vehicle trips (193 entering and 193 exiting) on a weekday. The proposed project will generate 28 trips during the weekday morning peak hour (12 trips entering and 16 trips exiting) and 29 trips in the evening peak hour (16 trips entering and 13 trips exiting).

- Overall safe on-site circulation and access/egress can be achieved within the project as planned.

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

RECOMMENDATIONS

A transportation improvement program has been developed that is designed to provide safe and efficient access and egress to the area. The following improvements are recommended as a part of this evaluation and, where applicable, will be completed subject to receipt of all necessary rights, permits, and approvals.

Project Access

The project will be accessed from one full-access site drive located on Canton Avenue and an emergency access drive across the existing Manor House access driveway. In addition, one emergency access drive will be located to the north of the main site drive.

- The Site Drive should be a minimum of 22-feet in width and accommodate two-way traffic.
- Vehicles exiting the Project site should be placed under STOP-sign control with a marked STOP-line provided. In addition, a centerline will be striped 100 feet back from Canton Avenue.
- All signs and pavement markings to be installed within the Project site shall conform to the applicable standards of the *Manual on Uniform Traffic Control Devices* (MUTCD).[1]
- Signs and landscaping to be installed along the Project site driveways should be designed and maintained so as not to restrict lines of sight.
- In coordination with the Town Traffic Commission, the project proponent has agreed to install speed radar signs, pavement markings, and signage along Canton Avenue to reduce overall speeds and improve safely conditions.
- The project proponent, working with the Town, MassDOT, and the Boston Regional Metropolitan Planning Organization will support and participate in the proposed Route 138 Corridor improvements.

With the above mentioned recommendations, safe and efficient access and egress can be provided at the site, with minimal impact on the study area roadways.

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

INTRODUCTION

Vanasse & Associates, Inc. (VAI) has conducted a Transportation Impact Assessment (TIA) to determine the potential traffic impacts associated with the construction of a 54-unit age-restricted project at 1672 Canton Avenue, in Milton Massachusetts. As part of this report, existing traffic operating parameters on key roadways and intersections are reported within the study area, the anticipated traffic-volume increases and traffic-related impacts are analyzed, and site access and egress requirements are evaluated.

As documented in this report, project-related traffic increases are not projected to result in a significant impact to area traffic operations during peak hours of project-related traffic.

PROJECT DESCRIPTION

The project entails the development of 54 age-restricted homes, located at 1672 Canton Avenue, north of Brush Hill Road. Access to the project site will be located on Canton Avenue approximately 1,600 feet north of the Blue Hill Avenue intersection. The project will be accessed from one full-access site drive located on Canton Avenue and an emergency access drive across the existing Manor House driveway. In addition, one emergency access drive will be located to the north of the main site drive. Figure 1 depicts the project location in relation to the existing roadway network.

STUDY METHODOLOGY

This study was performed in accordance with Executive Office of Energy and Environmental Affairs/Executive Office of Transportation (EEA/EOT) guidelines for the preparation of traffic impact assessments, and was conducted in three distinct stages. The first stage involved an assessment of existing traffic conditions in the study area and included an inventory of roadway geometrics, observations of traffic flow, 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. The traffic analysis conducted in stage two identifies existing or projected future roadway capacity and traffic safety 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.

Figure 1

Site Location Map

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EXISTING CONDITIONS

A comprehensive field inventory of existing conditions within the study area was conducted in May 2018. The field investigation consisted of an inventory of existing roadway geometrics; pedestrian and bicycle facilities; traffic volumes; and operating characteristics; as well as posted speed limits and land use information within the study area. The study area for the project contains the major roadway which provides access to the project, Canton Avenue. Specifically, the study area includes the following intersections located along these roadways which are expected to accommodate the majority of project-related traffic.

- Canton Avenue at Hemlock Drive
- Canton Avenue at Brush Hill Road
- Blue Hill Avenue at Brush Hill Road
- Blue Hill Avenue at Canton Avenue
- Washington Street at Royall Street/Blue Hill River Road
- Washington Street at Royall Avenue

It should be noted that the Route 138 corridor is subject to a study by MassDOT in order to improve safety, improve efficiency, and manage capacity. The project is in the study and design stages and is fully funded for 2020 construction.

GEOMETRY

Roadways

Canton Avenue

Within the study area, Canton Avenue is a two-lane roadway under local jurisdiction that traverses the study area in a general north-south direction. Canton Avenue provides one 12-foot wide travel lane per direction separated by a double yellow centerline. The posted speed limit along Canton Avenue within the study area is 30 miles per hour (mph), with land use consisting primarily of residential and recreational properties.

Intersections

Figure 2 graphically depicts the Existing Lane Use and Travel Lanes Widths.

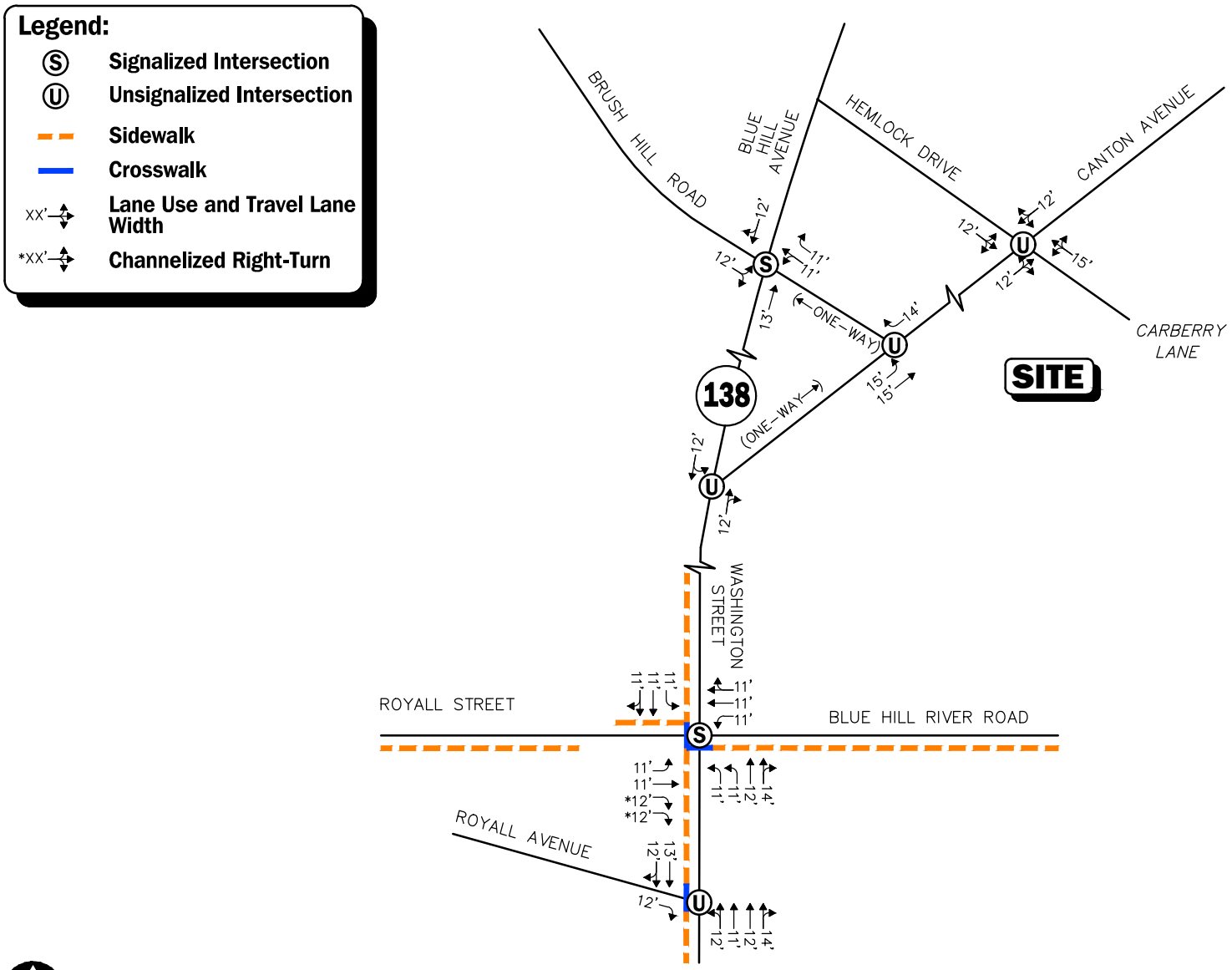

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Figure 2

Existing Intersection Lane Use, Travel Lane Width and Pedestrian Facilities

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EXISTING TRAFFIC VOLUMES

In order to establish existing traffic-volume demands and flow patterns within the study area, manual turning movement counts (TMCs) and vehicle classification counts were completed in May 2018 during the weekday morning (7:00 to 9:00 AM) and weekday evening (4:00 to 6:00 PM) time periods at each of the study area intersections. These time periods correspond to the peak hours of residential commuter traffic. Automatic traffic recorder (ATR) counts were also completed on Canton Avenue, in the vicinity of the project site, in order to record weekday traffic conditions over an extended time period.

Seasonal Adjustment

Based on a review of MassDOT data, May traffic volumes are typically 3 percent higher than average annual conditions and therefore represent a conservative analysis scenario. A review of the peak-period traffic counts indicates that the weekday morning peak hour generally occurs between 7:45 and 8:45 AM, with the weekday evening peak hour generally occurring between 5:00 and 6:00 PM. In all instances individual peak hour traffic volumes for each intersection were utilized for analysis purposes.

A summary of existing daily traffic volumes is provided in Table 1 and graphically depicted in Figure 3.

Table 1
EXISTING ROADWAY TRAFFIC-VOLUME SUMMARY

Location	Weekday Daily Volume (vpd)[a]	Weekday Morning Peak Hour			Weekday Evening Peak Hour		
		Volume (vph)[b]	Percent of Daily Traffic[c]	Predominant Flow[d]	Volume (vph)	Percent of Daily Traffic	Predominant Flow
Canton Avenue, south of Carberry Lane	6,000	499	8.3	73% NB	652	10.9	56% NB

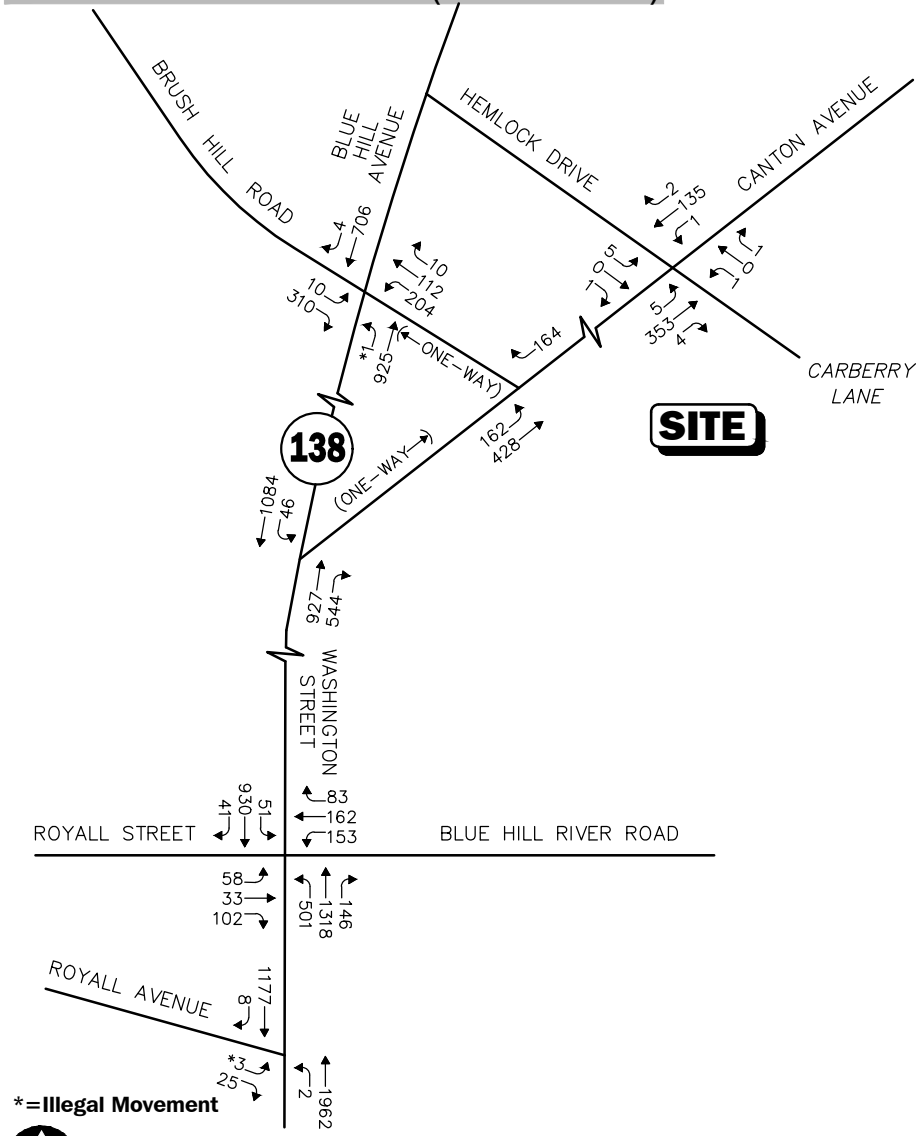
Source: ATR and TMC counts conducted in April 2018 and May 2018, respectively.
[a]Two-way daily traffic expressed in vehicles per day.
[b]Two-way peak-hour volume expressed in vehicles per hour.
[c]The percent of daily traffic that occurs during the peak hour.
[d]NB = northbound.

As presented in Table 1, under 2018 Existing conditions, Canton Avenue was found to accommodate approximately 6,000 vehicles on an average weekday, with approximately 499 vehicles per hour (vph) during the weekday morning peak hour and 652 vph during the weekday evening peak hour.

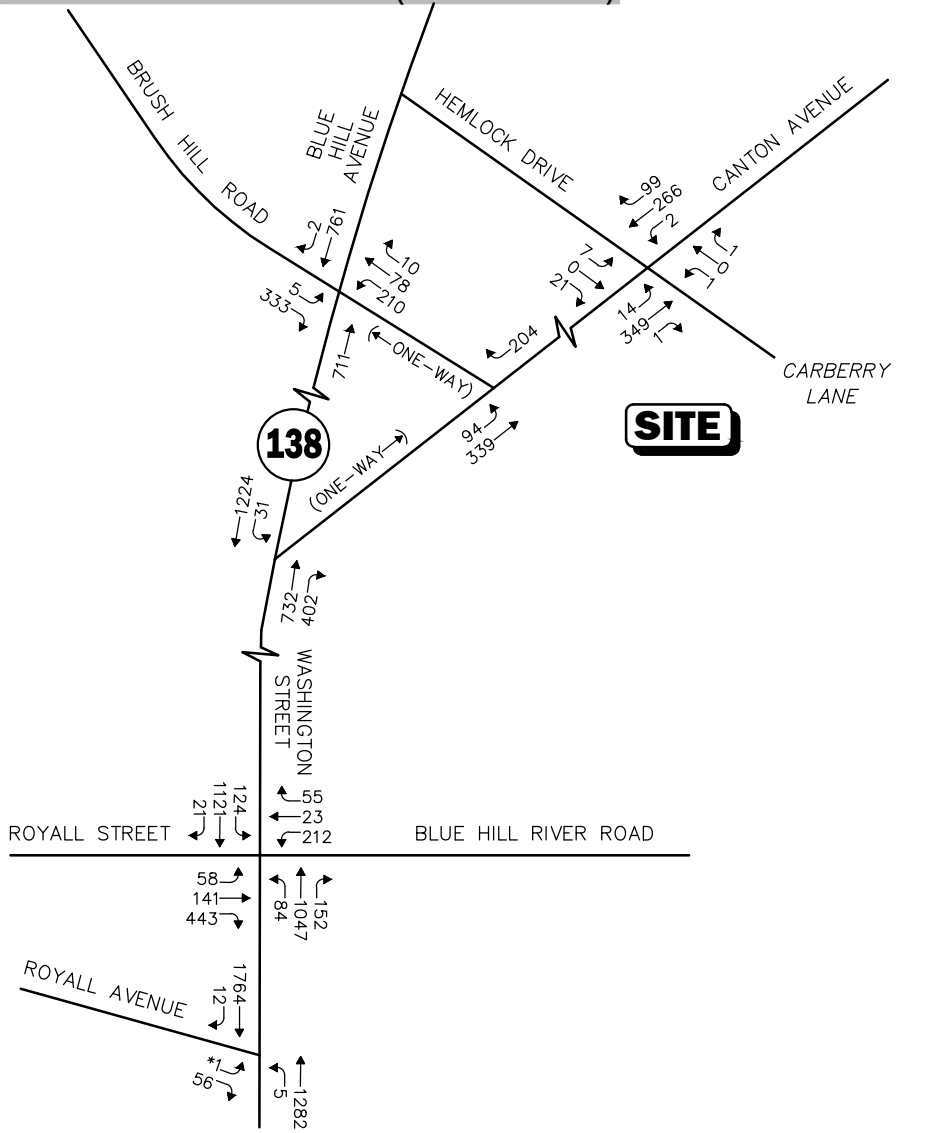
PEDESTRIAN AND BICYCLE FACILITIES

A comprehensive field inventory of pedestrian and bicycle facilities within the study area was undertaken in May 2018. The field inventory consisted of a review of the location of sidewalks and

WEEKDAY MORNING PEAK HOUR (7:00 - 9:00 AM)



WEEKDAY EVENING PEAK HOUR (4:00 - 6:00 PM)



*=Illegal Movement

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

Not To Scale

Figure 3

2018 Existing
Weekday
Peak Hour Traffic Volumes

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pedestrian crossing locations along the study roadways and at the study intersections, as well as the location of existing and planned future bicycle facilities. In general, sidewalks are provided along Washington Street, Blue Hill River Road, and Royall Street, with crosswalk and pedestrian traffic signal equipment and phasing provided at the signalized intersection of Washington Street at Blue Hill River Road and Royall Street. Bicycle lanes are located on Washington Street, which becomes Blue Hill Avenue.

PUBLIC TRANSPORTATION

At present, no public transportation facilities were identified within the immediate study area.

SPOT SPEED MEASUREMENTS

Vehicle travel speed measurements were performed on Canton Avenue in the vicinity of the Project site in conjunction with the ATR counts. Table 2 summarizes the vehicle travel speed measurements.

Table 2
VEHICLE TRAVEL SPEED MEASUREMENTS

	Canton Avenue	
	Northbound	Southbound
Mean Travel Speed (mph)	38	34
85th Percentile Speed (mph)	43	41
Posted Speed Limit (mph)	30	30

mph = miles per hour.

As can be seen in Table 2, the mean (average) vehicle travel speed along Canton Avenue in the vicinity of the Project site was found to be approximately 38 mph in the northbound direction and 34 mph in the southbound direction. The measured 85th percentile vehicle travel speed, or the speed at which 85 percent of the observed vehicles traveled at or below, was found to be approximately 43 mph in the northbound direction and 41 mph in the southbound direction. The 85th percentile speed is used as the basis of engineering design and in the evaluation of sight distances, and is often used in establishing posted speed limits. Overall, travel speeds were observed to be consistently above the posted speed limit.

MOTOR VEHICLE CRASH SUMMARY

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 (2011 through 2015) in order to examine motor vehicle crash trends occurring within the study area. MassDOT's average motor vehicle crash rates for signalized and unsignalized

intersections in District 6 are 0.76 and 0.58, respectively. The data is summarized by intersection, type, severity, and day of occurrence, and presented in Table 3.

As can be seen in Table 3, the location that experienced the greatest number of motor vehicle collisions over the last five years of available data was the intersection of Washington Street at Blue Hill River Road and Royall Street. Over the five-year review period a total of 62 motor vehicle collisions were reported at this location, the majority of which involved rear-end collisions. The majority of collisions at this location resulted in property damage only, with no reported fatalities over the five-year review period. It should be noted that this intersection is classified as a MassDOT HSIP Cluster 2011 – 2013, however, the crash rate at this location is lower than the state and district averages for signalized intersections.

For the remaining study area intersections significantly fewer motor vehicle collisions were reported with all locations experiencing less than 5 collusions per year on average and all locations exhibiting crash rates that fall below the MassDOT average crash rate for this District.

Table 3
MOTOR VEHICLE CRASH DATA SUMMARY[a]

	Blue Hill Ave./ Brush Hill Rd.	Canton Ave./ Brush Hill Rd.	Canton Ave./ Hemlock Dr.	Canton Ave./ Blue Hill Ave.	Washington St./ Blue Hill River Rd./ Royall St.	Washington St./ Royall St.
Year:						
2011	2	2	0	5	12	3
2012	6	3	0	4	9	4
2013	3	1	1	5	13	1
2014	4	0	0	2	16	5
2015	3	0	2	7	12	6
Total	18	6	3	23	62	19
Average	3.6	1.20	0.60	4.60	10.4	3.4
Rate[b]	0.42	0.46	0.19	0.47	0.74	0.30
Significant?[c]	No	No	No	No	No	No
Type:						
Angle	2	0	0	0	10	5
Rear-End	15	2	0	18	28	5
Head-On	0	1	1	0	1	1
Sideswipe	0	1	0	1	21	7
Fixed Object	1	2	2	4	1	1
Pedestrian	0	0	0	0	0	0
Unknown	0	0	0	0	1	0
Total	18	6	3	23	62	19
Road Surface Conditions:						
Clear	15	2	2	13		
Cloudy/Rain	3	1	0	7	48	13
Snow/Ice	0	3	1	1	14	5
Fog	0	0	0	0	0	1
Unknown	0	0	0	0	0	0
Total	18	6	3	23	62	19
Severity:						
Property	11	5	1	13	49	14
Damage Only	7	1	2	8	13	5
Personal Injury	0	0	0	0	0	0
Fatality	18	6	3	23	62	19
Total						

[a]Source: MassDOT Safety Management/Traffic Operations Unit records, 2011 through 2015.
[b]Crash rate per million vehicles entering the intersection.
[c]The intersection crash rate is significant if it is found to exceed 0.58 crashes per million vehicles entering an intersection for an unsignalized intersection and 0.76 crashes per million vehicles entering an intersection for a signalized intersection as defined by MassDOT for District 6.

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

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 particular planned development, which is realistically anticipated to have a major impact on study area roadways and intersections within the study timeframe, and assigns its estimated traffic to the area roadway network. This procedure helps to refine the 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.

In order to provide a conservative analysis scenario, use of both procedures was investigated.

Specific Development by Others

The Town of Milton Department of Community Development was contacted to determine whether there are any planned or approved development projects that are expected to influence future traffic volumes within the study area. Based on consultation with the Department, no developments were identified at this time that are expected to result in an increase in traffic within the study area beyond the background traffic growth rate.

General Background Traffic Growth

Traffic-volume data from historic traffic counts compiled by MassDOT were researched to determine traffic growth trends. Based on a review of this data, it was determined that traffic volumes within the

study area have exhibited little to no growth over the past several years. In order to provide a conservative estimate of non-site related traffic growth a 1.0 percent per year compounded annual background traffic growth rate was applied to existing traffic volumes over the seven-year planning horizon.

Roadway Improvement Projects

The Town of Milton Department of Community Development, Massachusetts Department of Transportation, in coordination with the Town of Milton and the Boston Regional Metropolitan Planning Organization, were consulted to determine whether there are any planned or approved roadway improvement projects within the study area. Based on discussions with both, the following roadway improvement project was identified.

- ***Route 138 Corridor Study –*** The Massachusetts Department of Transportation are currently in the design stages for Route 138 Corridor Improvements. The goals of the corridor improvements are to improve safety for all users, increase efficiency, be pedestrian and bicycle friendly, and to manage the capacity. The improvements entail the upgrading of the traffic signal system and assessing pedestrian and bicycle facilities.

No other improvements, outside of routine maintenance activities, were identified within the study area.

No-Build Traffic Volumes

The 2025 No-Build peak-hour traffic-volume networks were developed by applying the 1 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 evening peak-hour traffic volume networks are shown on Figure 4.

SITE-GENERATED TRAFFIC

The proposed project will consist of 54 age-restricted homes. In order to develop traffic characteristics of the project, similar type residential developments were monitored. Consistent with industry standards for developing trip rates, four similar projects were monitored and the average trip rate was established and utilized to estimated traffic for the project. The four monitored developments are listed below:

1) Quisset Brook Condominiums – 56 units (no age restriction), Milton, Massachusetts

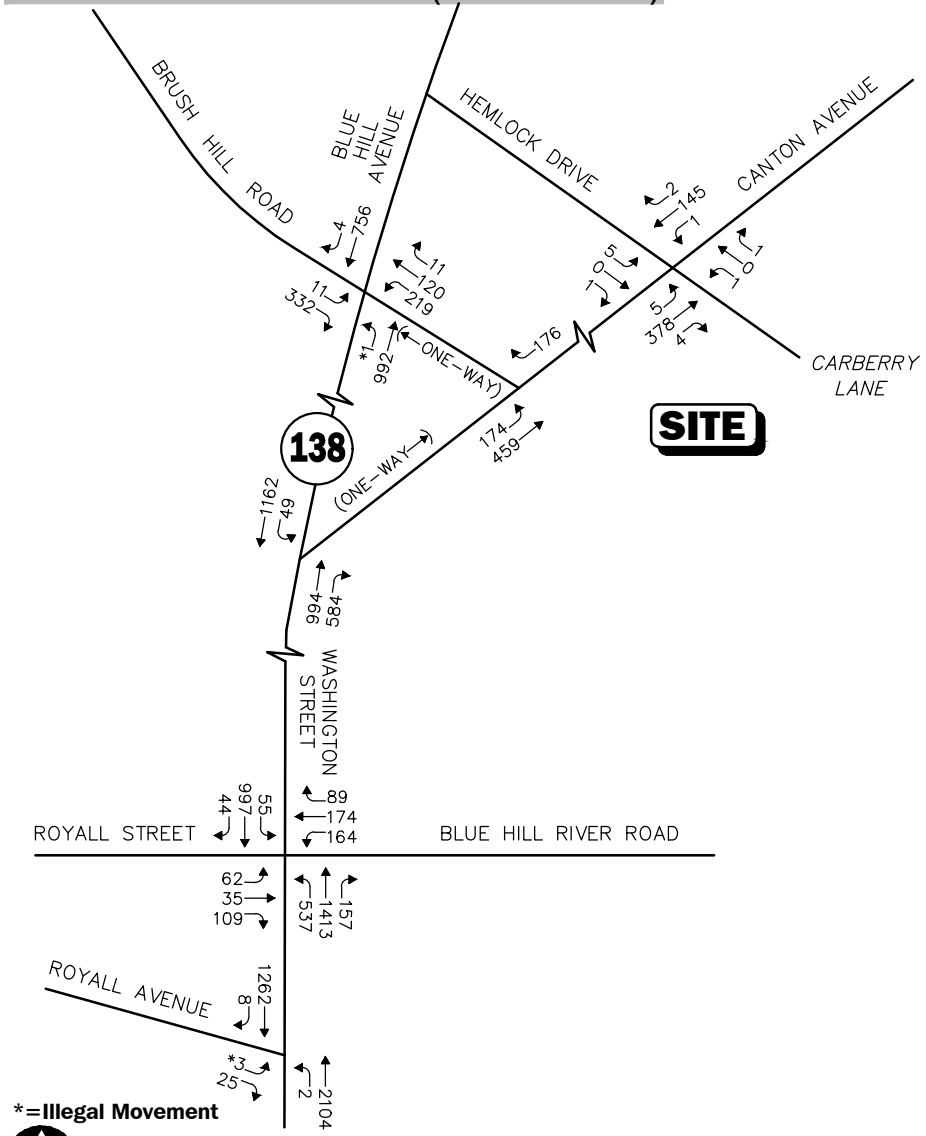
2) Pine Tree Brook Condominiums – 98 units (age-restricted) Milton, Massachusetts

3) South Cottage Condominiums – 62 units (age-restricted) Belmont, Massachusetts

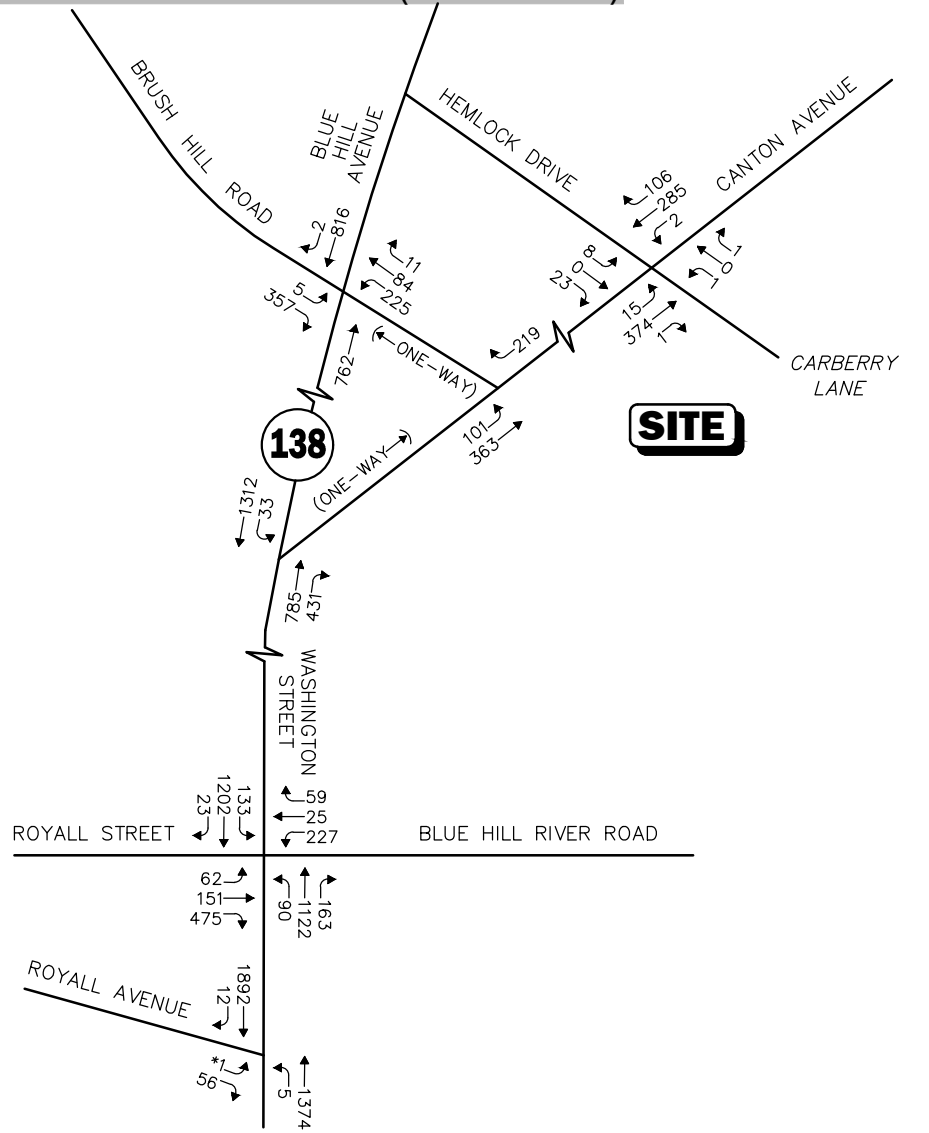
4) Summit Road Condominiums – 55 units (age-restricted) Belmont, Massachusetts

The results of the traffic monitoring are summarized in Table 4 which depicts actual traffic volumes counted and the trip-generation rates per unit.

WEEKDAY MORNING PEAK HOUR (7:00 - 9:00 AM)



WEEKDAY EVENING PEAK HOUR (4:00 - 6:00 PM)



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

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Figure 4

2025 No-Build
Weekday
Peak Hour Traffic Volumes

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Table 4
TRIP GENERATION SUMMARY – TRIP RATES

	Monitored Trip Rates								
	Quisset Brook Road Milton, MA 56 Units		Pine Tree Brook Road Milton, MA 98 Units		South Cottage Belmont, MA 62 Units		Summit Road Belmont, MA 55 Units		
Time Period/Direction	Observed Volumes	Trip Rate/ Unit	Observed Volumes	Trip Rate/ Unit	Observed Volumes	Trip Rate/ Unit	Observed Volumes	Trip Rate/ Unit	Average Rate/ Unit
Weekday Daily	329	5.88	536	5.47	586	9.45	426	7.75	7.14
Weekday Morning Peak Hour:									
Entering	13	0.23	19	0.18	7	0.19	12	0.22	0.21
Exiting	14	0.25	31	0.32	36	0.32	16	0.29	0.30
Total	27	0.48	50	0.51	43	0.51	28	0.54	0.51
Weekday Evening Peak Hour:									
Entering	15	0.27	31	0.32	25	0.19	21	0.38	0.29
Exiting	14	0.25	18	0.18	21	0.32	14	0.26	0.25
Total	29	0.52	49	0.50	46	0.51	35	0.64	0.54

Source: VAI – ATR traffic counts – May 2016.

Table 5 summarizes the trip generation for the proposed 54 age-restricted units using the rates developed in Table 4.

Table 5
TRIP GENERATION SUMMARY

	Proposed	
Time Period/Direction	Average Rate/Unit[a]	54 Units
Weekday Daily	7.14	386
Weekday Morning Peak Hour:		
Entering	0.21	12
Exiting	0.30	16
Total	0.51	28
Weekday Evening Peak Hour:		
Entering	0.29	16
Exiting	0.25	13
Total	0.54	29

[a]Source: VAI Traffic Counts

As can be seen in Table 5, the proposed 54-unit project will generate a total of 386 new vehicle trips (193 entering and 193 exiting) on a weekday. The proposed project will generate 28 trips during the weekday morning peak hour (12 trips entering and 16 trips exiting) and 29 trips in the evening peak hour (16 trips entering and 13 trips exiting).

It is important to note that typical age-restricted units have fewer vehicles per household and fewer occupants and, as such, generate less traffic than a single-family dwelling.

Trip Distribution and Assignment

The directional distribution of generated trips to and from the proposed development was determined based on a review of journey to work data. In general it is expected that approximately 65 percent of project-related traffic will be oriented to and from Canton Avenue, north of the project site; and 35 percent oriented to and from Washington Street, south of the project site. Utilizing these distribution patterns, the weekday morning and evening peak-hour site-generated traffic volumes were assigned on the study area roadway network as summarized in Table 6. Trip Distribution patterns are shown on Figure 5 and site-generated peak hour traffic volume increases are shown on Figure 6.

Table 6
TRIP-DISTRIBUTION SUMMARY

Roadway	Direction (to/from)	Percent
Canton Avenue	North	65%
Washington Street	South	35%
TOTAL		100%

FUTURE TRAFFIC VOLUMES - BUILD CONDITION

The 2025 Build condition networks consist of the 2025 No-Build traffic volumes with the anticipated site-generated traffic added to them. The 2025 Build weekday morning and 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.

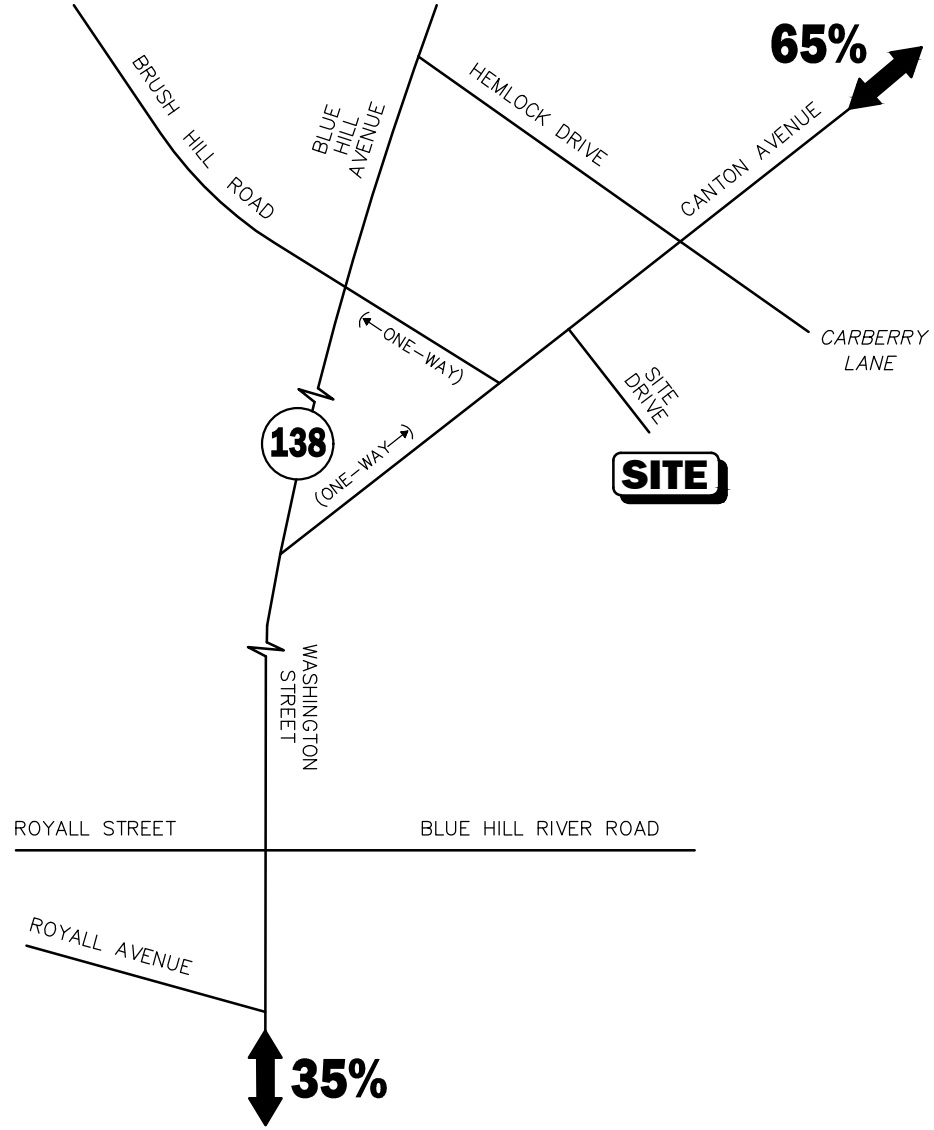

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Figure 5

Trip Distribution Map

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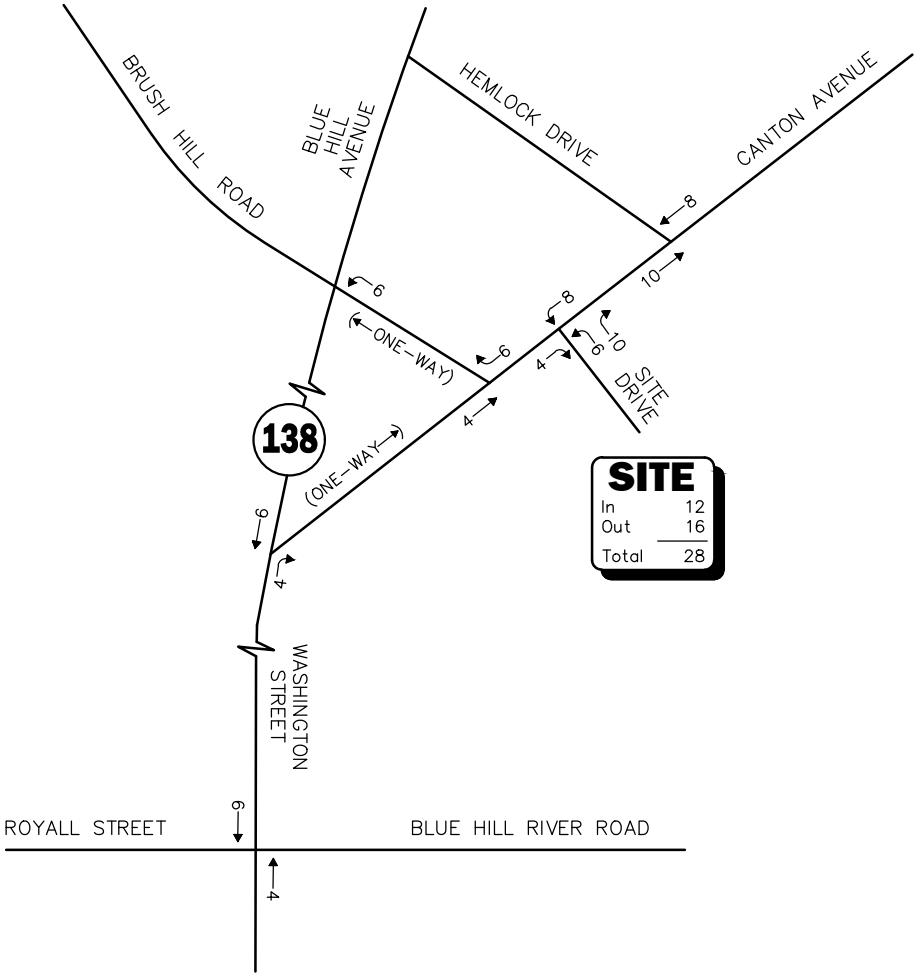
WEEKDAY MORNING PEAK HOUR (7:00 - 9:00 AM)



WEEKDAY EVENING PEAK HOUR (4:00 - 6:00 PM)

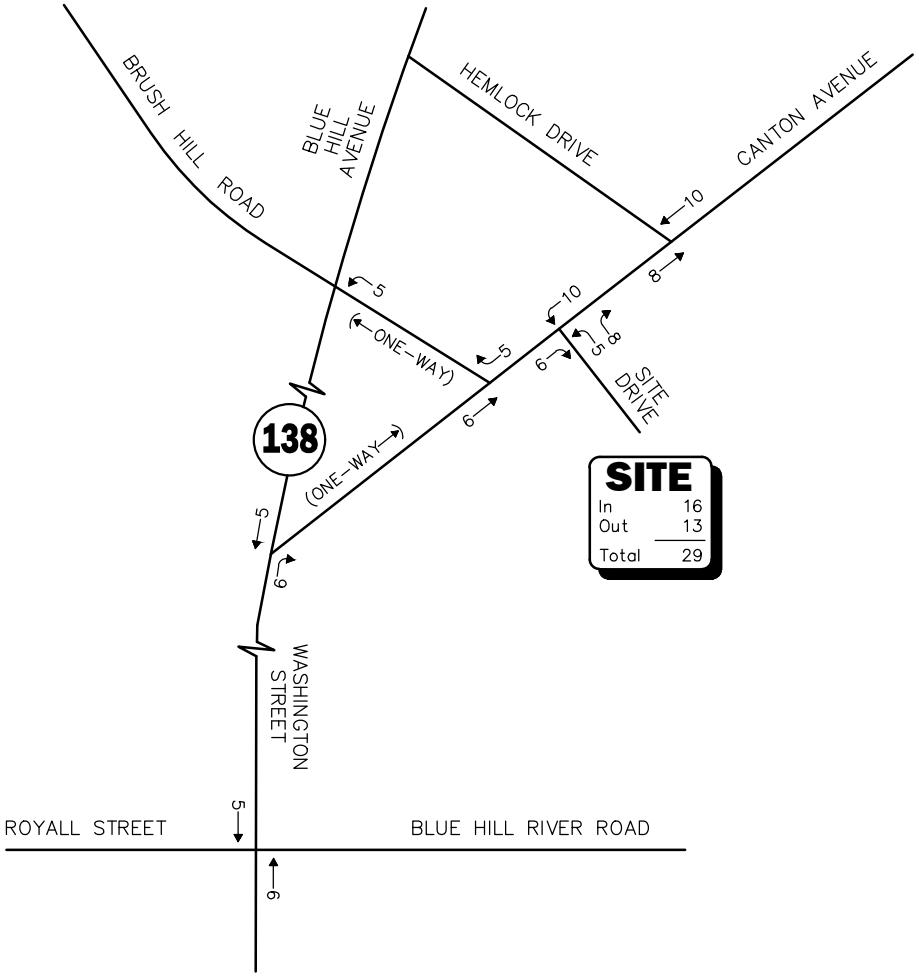


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Figure 6

Site-Generated Peak Hour Traffic Volumes

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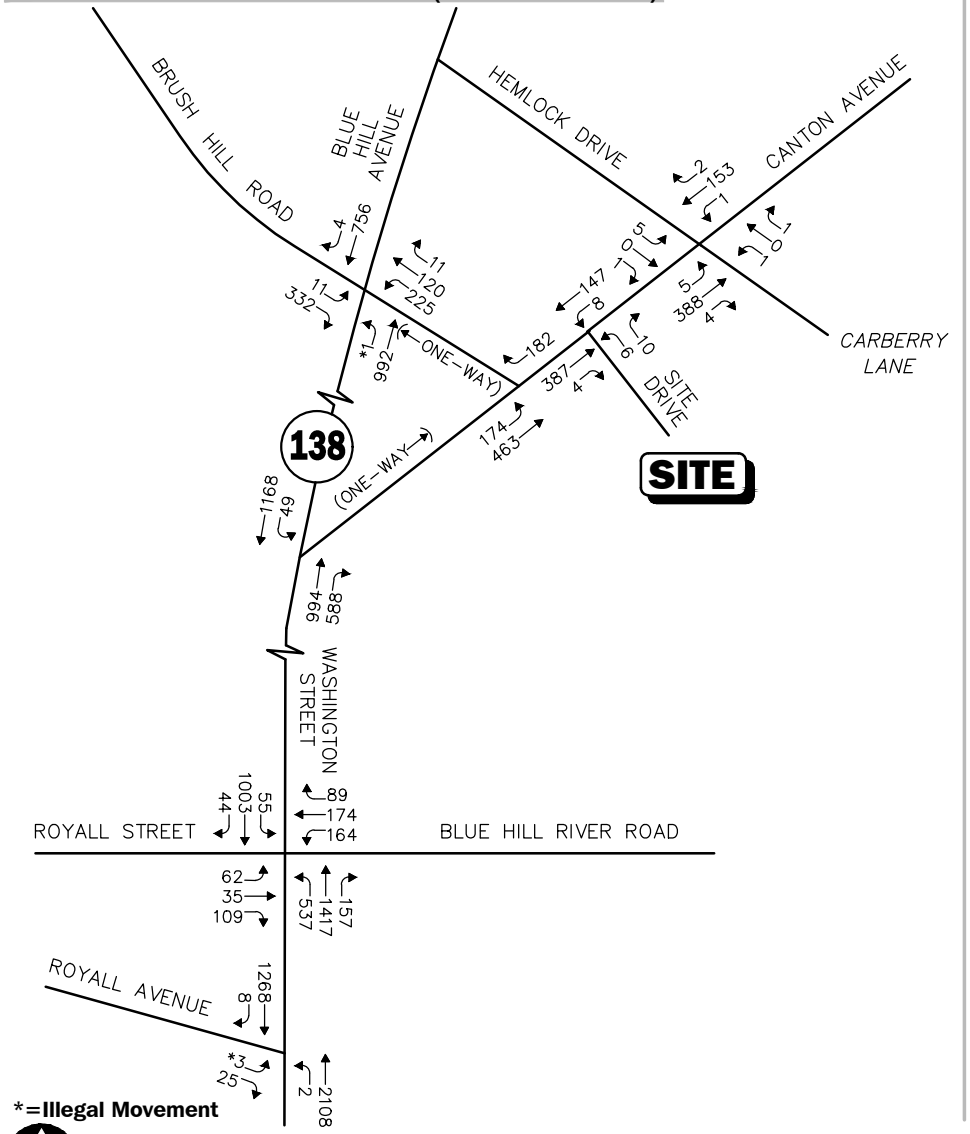
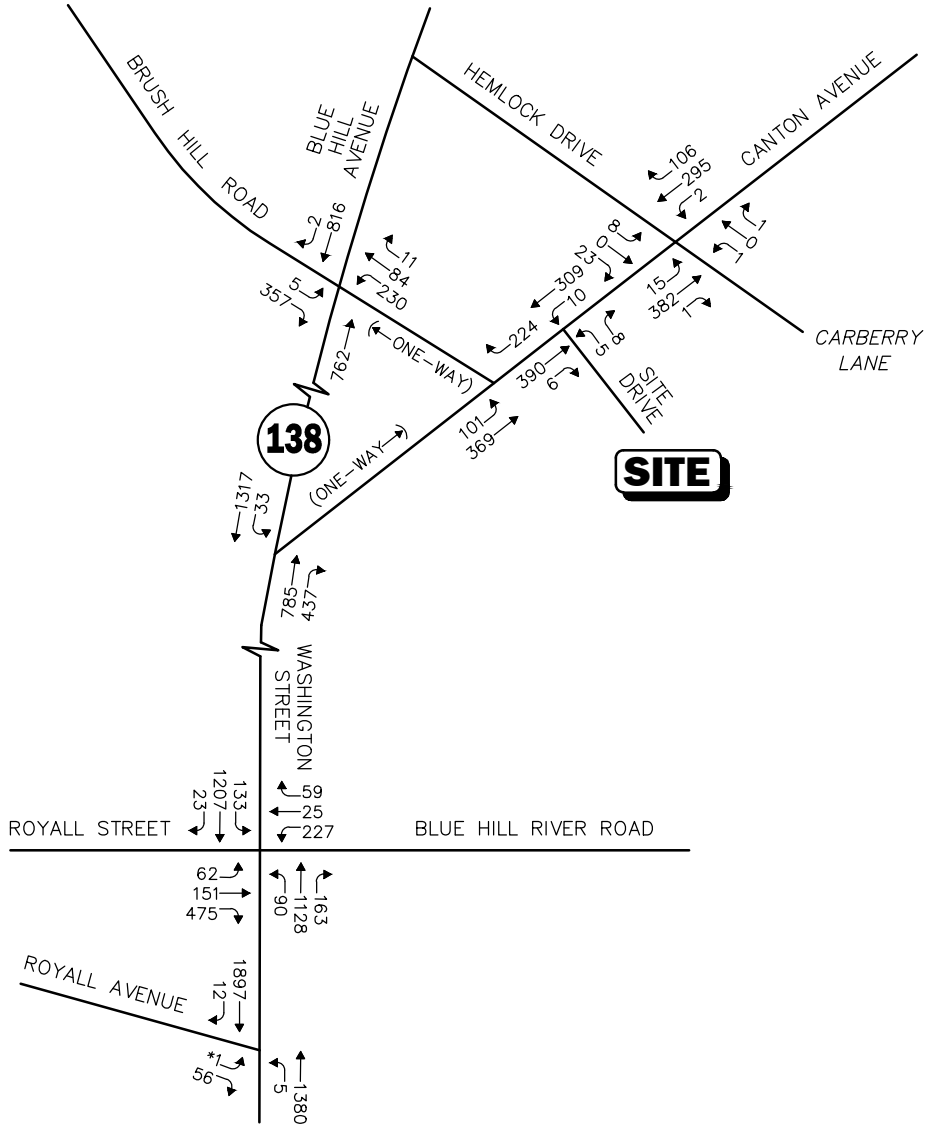
WEEKDAY MORNING PEAK HOUR (7:00 - 9:00 AM)



WEEKDAY EVENING PEAK HOUR (4:00 - 6:00 PM)



*=Illegal Movement

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

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Figure 7

2025 Build
Weekday
Peak Hour Traffic Volumes

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Table 7
PEAK-HOUR TRAFFIC-VOLUME INCREASES

Location/Peak Hour	2025 No-Build	2025 Build	Traffic Volume Increase Over No-Build	Percent Increase Over No-Build
Canton Avenue, north of Hemlock Drive:				
Weekday Morning	532	550	18	3.4
Weekday Evening	776	794	18	2.3
Washington Street, east of Royall Avenue:				
Weekday Morning	3,393	3,403	10	0.3
Weekday Evening	3,327	3,338	11	0.3

As shown in Table 7, project-related traffic-volume increases external to the study area relative to 2025 No-Build conditions are anticipated to range from 0.3 to 3.4 percent during the peak periods. During the peak hour, the project will add less than one (1) vehicle every three (3) minutes along Canton Avenue, north of the project site.

TRAFFIC OPERATIONS ANALYSIS

Measuring existing and future traffic volumes quantifies traffic flow within the study area. To assess quality of flow, roadway capacity 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.

METHODOLOGY

Levels of Service

A primary result of capacity analyses is the assignment of level of service to traffic facilities under various traffic-flow conditions.[2] 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 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 level-of-service (LOS) A representing the best operating conditions and LOS F representing congested or constrained operating conditions.

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.

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.

[2]The capacity analysis methodology is based on the concepts and procedures presented in the *Highway Capacity Manual;* Transportation Research Board; Washington, DC; 2000.

- *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 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 2000 *Highway Capacity Manual.*[3] 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 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 2000 *Highway Capacity Manual*. Table 8 summarizes the relationship between level of service and average control delay.

Table 8
LEVEL-OF-SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS[a]

Level of Service	Average Control Delay (Seconds Per Vehicle)
A	≤ 10.0
B	10.1 to 15.0
C	15.1 to 25.0
D	25.1 to 35.0
E	35.1 to 50.0
F	>50.0

[a]Source: *Highway Capacity Manual*; Transportation Research Board; Washington, DC; 2000; page 17-2.

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.

[3]*Highway Capacity Manual*; Transportation Research Board; Washington, DC; 2000.

- *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*. 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; 2000; page 16-2.

ANALYSIS RESULTS

Level-of-service analyses were conducted for 2017 Existing, 2025 No-Build and 2025 Build conditions for the intersections within the study area. The results of the intersection capacity analyses are summarized for signalized and unsignalized intersections in Tables 10 and 11, respectively, with the detailed analysis results presented in the Appendix.

The following is a summary of the level-of-service analyses for the intersections within the study area.

Table 10
SIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

Signalized Intersection/ Peak Hour/Movement	2018 Existing				2025 No-Build				2025 Build			
	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Washington Street at Royall Street and Blue Hill River Road												
Weekday Morning:												
Royall Street EB LT	0.43	49.0	D	45/90	0.42	48.8	D	44/94	0.42	48.8	D	44/94
Royall Street EB TH	0.17	42.9	D	25/55	0.17	43.3	D	24/57	0.17	43.3	D	24/57
Royall Street EB RT	0.04	42.0	D	0/15	0.04	42.3	D	0/18	0.04	42.3	D	0/18
Blue Hill River Road WB LT	0.85	72.2	E	131/241	0.80	64.7	E	122/262	0.80	64.7	E	122/262
Blue Hill River Road WB TH/RT	0.45	41.8	D	81/114	0.44	41.9	D	75/124	0.44	41.9	D	75/124
Washington Street NB LT	0.67	39.8	D	174/251	0.70	40.4	D	187/268	0.70	40.4	D	187/268
Washington Street NB TH/RT	0.84	25.6	C	464/746	0.90	29.5	C	528/834	0.91	29.7	C	531/838
Washington Street SB LT	0.37	48.9	D	36/80	0.39	48.9	D	38/84	0.39	48.9	D	38/84
Washington Street SB TH/RT	0.75	31.6	C	312/452	0.80	33.8	C	344/492	0.81	34.0	C	346/497
Overall	**0.78**	**34.0**	**C**	--	**0.82**	**35.6**	**D**	--	**0.82**	**35.8**	**D**	--
Weekday Evening:												
Royall Street EB LT	0.54	55.7	E	63/85	0.50	52.6	D	67/90	0.50	52.6	D	67/90
Royall Street EB TH	0.64	50.2	D	149/167	0.70	53.3	D	161/178	0.70	53.3	D	161/178
Royall Street EB RT	0.23	42.6	D	0/0	0.32	43.5	D	0/15	0.32	43.5	D	0/15
Blue Hill River Road WB LT	1.40	>80.0	F	297/358	1.50	>80.0	F	331/390	1.50	>80.0	F	331/390
Blue Hill River Road WB TH/RT	0.07	38.7	D	10/24	0.08	40.2	D	11/25	0.08	40.2	D	11/25
Washington Street NB LT	0.14	39.8	D	27/50	0.15	39.8	D	29/52	0.15	39.8	D	29/52
Washington Street NB TH/RT	0.74	26.4	C	397/486	0.79	28.1	C	445/543	0.79	28.3	C	448/547
Washington Street SB LT	0.71	63.9	E	99/188	0.75	67.4	E	107/206	0.75	67.4	E	107/206
Washington Street SB TH/RT	0.83	36.5	D	472/621	0.89	40.0	D	557/697	0.89	40.4	D	562/702
Overall	**0.85**	**52.4**	**D**	--	**0.89**	**57.2**	**E**	--	**0.89**	**57.3**	**E**	--

[a]Volume-to-capacity ratio.
[b]Average stopped delay per vehicle (in seconds).
[c]Level of Service
[d]Queue length, in feet

Table 10 (Continued)
SIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

Signalized Intersection/ Peak Hour/Movement	2018 Existing				2025 No-Build				2025 Build			
	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Blue Hill Avenue at Brush Hill Road												
Weekday Morning:												
Brush Hill Road EB LT/RT	0.43	28.0	C	72/160	0.49	28.8	C	96/195	0.49	28.8	C	96/195
Brush Hill Road WB LT/TH	1.48	>80.0	F	307/484	1.64	>80.0	F	345/526	1.68	>80.0	F	355/538
Brush Hill River Road WB RT	0.01	22.9	C	0/7	0.01	23.4	C	0/8	0.01	23.4	C	0/8
Blue Hill Avenue NB TH	0.87	25.7	C	489/808	0.94	33.0	C	571/909	0.94	33.0	C	571/909
Blue Hill Avenue SB TH/RT	0.70	16.9	B	308/451	0.75	18.7	B	349/512	0.75	18.7	B	349/512
Overall	**1.08**	**57.6**	**E**	--	**1.17**	**71.0**	**E**	--	**1.19**	**74.1**	**E**	--
Weekday Evening:												
Brush Hill Road EB LT/RT	0.51	29.0	C	105/195	0.55	30.1	C	125/229	0.55	30.1	C	125/229
Brush Hill Road WB LT/TH	1.61	>80.0	F	305/466	1.69	>80.0	F	319/493	1.72	>80.0	F	327/502
Brush Hill River Road WB RT	0.01	24.1	C	0/8	0.01	23.3	C	0/8	0.01	24.3	C	0/8
Blue Hill Avenue NB TH	0.65	15.4	B	287/411	0.70	16.7	B	324/466	0.70	16.7	B	324/466
Blue Hill Avenue SB TH/RT	0.73	17.9	B	343/497	0.78	20.0	B	390/571	0.78	20.0	B	390/571
Overall	**1.02**	**63.3**	**E**	--	**1.09**	**68.0**	**E**	--	**1.10**	**70.7**	**E**	--

[a]Volume-to-capacity ratio.
[b]Average stopped delay per vehicle (in seconds).
[c]Level of Service
[d]Queue length, in feet

Table 11
UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

Unsignalized Intersection/ Peak Hour/Movement	2018 Existing				2025 No-Build				???????			
	Demand[a]	Delay[b]	LOS[c]	Queue[d]	Demand	Delay	LOS	Queue	Demand	Delay	LOS	Queue
Canton Avenue at Hemlock Drive												
Weekday Morning Peak Hour:												
Hemlock Drive EB LT/RT	6	11.5	B	2	6	11.8	B	2	6	11.9	B	2
Weekday Evening Peak Hour:												
Hemlock Drive EB LT/RT	28	11.6	B	7	31	11.9	B	8	31	12.1	B	8
Blue Hill Avenue at Canton Avenue												
Weekday Morning Peak Hour:												
Blue Hill Avenue SB LT	46	33.6	D	30	49	>50.0	F	43	49	>50.0	F	44
Weekday Evening Peak Hour:												
Blue Hill Avenue SB LT	31	6.6	A	8	33	10.7	B	9	33	11.4	B	10
Washington Street at Royall Avenue												
Weekday Morning Peak Hour:												
Royall Avenue EB RT	28	9.6	A	3	28	9.8	A	4	28	9.8	A	4
Weekday Evening Peak Hour:												
Royall Avenue EB RT	57	10.9	B	10	57	11.7	B	12	57	10.8	B	10
Canton Avenue at Site Drive												
Weekday Morning Peak Hour:												
Site Drive WB LT/RT	--	--	--	--	--	--	--	--	16	11.4	B	2
Weekday Evening Peak Hour:												
Site Drive WB LT/RT	--	--	--	--	--	--	--	--	13	12.1	B	2

[a]Demand in vehicles.
[b]Average stopped delay per vehicle (in seconds).
[c]Level of Service
[d]Queue length, in feet

Signalized Intersection

Washington Street at Royall Street and Blue Hill River Road

The intersection is expected to operate at an overall LOS D during the weekday morning and LOS E during the weekday evening peak hours under the 2025 No-Build conditions with a minimal impact as a result of the project.

Blue Hill Avenue at Brush Hill Road

Under all conditions, this signalized intersection overall operates at LOS E, during both the weekday morning and weekday evening peak hours. The project will have minimal impact this location.

Unsignalized Intersection Results

Canton Avenue at Hemlock Drive

Under all conditions, the critical movements at this unsignalized intersection (turns from Hemlock Drive) operate at LOS B during both the weekday morning and weekday evening peak hours.

Blue Hill Avenue at Canton Avenue

Under existing conditions, the critical movements (southbound left-turns onto Canton Avenue) at this signalized intersection operate at LOS D during the weekday morning peak hour and at LOS A during the weekday evening peak hour. Under No-Build and Build conditions, the critical movements operate at LOS F during the weekday morning peak hour and at LOS B during the weekday evening peak hour.

Washington Street at Royall Avenue

Under all conditions, the critical movements at this unsignalized intersection (right-turns from Royall Avenue) operate at LOS A during the weekday morning peak hour and at LOS B during the weekday evening peak hour.

Site Drive at Canton Avenue

Under Future conditions, the critical movements at this unsignalized intersection (turns from Site Drive) operate at LOS B during both the weekday morning and weekday evening peak hours.

SIGHT DISTANCE EVALUATION

Sight distance measurements were performed at the Project site driveway intersection with Canton Avenue in accordance with MassDOT and American Association of State Highway and Transportation Officials (AASHTO)[4] requirements. 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 standards, if the measured ISD is at least equal to the required SSD value for the appropriate design speed, the intersection can operate in a safe manner. Table 12 presents the measured SSD at the subject intersection.

Table 12
SIGHT DISTANCE MEASUREMENTS[a]

	Feet				
	Required Minimum				
Intersection/Sight Distance Measurement	(30 mph)	(35 mph)	(40 mph)	(45 mph)	Measured
Canton Avenue at Site Driveway					
Stopping Sight Distance:					
Canton Avenue looking to the south	200	250	305	350	+500
Canton Avenue looking to the north	200	250	305	350	474

[a]Recommended minimum values obtained from *A Policy on Geometric Design of Highways and Streets,* 6th Edition; American Association of State Highway and Transportation Officials (AASHTO); 2011;

As can be seen in Table 12, the available lines of sight at the Project site driveway intersection with Canton Avenue was found to exceed the recommended minimum sight distance requirements to function in a safe and efficient manner for speeds over 45 mph on Canton Avenue.

[4]Ibid 7.

RECOMMENDATIONS AND CONCLUSIONS

Vanasse & Associates, Inc. (VAI) has conducted a Transportation Impact Assessment (TIA) to determine the potential traffic impacts associated with the development of a residential project located at 1672 Canton Avenue, in Milton Massachusetts. As part of this report, existing traffic operating parameters on key roadways and intersections are reported within the study area, the anticipated traffic-volume increases and traffic-related impacts are analyzed, and site access and egress requirements are evaluated.

The analyzed proposal entails the construction of 54 age-restricted homes, located at 1672 Canton Avenue, north of Brush Hill Road. Access to the project site will be located on Canton Avenue approximately 1,600 feet north of the Blue Hill Avenue intersection. Based upon the analysis, the following is concluded:

- The anticipated development will not have a significant impact (increase) on motorist delays or vehicle queuing along the study area roadways.

- No apparent safety deficiencies are expected at the study intersections.

- The project is expected to generate 386 new vehicle trips (193 entering and 193 exiting) on a weekday. The proposed project will generate 28 trips during the weekday morning peak hour (12 trips entering and 16 trips exiting) and 29 trips in the evening peak hour (16 trips entering and 13 trips exiting).

- Overall safe on-site circulation and access/egress can be achieved with the project as planned.

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

RECOMMENDATIONS

A transportation improvement program has been developed that is designed to provide safe and efficient access to the area. The following improvements have been recommended as a part of this evaluation and, where applicable, will be completed subject to receipt of all necessary rights, permits, and approvals.

Project Access

The project will be accessed from one full-access site drive located on Canton Avenue and an emergency access drive across the existing Manor House access driveway. In addition, one emergency access drive will be located to the north of the main site drive.

- The Site Drive should be a minimum of 22-feet in width and accommodate two-way traffic.
- Vehicles exiting the Project site should be placed under STOP-sign control with a marked STOP-line provided. In addition, a centerline will be striped 100 back from Canton Avenue.
- All signs and pavement markings to be installed within the Project site shall conform to the applicable standards of the *Manual on Uniform Traffic Control Devices* (MUTCD).[5]
- Signs and landscaping to be installed along the Project site driveways should be designed and maintained so as not to restrict lines of sight.
- In coordination with the Town Traffic Commission, the project proponent has agreed to install speed radar signs, pavement markings, and signage along Canton Avenue to reduce overall speeds and improve safely conditions. The Conceptual Plan is depicted in Figure 8.
- The project proponent, working with the Town, MassDOT, and the Boston Regional Metropolitan Planning Organization will support and participate in the proposed Route 138 Corridor improvements.

With the above mentioned recommendations, safe and efficient access and egress can be provided at the site, with minimal impact on the study area roadways.

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

Source: Google Earth.

0 150 300 Scale in Feet

Figure 8

Proposed Traffic Mitigation Plan

Vanasse & Associates, Inc.
Transportation Engineers & Planners