Elementary School Feasibility Study

Proposed Putterham Elementary School

Brookline, Massachusetts

Prepared for:

HMFH Architects
Cambridge, Massachusetts

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ELEMENTARY SCHOOL FEASIBILITY STUDY

PUTTERHAM SCHOOL
BROOKLINE, MASSACHUSETTS

Prepared for:

HMFH Architects
Cambridge, Massachusetts

March 2018

Prepared by:

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PUTTERHAM SCHOOL INTRODUCTION

Vanasse & Associates, Inc. (VAI) has prepared this Transportation Impact Assessment (TIA) in order to identify the potential traffic impacts associated with the proposed Putterham Elementary School located off of Hammond Street and Newton Street in Brookline, Massachusetts. This report identifies and analyzes existing and future traffic conditions both with and without the project and reviews access requirements, potential off-site improvements, and safety considerations. As typical with school traffic, there is a relatively short peak of impacts less than 30 minutes as drop-off and pick-up occur at the school. Generally, the morning peak is more pronounced than the afternoon peak.

PROJECT DESCRIPTION

The proposed Putterham Elementary School will consist of up to a 690 student elementary school. The anticipated school hours will be Monday – Thursday 8:00 AM to 2:30 PM and Friday 8:00 AM to 1:40 PM. The school will be serviced by a Drop-Off/Pick-Up Loop, with access at the intersection of Hammond Street at Laurel Road and egress at Newton Street at Wolcott Road. The Newton Street driveway will share access with the gold course. The site will accommodate 50 parking spaces.

STUDY METHODOLOGY

This study was prepared in general accordance with the state and town guidelines for Transportation Impact Assessments (TIA); 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; 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 school 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 TIA. 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.

PUTTERHAM SCHOOL EXISTING CONDITIONS

A comprehensive field inventory of traffic conditions on the study area roadways was conducted. The field investigation consisted of an inventory of existing roadway geometrics, 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 was selected to contain the major roadways providing access to the project site, Hammond Street and Newton Street, as well as three intersections located near the site:

- Hammond Street at Laurel Road
- Horace James Circle
- Newton Street at Wolcott Road

The following describes the study area roadways and intersections. Figure 1 provides a Study Location Map.

GEOMETRY

Roadways

Hammond Street

Hammond Street traverses the study area in a general northwest-southeast direction and is under Town jurisdiction. Within the study area, Hammond Street generally provides two 11-foot wide travel lanes in each direction, separated by a double-yellow centerline. Sidewalk is provided along both sides of Hammond Street, with illumination provided by way of street lamps mounted on wooden poles. The posted speed limit is 25 miles per hour (mph) approaching the rotary. Land use along Hammond Street within the study area consists of residential properties and the Fire Department.

Newton Street

Newton Street traverses the study area in a general east-west direction and is under Department of Conservation and Recreation jurisdiction. Within the study area, Newton Street generally provides two 11-foot wide travel lanes in each direction, separated by a landscaped median. Sidewalk is provided along the south side of Newton Street, with illumination provided by way of

Figure 1

Site Location Map

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street lamps mounted on wooden poles. Land use along Newton Street within the study area consists of residential properties and the Putterham Golf Course.

Intersections

Figure 2 graphically depicts the Existing Lane Uses and Travel Lane Widths for the study area intersections.

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 completed in March 2018 and January 2017, while school was in session. The traffic counts were conducted with weekday morning (7:00 to 9:00 AM) and weekday afternoon (2:00 to 5:00 PM) peak periods at the study intersections. These time periods were selected for analysis purposes as they are representative of the peak traffic volume hours for the school.

Traffic Volume Adjustments

In order to evaluate the potential for seasonal fluctuation of traffic volumes within the study area, historical traffic data collected by MassDOT were examined. Based on a review of seasonal adjustment factors collected by MassDOT for urban arterials and collectors, January traffic volumes are typically 3 percent lower than average monthly conditions, and therefore were adjusted upwards in order to represent an average-month analysis condition. In addition, the January volumes were grown to reflect 2018 volumes. March traffic volumes are typically 4 percent higher than average monthly conditions, and therefore were not adjusted in order to represent a conservative analysis scenario. The 2018 Existing traffic volumes are graphically depicted on Figure 3.

Existing Condition Observations

Vehicle queue and delay observation were taken during the weekday morning period at the James Horace Circle as part of the VAI traffic study for the Baldwin School. The observed typical delay and queues were as follows:

Street	Delay	Queue
Newton Street *(Eastbound)*	88 seconds	14 vehicles
LaGrange Street *(Northbound)*	185 seconds	24 vehicles
Newton Street *(Westbound)*	69 seconds	30 vehicles

PEDESTRIAN AND BICYCLE FACILITIES

A comprehensive field inventory of pedestrian and bicycle facilities within the study area was undertaken in March 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 and planned future bicycle facilities. Sidewalks are provided along both sides of Hammond Street, Newton Street (western leg), LaGrange Street, Laurel Road and

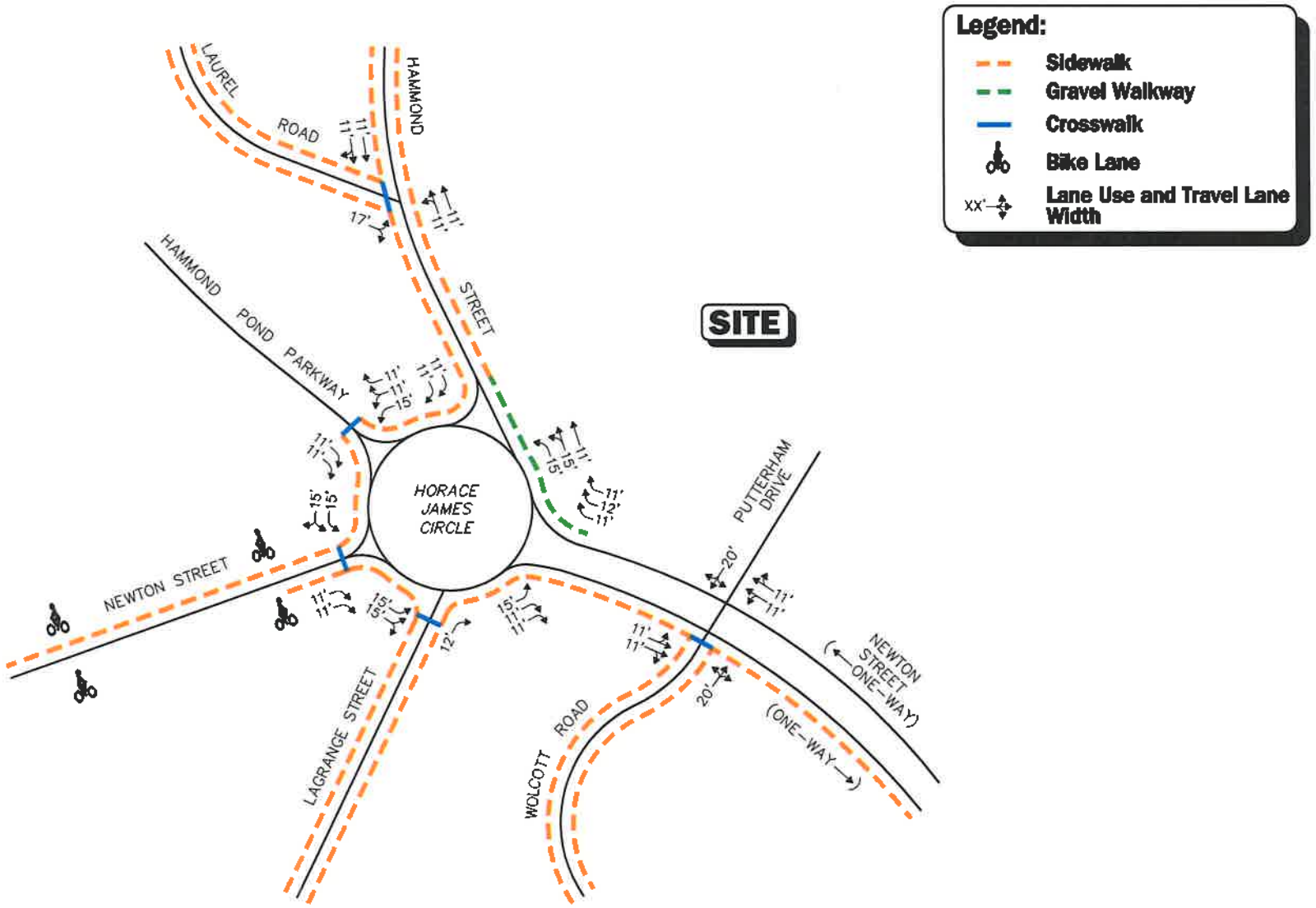

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Figure 2

Existing Intersection Lane Use, Travel Lane Width and Pedestrian Facilities

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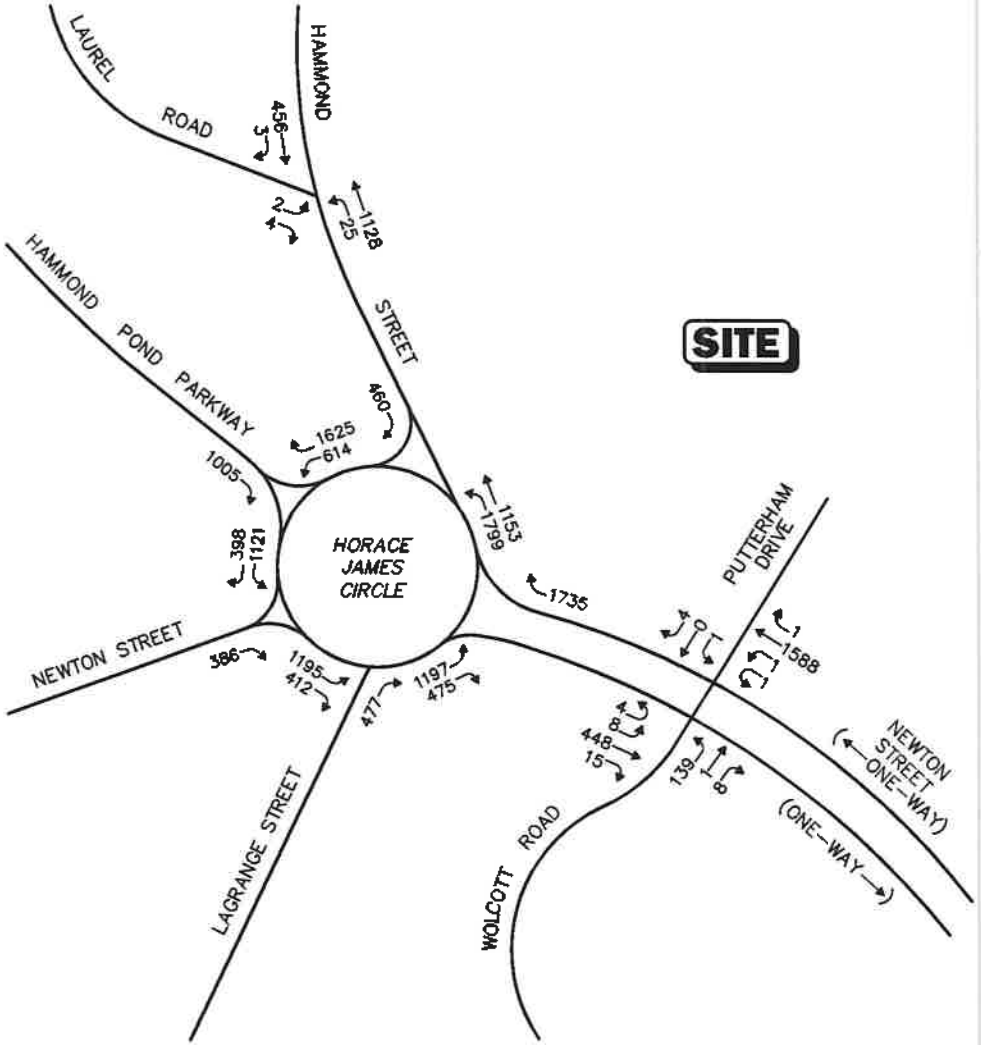
WEEKDAY MORNING PEAK HOUR



WEEKDAY AFTERNOON PEAK HOUR

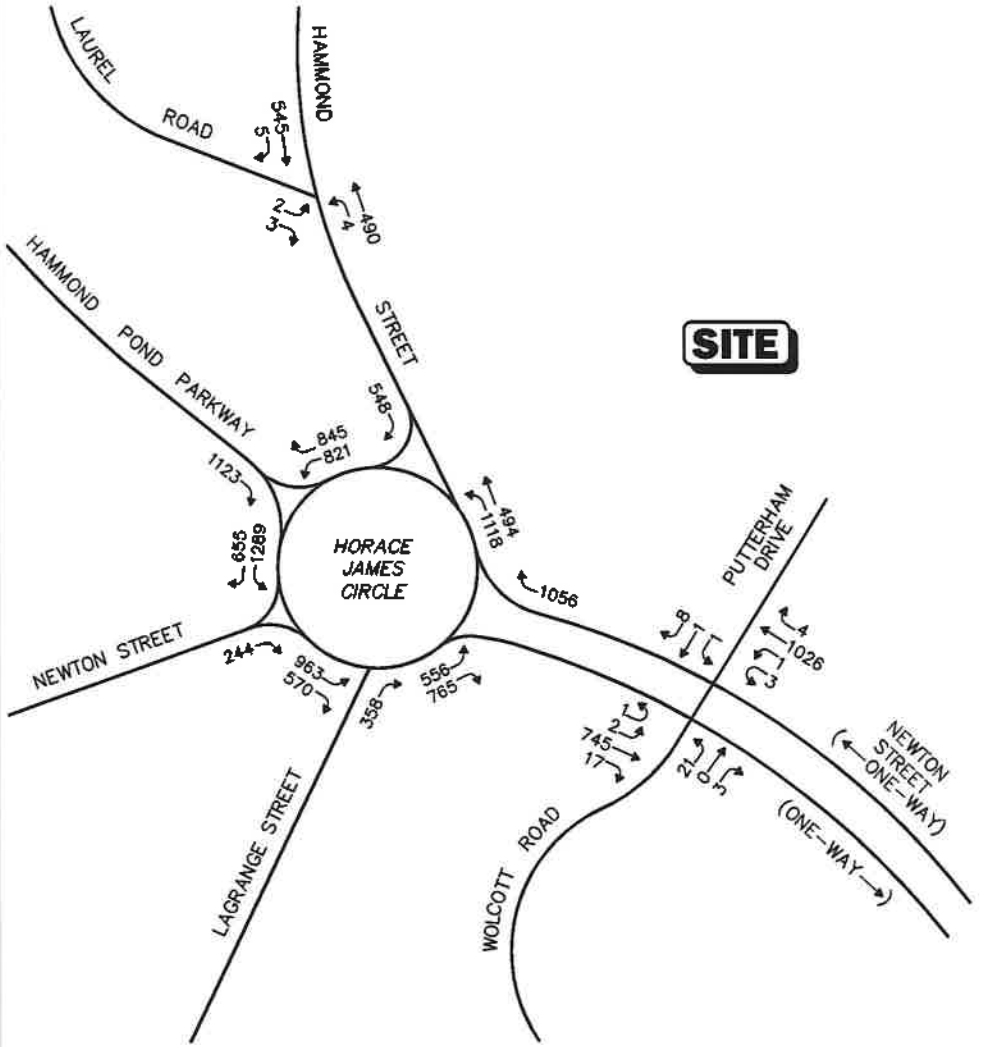


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Figure 3

2018 Existing Weekday Peak Hour Traffic Volumes

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Wolcott Road. Sidewalk is also provided along the south side of Newton Street (eastern leg). Crosswalks are located at Laurel Road, Wolcott Road, Hammond Pond Parkway, Newton Street (western leg) and LaGrange Street. Bicycle lanes were noted on Newton Street (western leg).

PUBLIC TRANSPORTATION

No public transportation was noted within the study area.

MOTOR VEHICLE CRASH DATA

Motor vehicle crash information for the study area intersections was provided by the MassDOT 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. The data is summarized by intersection, type, pavement condition and severity in Table 1.

Table 1
MOTOR VEHICLE CRASH DATA SUMMARY[a]

Scenario	Horace James Circle
Year:	
2011	10
2012	5
2013	11
2014	14
2015	15
Total	55
Average[a]	11.0
Crash Rate[b]	0.33
Significant	No
Type:	
Angle	21
Rear-End	15
Head-On	0
Sideswipe	14
Fixed Object	5
Other	0
Total	55
Pavement Conditions:	
Dry	44
Wet	10
Snow/Ice	1
Unknown/ Other	0
Total	55
Severity:	
Property Damage Only	40
Personal Injury	15
Fatality	0
Unknown	0
Total	55

[a]Average crash over five-year period.
[b]Crash rate per million entering vehicles (mev).
Source: MassDOT Crash Data, 2011 through 2015.

As can be seen in Table 1, the intersection of Horace James Circle experienced a total of 55 accidents reported at the intersection over the five-year review period, averaging 11 accidents per year (the majority of which were angle collisions). Horace James Circle was found to have a motor vehicle crash rate below the MassDOT average for the District 6 (0.76 for signalized intersections and 0.58 for unsignalized intersections). This is typical of traffic circles with many conflict points within the circle. Based upon a review of the accident data, it can be concluded that safe conditions currently exist in the area. No fatalities were reported at Horace James Circle over the five-year review period. No crashes were reported at the intersections of Hammond Street at Laurel Road and Newton Street at Wolcott Road during the five-year review period.

PUTTERHAM SCHOOL FUTURE CONDITIONS

To determine the impact of school traffic volumes on the roadway network under future conditions, baseline traffic volumes in the study area were projected to the year 2025. Traffic volumes on the roadway network at that time, in the absence of the project (that is, the No-Build condition), would include existing traffic, new traffic due to general background traffic growth, and traffic related to specific development by others expected to be completed by 2025. Inclusion of these factors resulted in the development of 2025 No-Build traffic volumes. Anticipated site-generated traffic volumes were then superimposed upon these No-Build traffic-flow networks to develop the 2025 Build traffic-volume conditions.

FUTURE TRAFFIC GROWTH

Traffic growth on area roadways is a function of the expected land development in the immediate area, as well as the surrounding region. Several methods are 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 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.

General Background Growth

Traffic-volume data compiled by MassDOT from permanent count stations and historic 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, a 1.0 percent per year compounded annual background traffic growth rate was used in order to conservatively account for future traffic growth and presently unforeseen development within the study area. This is consistent with previous traffic studies conducted for the area.

Specific Development by Others

The Town of Brookline 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. Based on these discussions the following projects were identified:

Chestnut Hill Square. This mixed-use project has yet to construct 91 residential units. The Residential Phase from the traffic study was added to the No-Build volumes.

Kesseler Woods. This project consists of the development of 88 apartment units off of LaGrange Street in Newton. The Site Generated volumes from the traffic study were added to the No-Build volumes.

Former Atrium Mall Building. This project is a 260,500 sf reuse to consist of a health club, office, and medical office. Traffic volumes were estimated and incorporated, as no traffic study has been completed.

No other background developments were identified within the study area.

Planned Roadway Improvements

The Town of Brookline was contacted in order to determine if there are any planned roadway improvement projects expected to be completed within the study area. Based on these discussions, no projects were identified.

No-Build Traffic Volumes

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

PROJECT-GENERATED TRAFFIC

Design year (2025 Build) traffic volumes for the study area roadways were determined by estimating Project-generated traffic volumes and assigning these volumes on the study roadways. The following describes the methodology used to establish the traffic characteristics of the Project. As proposed, the Project will entail the construction of up to a 690-student elementary school. Teacher and staff levels are estimated at 90 staff.

In order to develop the traffic characteristics of the Project, trip-generation statistics published by the ITE[1] for similar land uses as those proposed were used. ITE Land Use Code (LUC) 520, *Elementary School,* with the independent variable of "Number of Students" equal to 690. It should be noted that the trip-generation statistics published by the ITE for the aforementioned land uses reflect the common modes of transportation for schools and include buses, vans/carpools, as well as students that may walk or bicycle to school. Table 2 summarizes the anticipated characteristics of the Project based upon Industry Standards.

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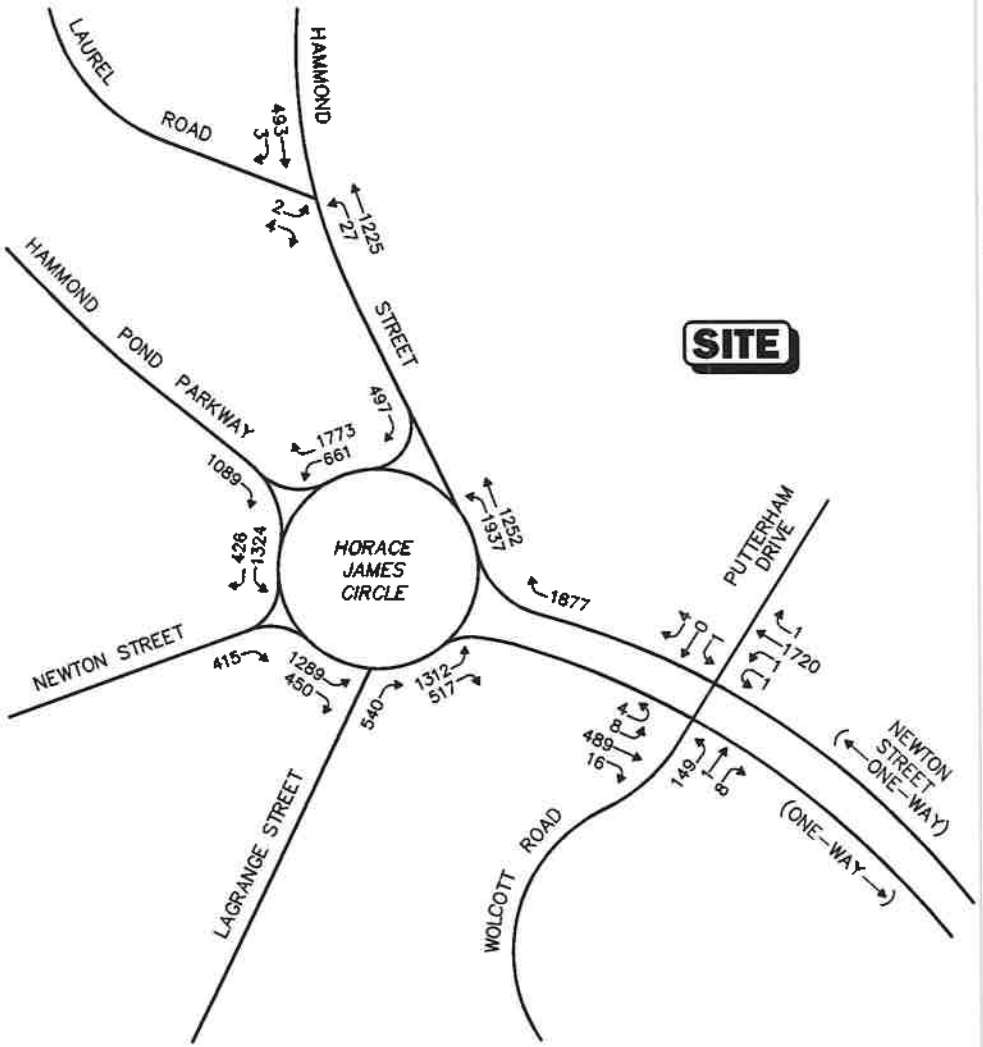
[1]Ibid 2.

WEEKDAY MORNING PEAK HOUR



WEEKDAY AFTERNOON PEAK HOUR

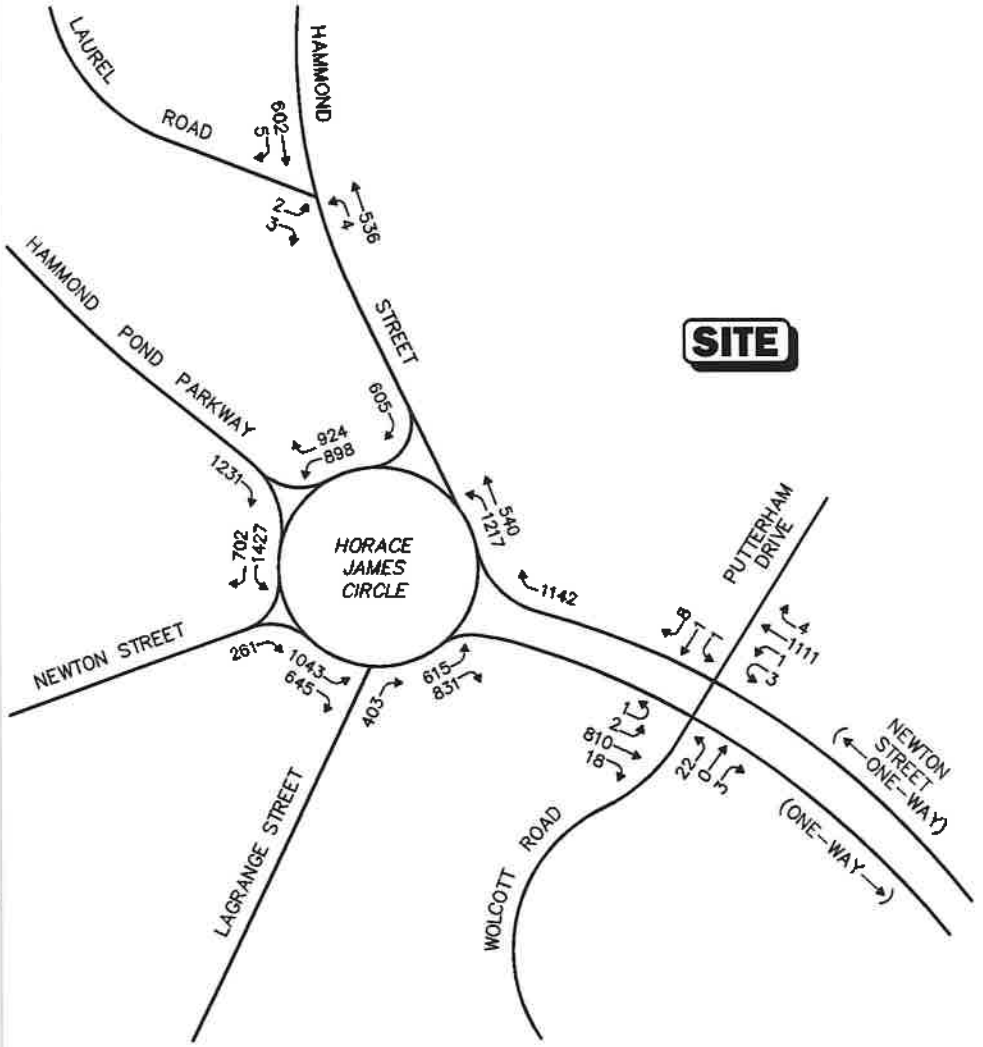


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Figure 4

2025 No-Build Weekday Peak Hour Traffic Volumes

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Table 2
ELEMENTARY SCHOOL
TRIP GENERATION SUMMARY[a]

Time Period/Direction	Vehicle Trips[a] Elementary School (690 Students)[a]
Average Weekday Daily:	
Entering	652
Exiting	652
Total	1,304
Weekday Morning Peak Hour:	
Entering	250
Exiting	212
Total	462
Weekday Afternoon Peak Hour:	
Entering	56
Exiting	61
Total	117

[a]Based on ITE LUC 520, *Elementary School*

Overall, the above ITE estimates appear low and may not reflective of actual Brookline conditions. As such, an alternative approach was developed based upon the following assumption provided to VAI.

- 690 Students
- 4% Daily absenteeism
- 15 Students carpool with staff
- 25 students bus with METCO
- 50 students walk
- 150 students bus
- Student car occupancy of 1.45 student/car

A summary of expected vehicle trip generation is summarized in Table 3 based upon the above assumptions.

Table 3
PUTTERHAM SCHOOL TRIP GENERATION SUMMARY

Time Period	Staff	Buses	Drop-off/ Pick-up	**Total Trips**
Weekday Morning Peak Hour:				
Entering	70	7	291	**368**
Exiting	0	7	291	**298**
Total	70	14	582	**666**
Weekday Afternoon Peak Hour:				
Entering	0	7	162	**169**
Exiting	0	7	199	**206**
Total	0	14	361	**375**

As can be seen in Table 3, the 690-student Putterham Elementary School is expected to generate approximately 666 vehicle trips during the weekday morning peak hour (368 entering and 298 exiting), with 375 vehicle trips during the weekday evening peak hour (169 entering and 206 exiting).

TRIP DISTRIBUTION AND ASSIGNMENT

The directional distribution of the site-generated trips to the proposed development by the staff was determined based on a review of existing traffic patterns at the study area intersections and assumptions made in the Baldwin traffic study. The trip distribution on Figure 5 and summarized in Table 4. The site generated traffic as a result of the expansion is graphically depicted on Figure 6.

Table 4
TRIP-DISTRIBUTION SUMMARY

Roadway	Direction (To/From)	Weekday Morning (Entering)
Newton Street	East	30
Hammond Street	North	20
LaGrange Street	South	20
Hammond Pond Parkway	Northwest	15
Newton Street	West	10
Wolcott Road	South	5
TOTAL		100

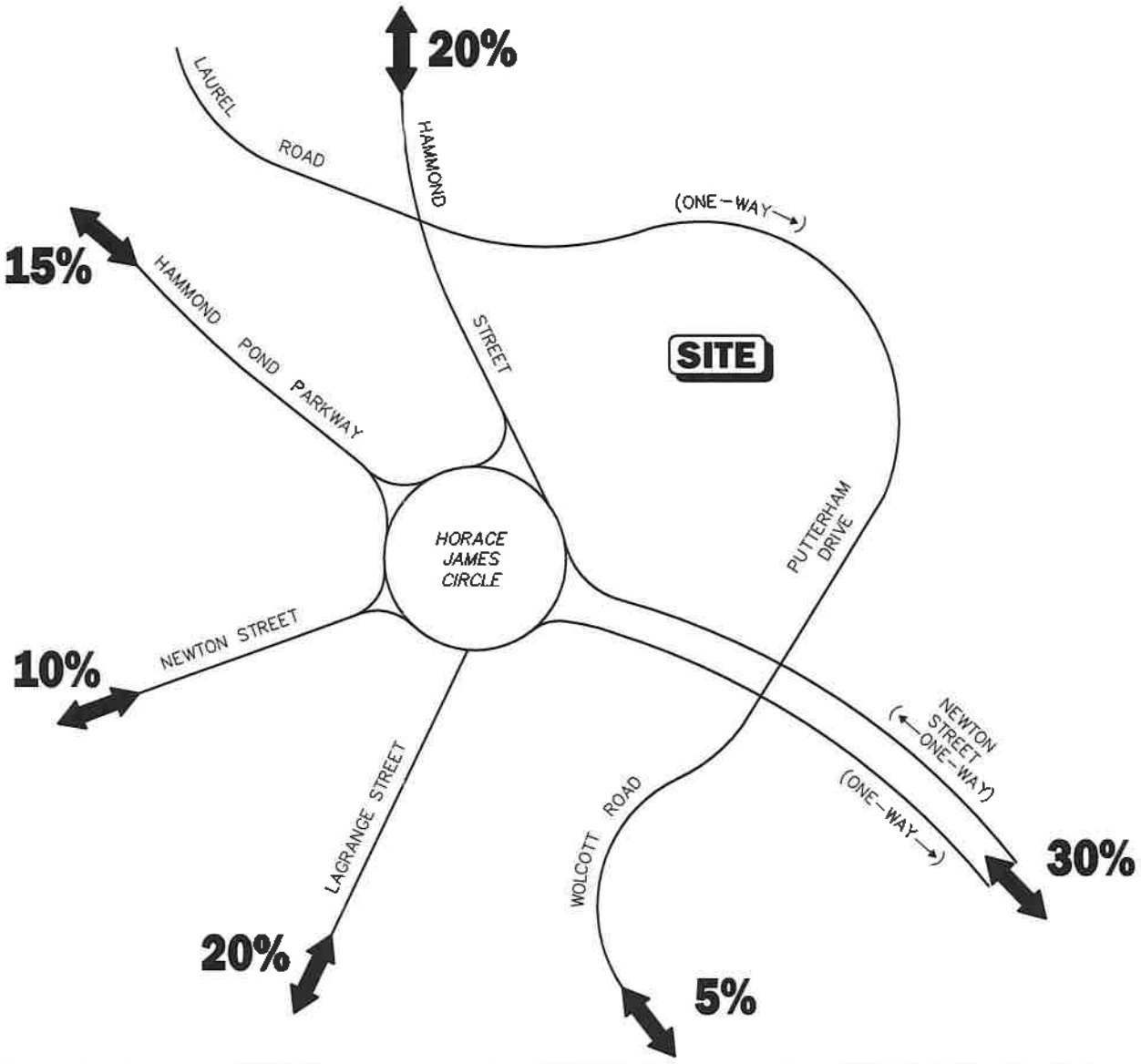

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Figure 5

Trip Distribution Map

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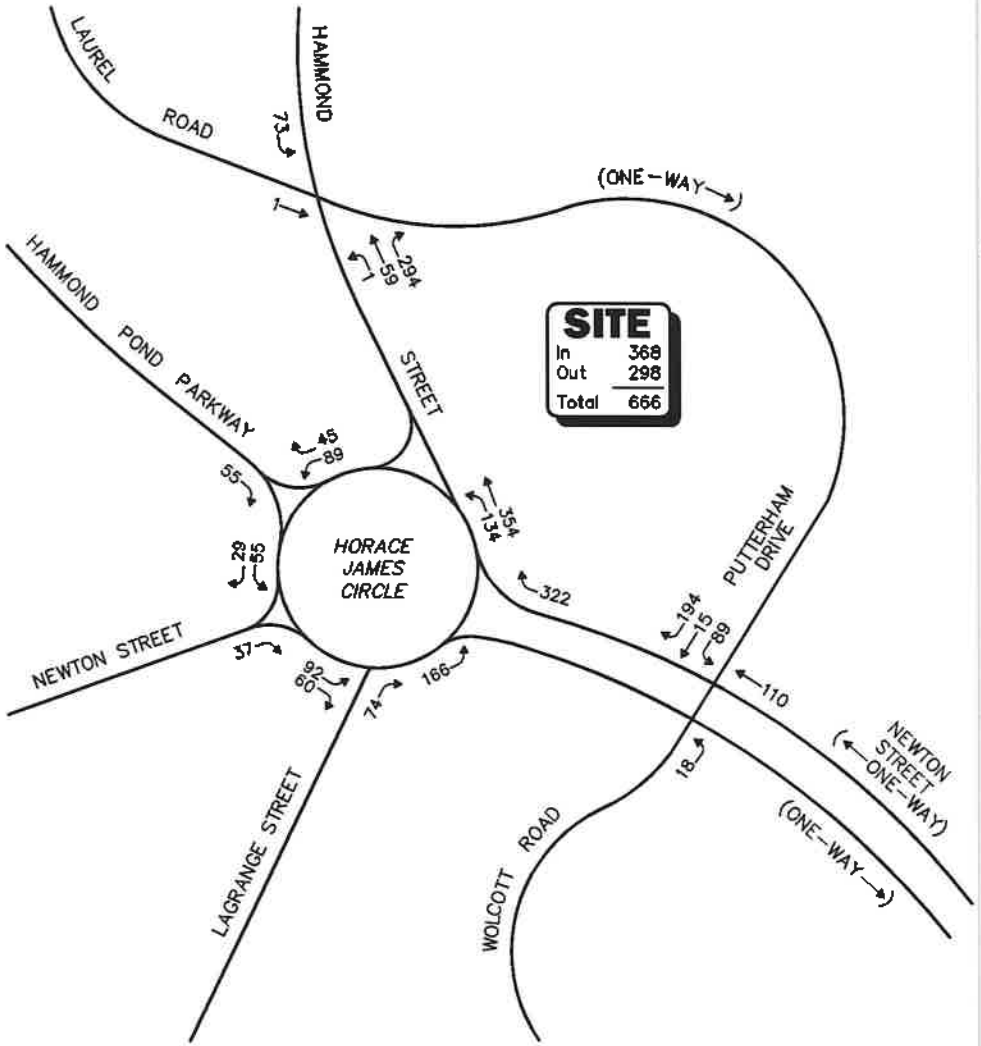
WEEKDAY MORNING PEAK HOUR



WEEKDAY AFTERNOON PEAK HOUR

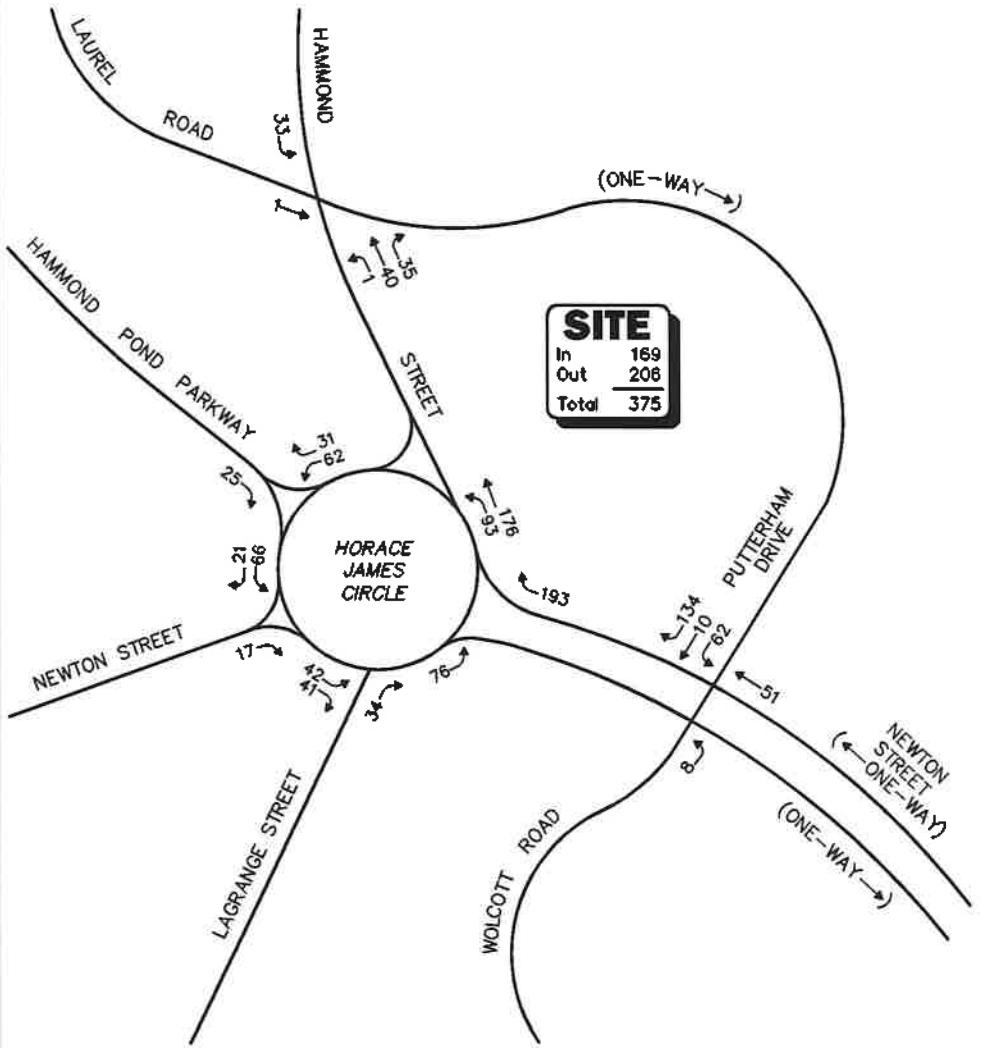


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Figure 6

Site Generated Peak Hour Traffic Volume

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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 weekday afternoon traffic-volume networks are graphically depicted on Figure 7.

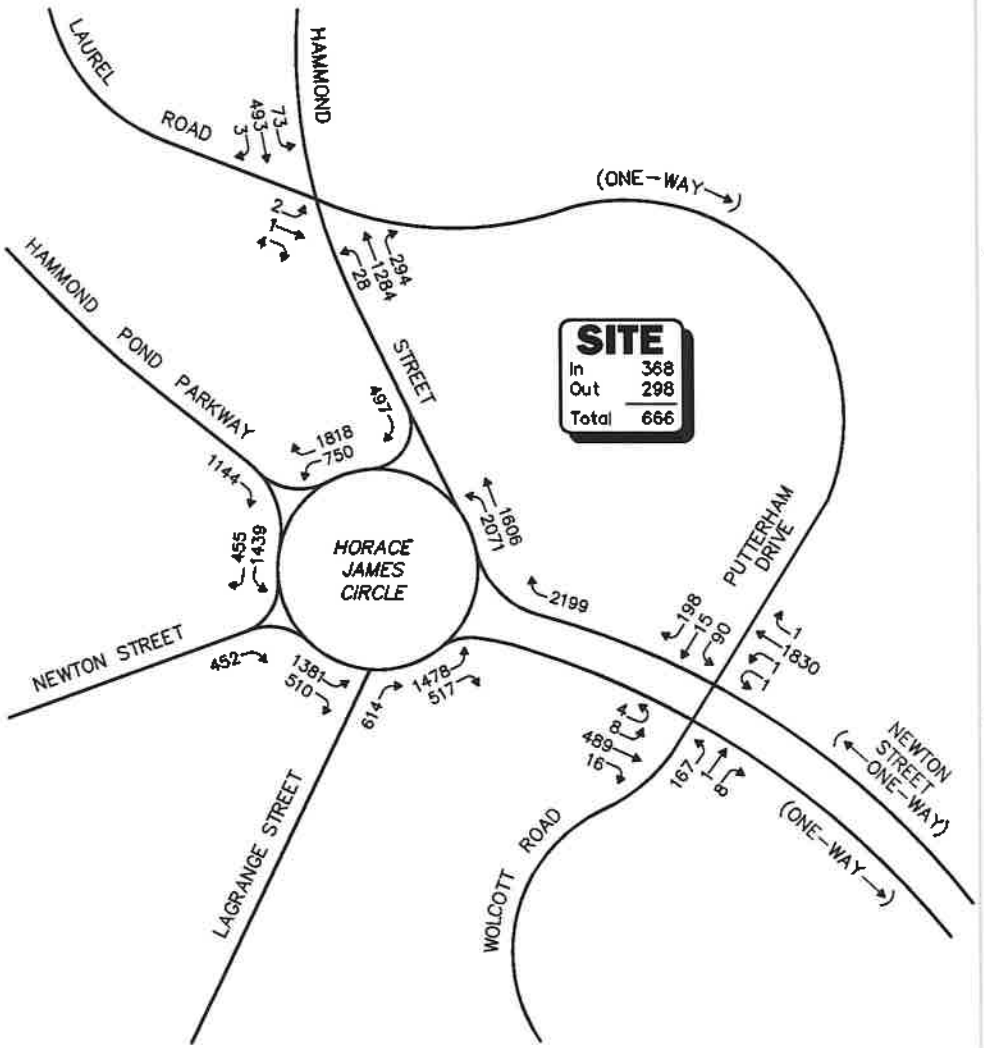
A summary of peak-hour projected traffic-volume increases external to the study area that is the subject of this assessment is shown in Table 5. These volumes are based on the expected increases from the project.

Table 5
PEAK-HOUR TRAFFIC-VOLUME INCREASES

Location/Peak Hour	2025 No-Build	2025 Build	Traffic Volume Increase Over No-Build	Percent Increase Over No-Build
Newton Street, east of Wolcott Road:				
Weekday Morning	2,222	2,421	199	9.0
Weekday Afternoon	1,936	2,049	113	5.8
Hammond Street, north of Laurel Road:				
Weekday Morning	1,723	1,855	132	7.7
Weekday Afternoon	1,145	1,218	73	6.4
LaGrange Street, south of Horace James Circle:				
Weekday Morning	990	1,124	134	13.5
Weekday Afternoon	1,048	1,123	75	7.2
Hammond Pond Parkway, north of Horace James Circle:				
Weekday Morning	2,862	2,962	100	3.5
Weekday Afternoon	2,155	2,211	56	3.0
Newton Street, west of Horace James Circle:				
Weekday Morning	841	907	66	7.8
Weekday Afternoon	963	1,001	38	3.9
Wolcott Street, south of Newton Street:				
Weekday Morning	175	208	33	18.9
Weekday Afternoon	45	63	18	40.0

As shown in Table 5, project-related traffic-volume increases external to the study area relative to 2025 No-Build conditions are anticipated to range from 3.0 to 40 percent during the peak periods.

WEEKDAY MORNING PEAK HOUR



WEEKDAY AFTERNOON PEAK HOUR

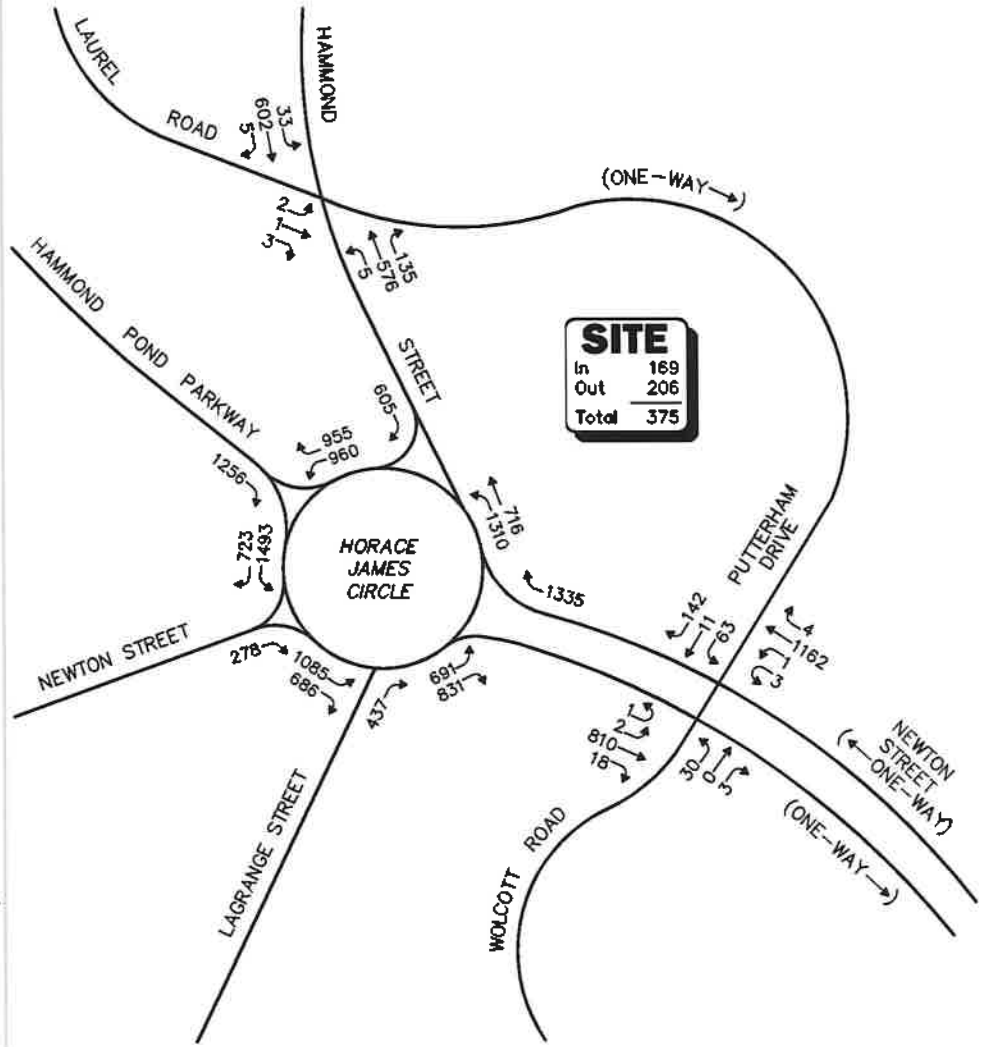


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Figure 7

2025 Build Weekday Peak Hour Traffic Volumes

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Measuring existing and future traffic volumes quantifies traffic flow within the study area. To assess 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 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.

[2]The capacity analysis methodology is based on the concepts and procedures presented in the *Highway Capacity Manual;* Transportation Research Board; Washington, DC; 2010.

- *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 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 6 summarizes the relationship between level of service and average control delay for two way stop controlled and all-way stop controlled intersections.

Table 6
LEVEL-OF-SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS[a]

Level-Of-Service by Volume-to-Capacity Ratio		Average Control Delay
v/c ≤ 1.0	v/c > 1.0	(Seconds Per Vehicle)
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; 2000; page 19-2.

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.

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

- *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*. 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 7 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 7
LEVEL-OF-SERVICE CRITERIA
FOR SIGNALIZED INTERSECTIONS[a]

Level-Of-Service by Volume-to-Capacity Ratio		Average Control Delay
v/c ≤ 1.0	v/c > 1.0	(Seconds Per Vehicle)
A	F	≤10.0
B	F	10.1 to 20.0
C	F	20.1 to 35.0
D	F	35.1 to 55.0
E	F	55.1 to 80.0
F	F	>80.0

[a]Source: *Highway Capacity Manual*; Transportation Research Board; Washington, DC; 2000; page 18-6.

Roundabouts

The roundabout capacity analysis is based on the procedures described in the *Traffic Signalized* and *Unsignalized Intersection Design and Research Aid* (*SIDRA*) *Intersection*.[4] The main features of the *SIDRA Intersection* method for roundabout capacity estimation are the dependence of gap acceptance parameters on rotary geometry, circulating flows and entry lane flows, and the designation of approach lanes as controlling and otherwise that have different capacity characteristics. Provision of two-lane approaches tend to substantially increase roundabout capacity. As a general rule, individual approach volumes exceeding 85 percent of the calculated capacity of that approach are considered over-saturated and indicate areas of concern.

The SIDRA analytical model calculates several components of delay. One of these, the average total delay component, produces level-of-service results based on the concepts described in the HCM. The delay ranges that define levels of service for roundabouts are shown in Table 8.

Table 8
LEVEL-OF-SERVICE CRITERIA FOR ROUNDABOUTS[a]

Level-Of-Service by Volume-to-Capacity Ratio		Control Delay Per Vehicle (Seconds)
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: *SIDRA Intersection User Guide;* Akcelik & Associates Pty Ltd; Greythorn, Victoria 3104, Australia; November 2012.

[4]Traffic Signalized and Unsignalized Intersection Design and Research Aid, SIDRA Intersection User Guide; Akcelik & Associates Pty Ltd; Greythorn, Victoria 3104, Australia; November 2012.

ANALYSIS RESULTS

Level-of-service analyses were conducted for Baseline, 2025 No-Build, and 2025 Build conditions for the study area intersections. The results of the intersection capacity analysis within the study area are described below, with a tabular summary provided in Tables 9 and 10. The results of the SIDRA Rotary Capacity Analysis are summarized in Table 11.

Unsignalized Intersection Analysis Results

Hammond Street at Laurel Road

Under Existing and No-Build conditions, as an unsignalized intersection, the critical movements (turns from Laurel Road) operate at LOS B during both the weekday morning and weekday afternoon peak hours. Under Build conditions, as a signalized intersection, Hammond Street at Laurel Road operates overall at LOS B during the weekday morning peak hour and at LOS A during the weekday evening peak hour. It should be noted that vehicle queues on Hammond Street northbound during the morning period may extend over 850 feet. This is a result of the signalization and the necessary pedestrian phase for student crossings.

Newton Street at Wolcott Road

Under Existing and No-Build conditions, as an unsignalized intersection, the critical movements (turns from Wolcott Road) operate at LOS F during the weekday morning peak hour and at LOS D during the weekday afternoon peak hour. Under Existing and No-Build conditions, as an unsignalized intersection, the critical movements (turns from Putterham Drive) operate at LOS C during both the weekday morning and weekday afternoon peak hours. Under Build conditions, as a signalized intersection, Newton Street at Wolcott Road operates overall at LOS F during the weekday morning peak hour and at LOS B during the weekday evening peak hour. It should be noted that significant queues over 1000 feet may result as the intersection will be signalized, and up to 38 seconds will be required for pedestrian crossing of the intersection.

SIDRA Rotary Analysis Result

Horace James Circle

Under all conditions, the Horace James Rotary operates at an overall LOS F during both the weekday morning and weekday afternoon peak hours. Long delays and queues will continue to exist on all approaches and will be further impacted by the project.

Table 9
UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

	2018 Existing				2025 No-Build				2025 Build			
Unsignalized Intersection Movements	Demand[a]	Delay[b]	LOS[c]	Queue[d]	Demand	Delay	LOS	Queue	Demand	Delay	LOS	Queue
Hammond Street at Laurel Street												
Weekday Morning:												
Laurel Street EB LT/RT	6	13.2	B	2	6	13.9	B	1	See Signalized Table Under Build Conditions			
Weekday Afternoon:												
Laurel Street EB LT/RT	5	12.1	B	2	5	12.6	B	1				
Newton Street at Wolcott Road and Putterham Drive												
Weekday Morning :												
Wolcott Road NB LT/TH/RT	148	>50.0	F	239	158	>50.0	F	228	See Signalized Table Under Build Conditions			
Putterham Drive SB LT/TH/RT	5	22.7	C	3	5	25.4	C	1				
Weekday Afternoon:												
Wolcott Road NB LT/TH/RT	24	29.4	D	20	25	30.9	D	14				
Putterham Drive SB LT/TH/RT	10	17.4	C	3	10	19.1	C	2				

[a]Demand in vehicles per hour
[b]Delay in seconds per vehicle.
[c]Level of service.
[d]Queue Length in feet
NB = northbound; WB = westbound; LT = left-turning movements; RT = right-turning movements

Table 10
SIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

	2018 Existing				2025 No-Build				2025 Build			
Unsignalized Intersection Movements	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Hammond Street at Laurel Street												
Weekday Morning:												
Laurel Road EB LT/TH/RT									0.06	39.4	D	1/16
Hammond Street NB LT/TH/RT									0.89	19.4	B	97/864
Hammond Street SB LT									0.46	14.1	B	0/49
Hammond Street SB TH/RT									0.22	3.8	A	0/127
Overall	See Unsignalized Table Under Existing and No-Build Conditions								**0.73**	**15.7**	**B**	--
Weekday Afternoon:												
Laurel Street EB LT/TH/RT									0.05	30.7	C	1/15
Hammond Street NB LT/TH/RT									0.40	7.2	A	0/237
Hammond Street SB LT									0.10	3.8	A	1/24
Hammond Street SB TH/RT									0.28	4.0	A	0/158
Overall									**0.31**	**5.7**	**A**	--
Newton Street at Wolcott Road and Putterham Drive												
Newton Street EB LT/TH/RT									0.08	14.8	B	1/18
Newton Street WB LT									0.32	10.5	B	28/178
Newton Street WB TH/RT									1.45	>80.0	F	43/1166
Wolcott Road NB LT/TH/RT									0.95	75.8	E	42/297
School Drive SB LT/TH									0.47	26.1	C	28/119
School Drive SB RT									0.16	23.7	C	0/32
Overall	See Unsignalized Table Under Existing and No-Build Conditions								**1.01**	**>80.0**	**F**	--
Weekday Afternoon:												
Newton Street EB LT/TH/RT									0.02	11.2	B	0/
Newton Street WB LT									0.50	10.5	B	47/318
Newton Street WB TH/RT									0.86	22.3	C	81/680
Wolcott Road NB LT/TH/RT									0.03	24.3	C	0/0
School Drive SB LT/TH									0.42	27.1	C	19/90
School Drive SB RT									0.12	24.8	C	0/32
Overall									**0.60**	**18.4**	**B**	--

[a]Volume to Capacity Ratio
[b]Delay in seconds per vehicle.
[c]Level of service.
[d]Queue Length in feet
*Geometry only existing under Build conditions with construction of Site Driveway. NB = northbound; WB = westbound; LT = left-turning movements; RT = right-turning movements

Table 11
SIDRA ROTATY CAPACITY ANALYSIS

Signalized Intersection/Peak Hour/Movement	2018 Existing				2025 No-Build				2025 Build			
	Demand[a]	Delay[b]	LOS[c]	Queue[d]	Demand	Delay	LOS	Queue	Demand	Delay	LOS	Queue
James Horace Circle												
Weekday Morning:												
Hammond Street SWB	460	31.3	D	109	497	44.8	E	170	497	38.6	E	144
Hammond Pond Parkway SEB	1005	16.7	C	132	1089	21.1	C	178	1144	25.9	D	200
Newton Street EB	386	>50.0	F	239	415	43.5	E	144	452	>50.0	F	339
LaGrange Street NB	477	>50.0	F	1928	540	>50.0	F	2448	614	>50.0	F	3420
Newton Street WB	1735	>50.0	F	1940	1877	>50.0	F	2309	2199	>50.0	F	3117
Overall	--	**>50.0**	**F**	--	--	**>50.0**	**F**	--	--	**>50.0**	**F**	--
Weekday Afternoon:												
Hammond Street SWB	548	>50.0	F	2107	605	>50.0	F	2939	605	>50.0	F	2864
Hammond Pond Parkway SEB	1123	>50.0	F	709	1231	>50.0	F	1178	1256	>50.0	F	1554
Newton Street EB	244	15.1	C	32	261	16.0	C	36	278	17.0	C	41
LaGrange Street NB	358	>50.0	F	767	403	>50.0	F	1276	437	>50.0	F	1606
Newton Street WB	1056	15.8	C	101	1142	18.4	C	123	1335	>50.0	F	1279
Overall	--	**>50.0**	**F**	--	--	**>50.0**	**F**	--	--	**>50.0**	**F**	--

[a]Demand in Vehicles per Hour.
[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

PUTTERHAM SCHOOL SUMMARY AND RECOMMENDATIONS

SUMMARY

VAI has completed a detailed assessment of the potential impacts associated with the proposed Putterham Elementary School. This assessment has been completed in accordance with State and Town standards and those of the Traffic Engineering and Transportation Planning professions for the preparation of such reports. Based on this assessment, we have noted the following with respect to the Project:

- The expansion is expected to generate approximately 666 vehicle trips during the weekday morning peak hour (368 entering and 298 exiting), with 375 vehicle trips during the weekday afternoon peak hour (169 entering and 206 exiting);
- A review of accident data researched from MassDOT indicates that area intersections experience accident rates below state averages indicating safe operations.
- It should be noted that with 50 parking spaces provided for a parking demand of 90 staff. It is recommended that a minimum of 90 spaces be provided for staff and visitors.

Overall, the proposed Putterham Elementary School will increase delays and queues along Hammond Street and Newton Street, as the new traffic signals will stop traffic and pedestrian crossing times will further delay traffic.

RECOMMENDATIONS

The following improvements have been recommended as a part of this evaluation.

Project Access

School access will be provided via two new traffic signals located at Hammond Street at Laurel Road and at Newton Street at Wolcott Road.

- The School Entrance will be located at the intersection of Hammond Street at Laurel Road
- The School Exit will be located at the intersection of Newton Street at Wolcott Road. This location would also share access and egress to the golf course.

- Students are dropped-off and pick-up up via this one-way School Loop with entry on Hammond Street and exit on Newton Street.

The following recommendations are offered with respect to the design and operation of the Project site driveways:

- Signals are to be installed at both the School Driveway Entrance and Exit, which are located at the intersections of Hammond Street at Laurel Road and Newton Street at Wolcott Road and Putterham Drive. Figures 8 and 9 graphically depict the Conceptual Improvement Plans.

- The Entrance-Only drive should be a minimum of 16 feet wide with appropriate DO NOT ENTER signs should be placed internal to the site.

- School Zone signs, pavement markings and traffic control devices (i.e., flashing school speed limit signs) should be installed along both Newton Street and Hammond Street in consultation with the Transportation Department.

- All signs and other pavement markings to be installed within the Project site shall conform to the applicable standards of the current Manual on Uniform Traffic Devices (MUTCD).[5]

- Signs and landscaping adjacent to the Project site driveway intersections should be designed and maintained so as not to restrict lines of sight.

- At the signalized intersection of Newton Street at Wolcott Road and the School Drive should have an exclusive left-turn lane be installed on Newton Street in the eastbound direction.

- At the signalized intersection of Hammond Street at Laurel Road and the School Drive should have an exclusive left-turn lane installed on Hammond Street in the southbound direction.

Pedestrian Facilities

Crosswalks would need to be installed at the two signals (Hammond Street at Laurel Road and Newton Street at Wolcott Road and Putterham Drive), along with appropriate pedestrian signal equipment. A cross guard should be stationed at both intersections during peak school morning and afternoon periods, to ensure adequate pedestrian crossing time and safety for students. Additionally, the sidewalk on the east side of Hammond Street should be extended, connecting to Newton Street and the Putterham School site.

Bicycle Considerations

While bicycle usage to the site will be limited, the following should be incorporated.

- Bicycle racks should be provided proximate to the building entrance in a visible location.

- Bicycle consideration by the Town should be reviewed for both Hammond Street and Newton Street.

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[5]Ibid 4

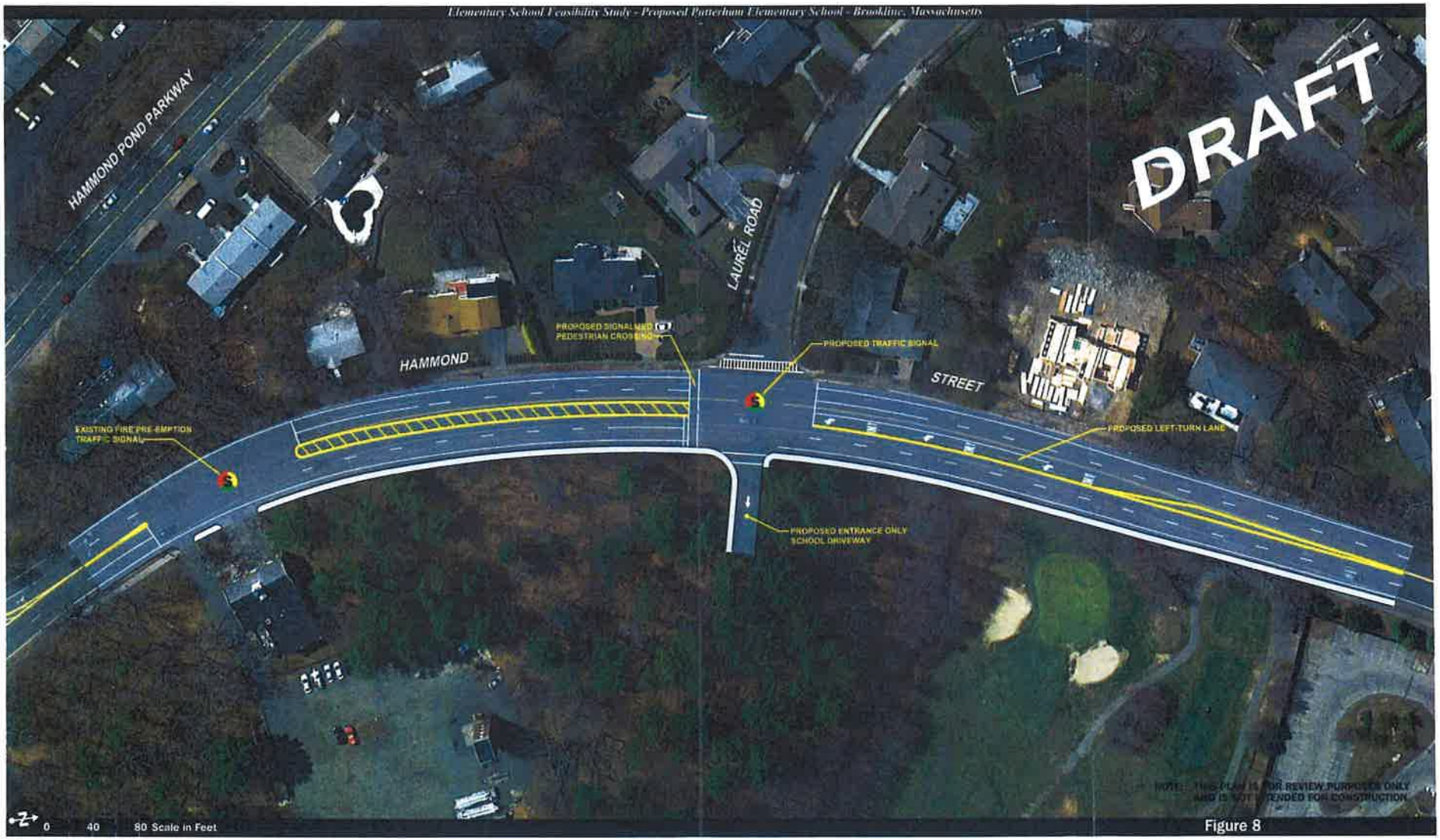

Figure 8

Conceptual Improvement Plan
Hammond Street at Laurel Road

Vanasse & Associates, Inc.

Figure 9

Vanasse & Associates, Inc.

Conceptual Improvement Plan
Newton Street at Wolcott Road

Transit Usage

While transit usage will be limited to staff, the school should promote staff usage of public transportation to the school.

School Drop-Off and Pick-Up Traffic Management Plan

A central feature of the Project is the implementation of a traffic and parking management plan for school drop-off and pick-up activities. The Project site has been designed with a drop-off area of over 1,000 feet from Hammond Street, into the site. The following major elements should be incorporated into the plan:

- Police detail officer should be located at both driveways serving the site in order to manage the flow of vehicles and pedestrians entering and exiting the site, and pedestrian crossings of Hammond Street and Newton Street at the school crossing.
- School staff should be stationed at the drop-off areas to manage traffic within the site and along the driveways, as well as to facilitate the safety of pedestrians and bicyclists.
- A designated drop-off/pick-up area has been designed to facilitate these movements.
- A lane along the entryway will remain unobstructed during student drop-off and pick-up periods for emergency vehicles.
- Parents and caregivers will be given information on school drop-off and pick-up times and procedures at the beginning of the school year, with periodic updates and reminders provided as may be necessary.

The elements of the traffic and parking management plan for school drop-off and pick-up activities will be reviewed and updated as may be necessary in order to ensure the safety of students and to minimize potential impacts to the safe and efficient movement of vehicles, pedestrians and bicyclists.

Construction Management Plan

A detailed Construction Management Plan should be prepared and reviewed by the Town.

Traffic Monitoring

Within three months after school opening, a traffic monitoring study should be completed to review traffic counts at the site driveways and evaluate the traffic condition within the area.

Annually, the school should assess conditions and evaluate pedestrian safety, crossing guards, and evaluate the level of student busing and make adjustments, as necessary.

Additional Considerations

- Safety concerns will exist for the elementary school students crossing both Hammond Street and Newton Street when a crossing guard is not present. These crossings range from 72 feet to 108 feet, and will take up to 38 seconds for crossing.

- It should be noted that with necessary signal installation at the School Entrance at Laurel Street, vehicle queues may extend into the Horace James Circle Rotary from Hammond Street northbound. The pedestrian crossing time is expected to be up to 28 seconds and will stop northbound traffic, in addition to the time to process southbound left-turns. Along Newton Street, pedestrians will need to cross 108 feet of roadway, and will require up to 38 seconds of stop-time and add to the already long queue to the traffic circle along Newton Street westbound during the morning period. Due to the roadway widths of Hammond Street and Newton Street, lengthy crossing times are required for students crossing these roadways.

Overall, the proposed Putterham Elementary School will increase delays and queues, but during limited periods of the day.