Elementary School Feasibility Study

Pierce Elementary School

Brookline, Massachusetts

Prepared for:

HMFH Architects
Cambridge, Massachusetts

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ELEMENTARY SCHOOL FEASIBILITY STUDY

PIERCE ELEMENTARY SCHOOL
BROOKLINE, MASSACHUSETTS

Prepared for:

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March 2018

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PIERCE 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 expansion of the Pierce Elementary School located on Pierce Street and School Street in Brookline, Massachusetts. 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. The focus on this study is to assess the traffic impacts of the potential expansion to the Pierce Elementary School. 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.

PROJECT DESCRIPTION

The Pierce School consists of an 859 student elementary school with 112 staff, which will expand to a total of 1100 students in Brookline, MA. School hours are Monday – Thursday 8:00 AM to 2:30 PM and Friday 8:00 AM to 1:40 PM. The school will continue to be serviced by the parking and service driveways on School Street and the drop-off/pick-up circle off of Pierce Street. The school is primarily a walking school with up to 80 percent of the students walking to school.

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.

PIERCE 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, Holden Street, Pierce Street, Harvard Street and Schools Street, as well as six intersections located near the site:

1. School Street at Service Driveway
2. School Street at School Driveway
3. School Street at Harvard Street and Aspinwall Avenue
4. Harvard Street at Pierce Street
5. Pierce Street at Holden Street
6. Student Drop-Off/Pick-up Circle with Pierce Street

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

GEOMETRY

Roadways

Harvard Street

Harvard Street traverses the study area in a general north-south direction and is under Town jurisdiction. Within the study area, Harvard Street generally provides one 11-foot wide travel lane in each direction, separated by a double-yellow centerline with 5-foot wide bicycle lanes in each direction and on-street metered parking. Sidewalk is provided along both sides of Harvard Street, with illumination provided by way of street lamps mounted on black steel poles. Land use along Harvard Street within the study area consists of commercial, municipal and residential properties.

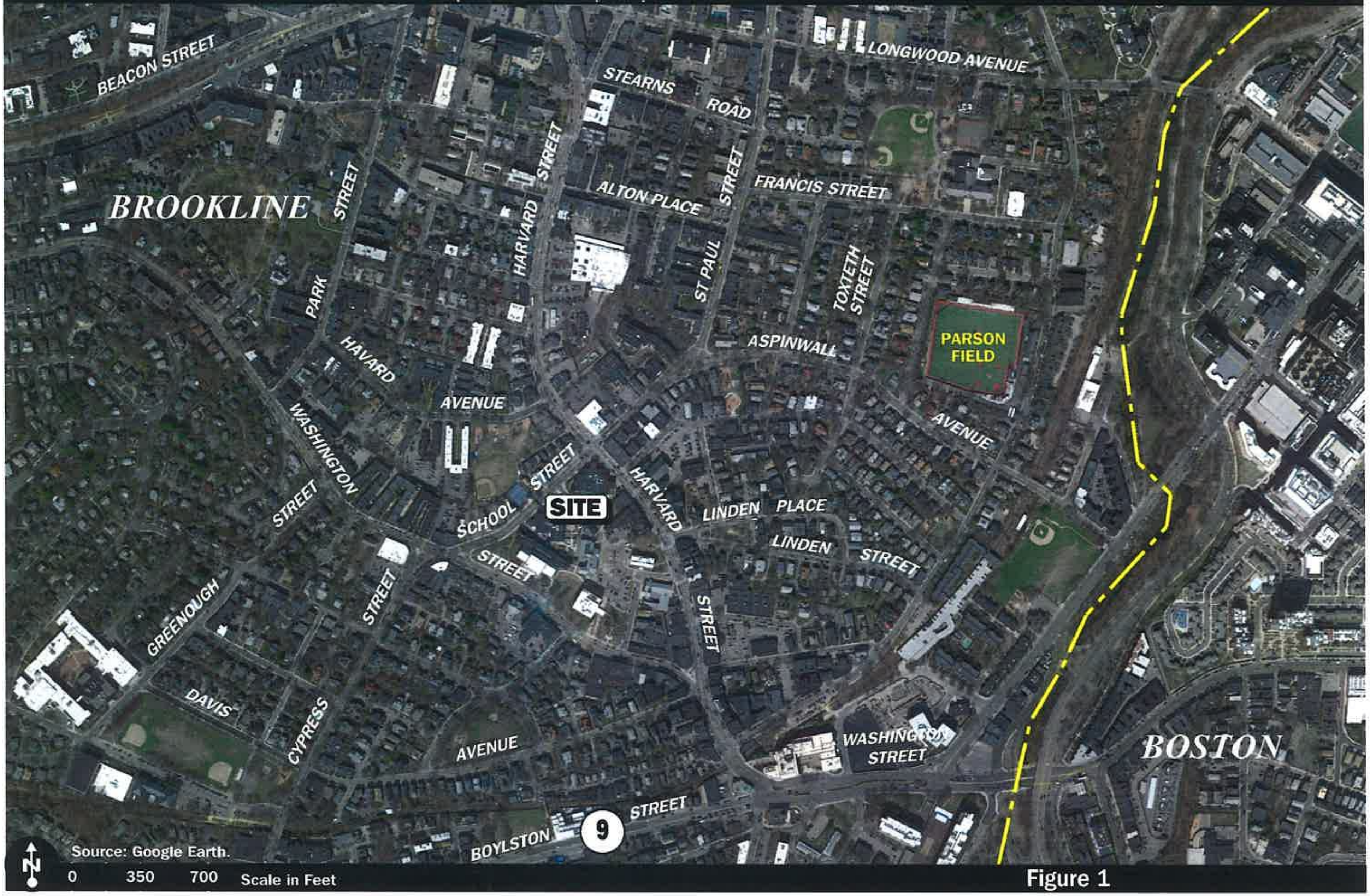

Figure 1

Site Location Map

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School Street

School Street traverses the study area in a general east-west direction and is under Town jurisdiction. Within the study area, School Street generally provides two 10-foot wide travel lanes in one direction, and one 11-foot wide lane in the other direction, separated by a double-yellow centerline. Sidewalk is provided along both sides of School Street, with illumination provided by way of street lamps mounted on black steel poles. Land use along School Street within the study area consists of commercial, municipal and residential properties.

Pierce Street

Pierce Street traverses the study area in a general east-west direction and is under Town jurisdiction. Within the study area, Pierce Street generally provides one travel lane in each direction, separated by a double-yellow centerline near Harvard Street, and with no pavement markings near Holden Street. Sidewalk is provided along both sides of Pierce Street, with illumination provided by way of street lamps mounted on black steel poles. Land use along Pierce Street within the study area consists of municipal properties and the Pierce School.

Holden Street

Holden Street traverses the study area in a general north-south direction and is under Town jurisdiction. Within the study area, Holden Street generally provides one travel lane in each direction, separated by no pavement markings. Sidewalk is provided along both sides of Holden Street, with illumination provided by way of street lamps mounted on black steel poles. Land use along Holden Street within the study area consists of municipal properties and the Pierce School.

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 November 2017 and January 2018, 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.

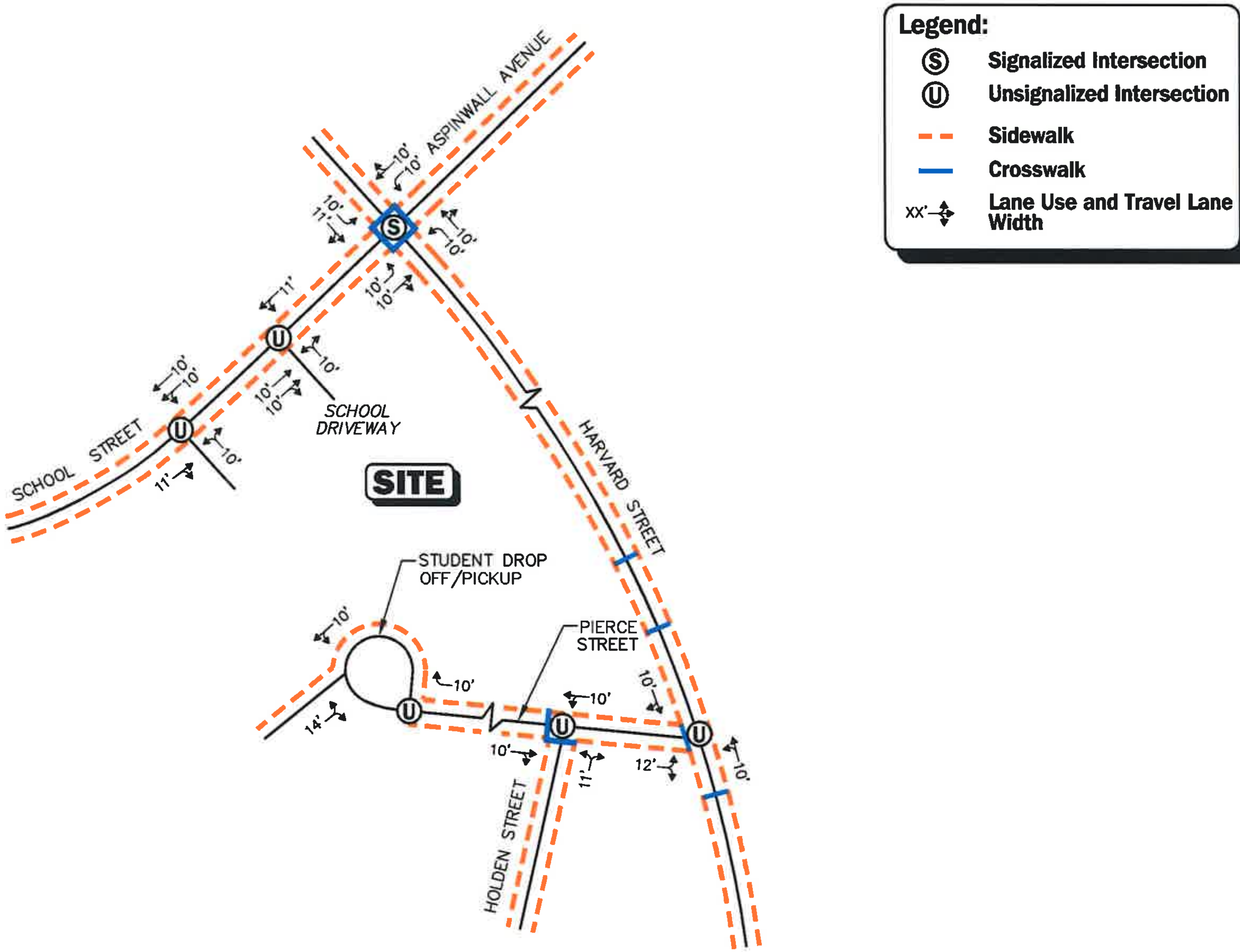

Figure 2

Existing Intersection Lane Use, Travel Lane Width and Pedestrian Facilities

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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, November traffic volumes are typically 3 percent higher than average monthly conditions, and therefore were not adjusted in order to represent an average-month analysis condition. 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. The morning peak hour is 7:30 to 8:30 AM, after the expected school peak, and the afternoon peak hour is after from 2:00 to 3:00 PM. The 2018 Existing traffic volumes are graphically depicted on Figure 3.

Existing Condition Observations

Observations were made in the area to obtain a better understanding of existing conditions. The primary drop-off/pick-up area is located at the Pierce Street loop and parents also utilize the public parking lot off of Holden Street. Crossing guards are located at the intersections of School Street at Washington Street and Harvard Street at School Street and Aspinwall Avenue. Main pedestrian routes include the southern side of School Street, the west side of Harvard Street and Holden Street. During the weekday morning, a maximum 10-vehicle queue was noted and during the weekday evening, a maximum 5-vehicle queue was noted on the Pierce Street loop.

PEDESTRIAN AND BICYCLE FACILITIES

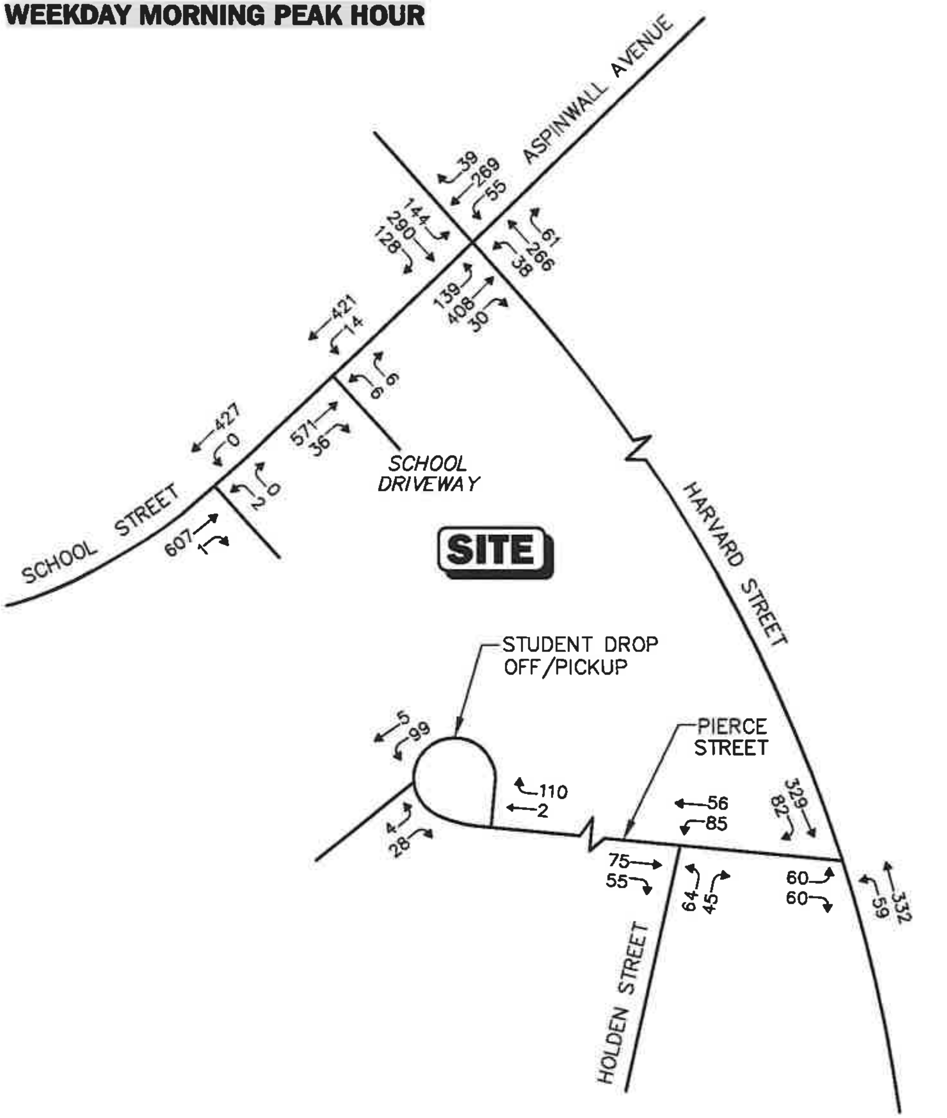
A comprehensive field inventory of pedestrian and bicycle facilities within the study area was undertaken in January 2018. The field inventory consisted of a review of the location of sidewalks and pedestrian crossing locations along the study roadways and at the study intersections, as well as the location of existing and planned future bicycle facilities. Sidewalks are provided both sides of the study roadways with marked crosswalks and pedestrian traffic signal equipment provided at the signalized study intersection. Additional crosswalks are provided on Pierce Street and Holden Street. Bicycle lanes are installed on both sides of Harvard Street, within the study area. Cross guards are stationed at all major locations surrounding the Pierce School.

PUBLIC TRANSPORTATION

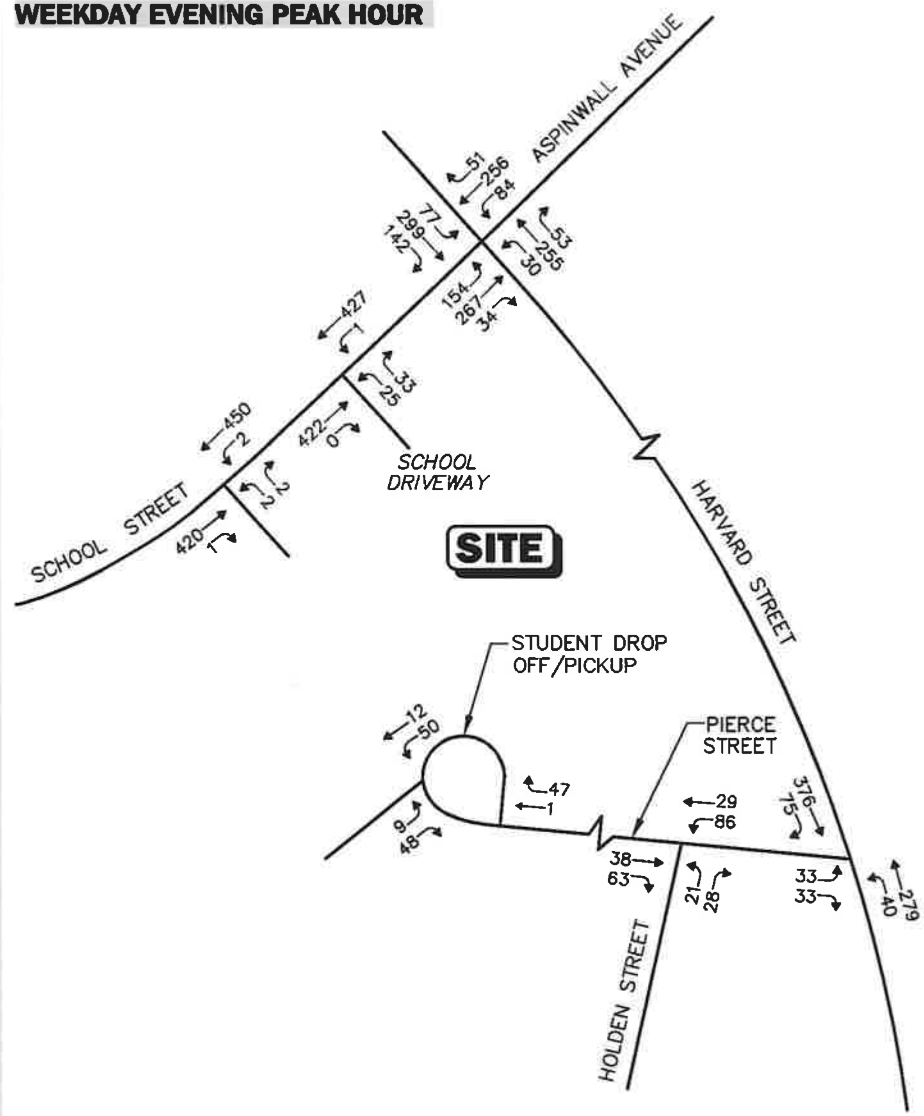
Public transportation services are provided within the study area by the Massachusetts Bay Transit Authority (MBTA) via the *Route 66 Bus*. Fixed Bus Route 66: *Harvard Square – Dudley Squ*are provides bus service Monday through Friday from approximately 4:45 AM to 1:33 AM, on Saturday from 4:40 AM to 1:36 AM, and on Sunday from 5:50 AM to 1:34 AM, with 9-minute headways on weekdays and 17-minute-or-less headways on Saturdays. The closest bus stop to the project site is located at the signalized intersection of Harvard Street at School Street and Aspinwall Avenue, at *Harvard Street @ School Street* (southbound direction) and at *Harvard Street @ Aspinwall Street* (northbound direction).

In addition, fixed Bus Route 65: *Brighton Center – Kenmore Station* provides bus service Monday through Friday from approximately 6:20 AM to 8:58 PM, on Saturday from 6:45 AM to 6:39 PM, and no service on Sunday, with 10-minute headways on weekdays and 60-minute headways on Saturdays. The closest bus stop to the project site is located at the signalized

WEEKDAY MORNING PEAK HOUR



WEEKDAY EVENING PEAK HOUR



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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headways on Saturdays. The closest bus stop to the project site is located at the signalized intersection of Washington Street at School Street, at *Washington Street @ School Street* (northbound direction) and at *Washington Street @ Cypress Street* southbound direction).

All MBTA buses are handicapped and wheelchair accessible.

Also in the vicinity of the study area, the MBTA runs the Green Line C and Green Line D trains. The Green Line C train runs north of the project site, along Beacon Street. The closest T-stop (*Coolidge Corner*) is 0.5 miles away. The Green Line D train runs south of the project site, paralleling Washington Street (Route 9). The closest T-stop (*Brookline Village*) is 0.4 miles away.

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	School Street at Harvard Street and Aspinwall Avenue	Harvard Street at Pierce Street
Year:		
2011	2	1
2012	4	1
2013	0	0
2014	1	2
2015	4	0
Total	11	4
Average[a]	2.2	0.8
Crash Rate[b]	0.32	0.24
Significant	No	No
Type:		
Angle	0	2
Rear-End	7	0
Head-On	0	0
Sideswipe	3	0
Fixed Object	1	2
Other	0	0
Total	11	4
Pavement Conditions:		
Dry	9	4
Wet	1	0
Snow/Ice	1	0
Unknown/ Other	0	0
Total	11	4
Severity:		
Property Damage Only	7	3
Personal Injury	4	1
Fatality	0	0
Unknown	0	0
Total	11	4

[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 study area intersections were found to have experienced an average of less than three reported motor vehicle crashes over the five-year review period, with the intersection of Harvard Street at Aspinwall Street and School Street found to have experienced the largest number of reported crashes (11 total). Further review of the crash data indicates that the majority of the reported collisions resulted in property damage only, and involved rear-end collisions. This type of accident is typical for a signalized location. All of the study intersections were found to have a motor vehicle crash rate below the MassDOT statewide and Highway Division District 6 (the MassDOT Highway Division District in which the intersections are located) average crash rates for a signalized or unsignalized intersection, as appropriate. In addition, no fatal motor vehicle crashes were reported within the study area over the five-year review period.

PIERCE 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 were 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:

Brookline Early Education Program, Harvard Street, Brookline. The Center for Early Education development to be located at 127-131 Harvard Street in Brookline, Massachusetts. The proposed 24,997 sf building will accommodate up to 115 students and 50 employees, which will provide early education needs for Brookline residents.

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

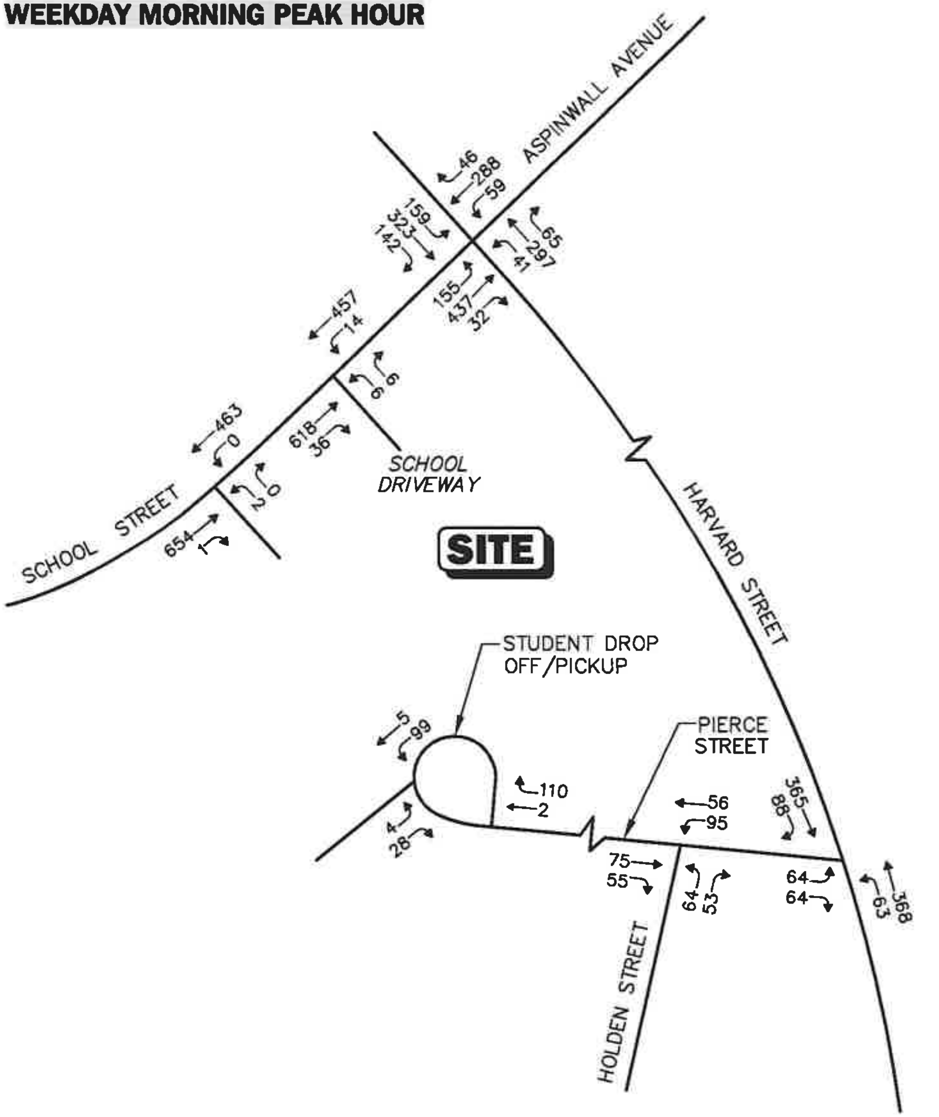
Design year (2025 Build) traffic volumes for the study area roadways were determined by estimating Project-generated traffic volumes and assigning these volumes on the study roadways. The following describes the methodology used to establish the traffic characteristics of the Project. As proposed, the Project will entail the expansion of an 859 student elementary school to a 1,100 student elementary school.

In order to develop the traffic characteristics of the Project, vehicles entering and exiting at the site access and egress points were counted, and a vehicle trip-rate per student was developed and applied to the increase of 241 students. Based upon data provided by the Public Schools of Brookline, approximately 700 students walk to the Pierce School, which is approximately 80%. Table 2 summarizes the anticipated characteristics of the Project based upon vehicle counts conducted at key school access and egress locations.

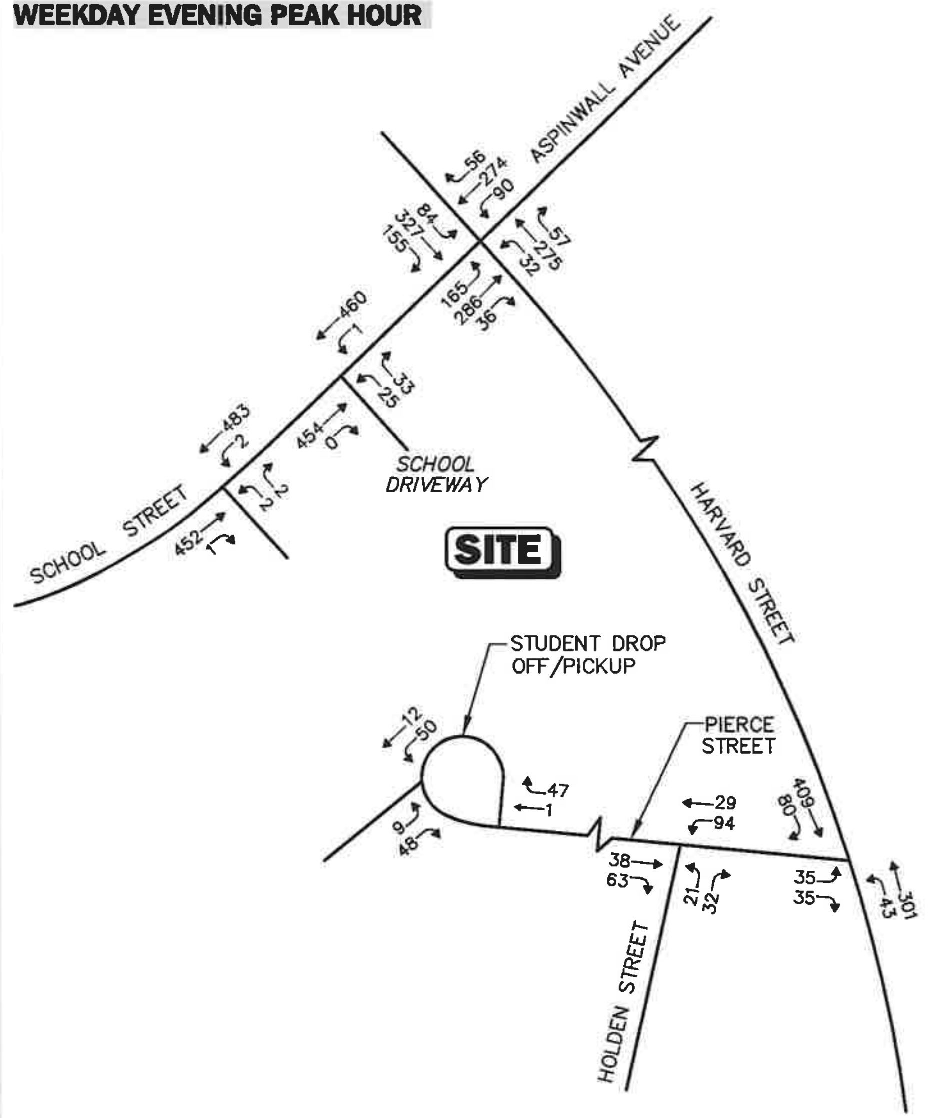
Survey results of the existing student population of the Pierce School include the following:

- 82% walk to/from Pierce School
- 1% bus to/from Pierce School
- 16% vehicle drop-off/pick-up
- 1% use public transportation to/from Pierce School

WEEKDAY MORNING PEAK HOUR



WEEKDAY EVENING PEAK HOUR



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

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Not To Scale

Figure 4

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No-Build Weekday
Weekday
Peak Hour Traffic Volumes

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Table 2
EXISTING PIERCE SCHOOL VEHICLE TRIPS[a]

Time Period/Direction	Drop-Offs/ Pick-Ups[b]	School Street Driveways	**Total Elementary School Trips** (859 Students)
Weekday Morning Peak Hour:			
Entering	127	51	**178**
Exiting	127	14	**141**
Total	254	65	**319**
Weekday Afternoon Peak Hour:			
Entering	66	4	**70**
Exiting	66	62	**128**
Total	132	66	**198**

[a]Based on TMCs conducted January 2018.
[b]Includes both drop-off area and municipal parking lot.

As can be seen in Table 2, the existing 859-student Pierce Elementary School generates approximately 319 vehicle trips during the weekday morning peak hour (178 entering and 141 exiting), with 198 vehicle trips during the weekday evening peak hour (70 entering and 128 exiting). A summary of expected vehicle trip generation for the expansion of the Pierce School is summarized in Table 3, and is based upon a trip-rate developed from Table 2.

Table 3
TRIP GENERATION SUMMARY

Time Period	Existing Vehicle Trips (859 students)	Trip-Rate Per Student	New Vehicle Trips (241 students)	Total Trips (1100 students)
Weekday Morning Peak Hour:				
Entering	178	0.21	51	229
Exiting	141	0.16	39	180
Total	319	0.37	90	409
Weekday Afternoon Peak Hour:				
Entering	70	0.08	19	89
Exiting	128	0.15	36	164
Total	198	0.23	55	253

As can be seen in Table 3, the Project is expected to generate approximately 90 new vehicle trips (51 vehicles entering and 39 exiting) expected during the weekday morning peak-hour. During the weekday afternoon peak hour the Project is expected to generate approximately 55 new vehicle trips (19 vehicles entering and 36 exiting). The above estimates were utilized for analysis purposes in assessing the overall impacts.

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. 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)	Residential (To/From)
Harvard Street	South	30
Holden Street	South	30
Harvard Street	North	25
Aspinwall Avenue	East	10
School 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 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.

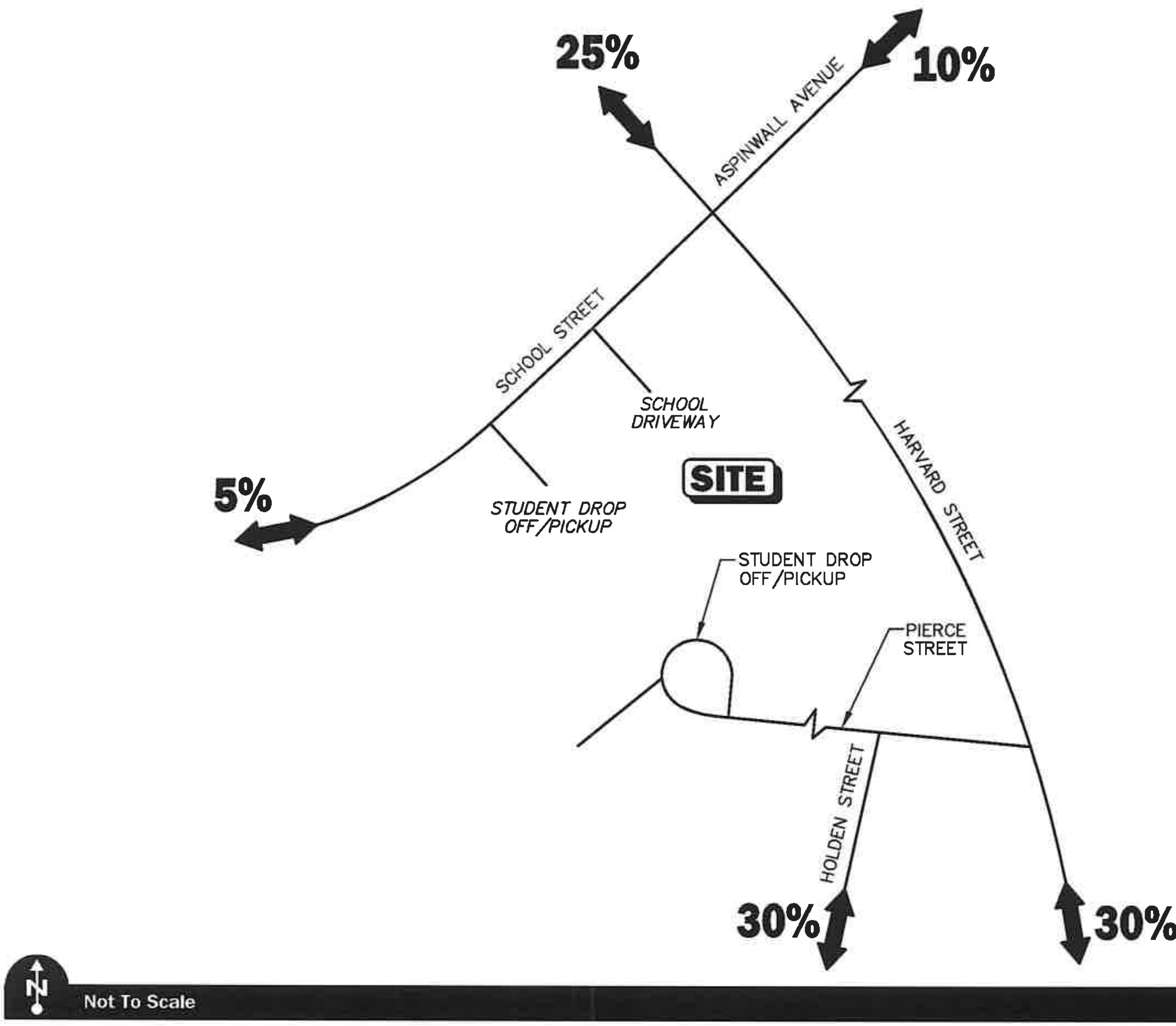

Figure 5

Trip Distribution Map

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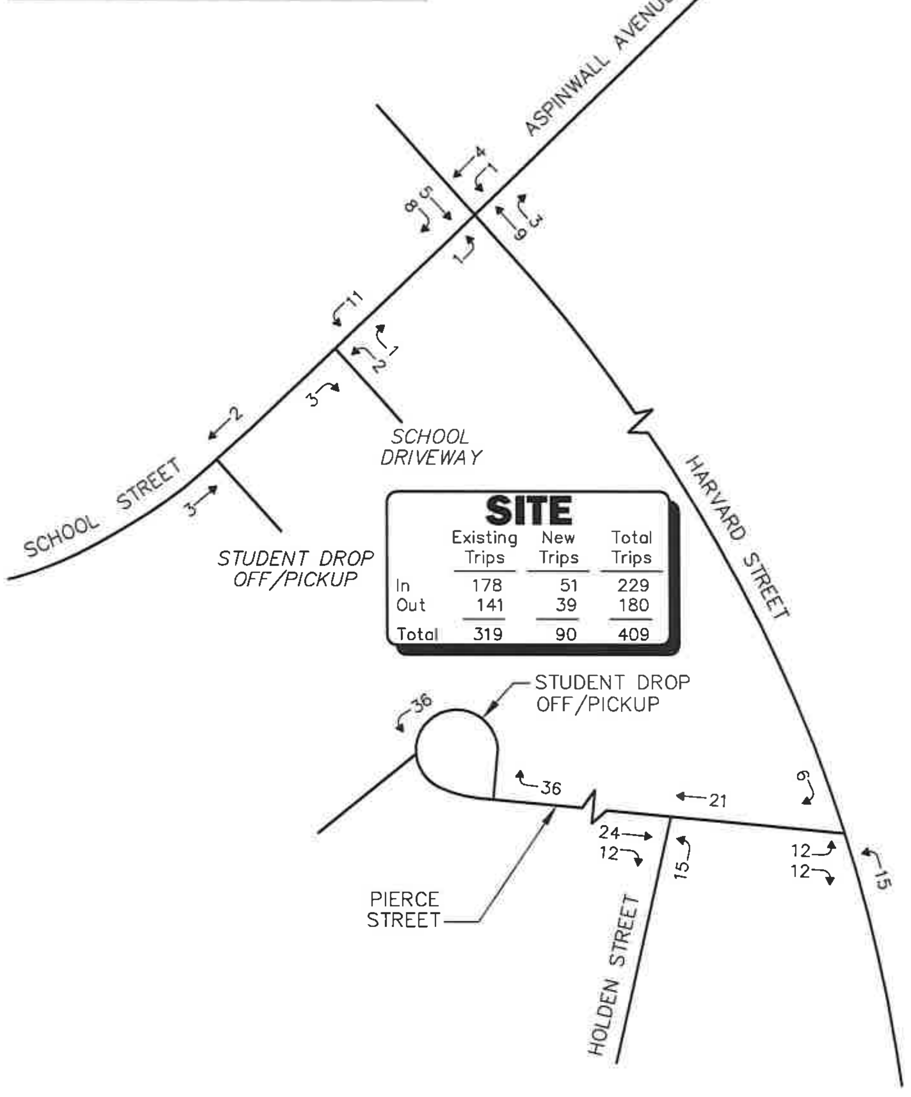
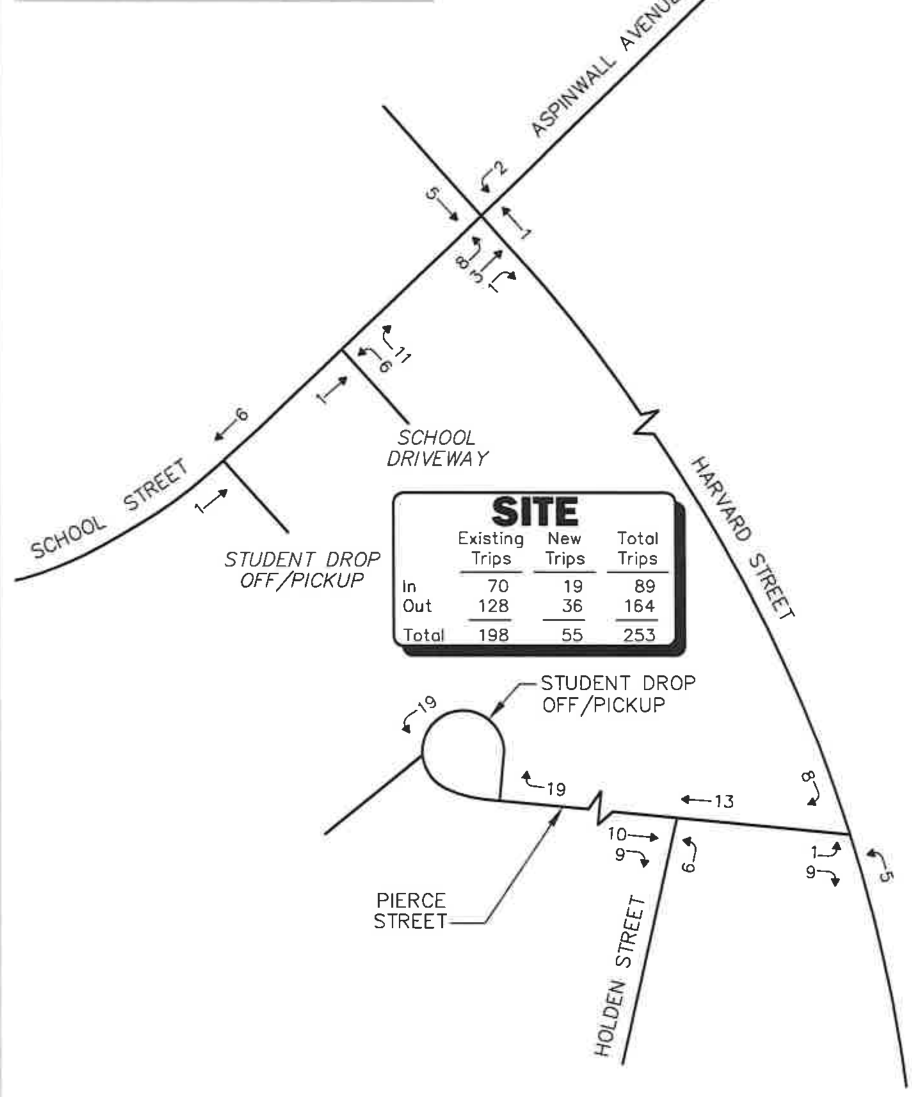
WEEKDAY MORNING PEAK HOUR



SITE

	Existing Trips	New Trips	Total Trips
In	178	51	229
Out	141	39	180
Total	319	90	409

WEEKDAY EVENING PEAK HOUR



SITE

	Existing Trips	New Trips	Total Trips
In	70	19	89
Out	128	36	164
Total	198	55	253

Not To Scale

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Figure 6

Site Generated
Weekday
Peak Hour Traffic Volumes

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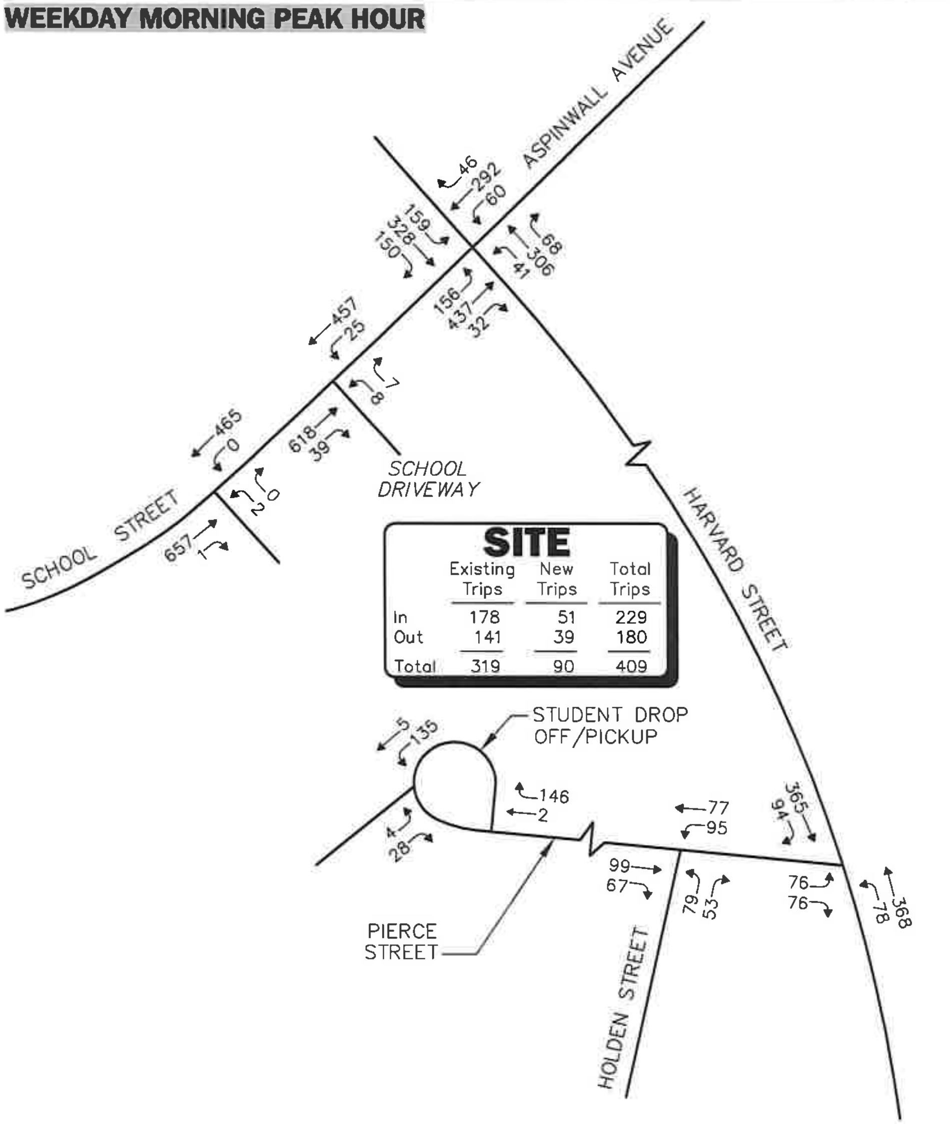
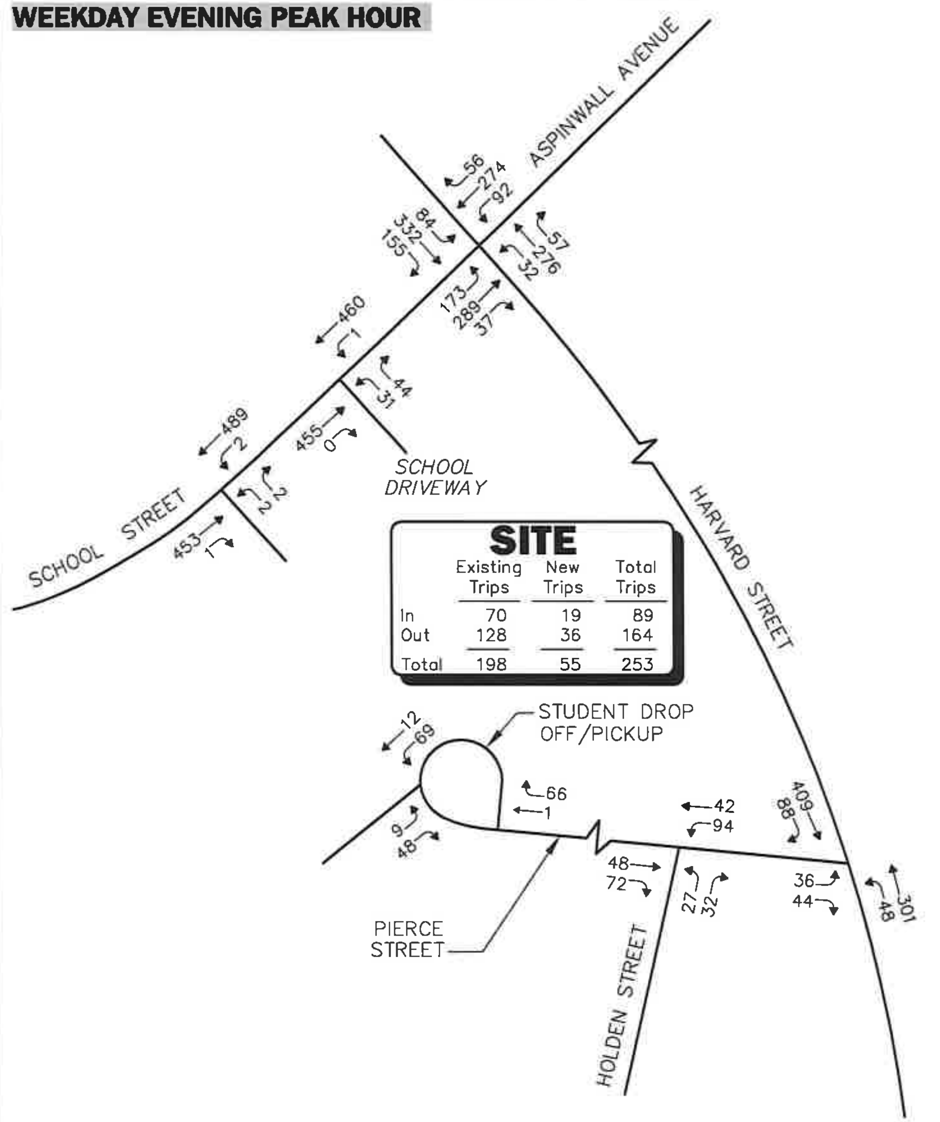
WEEKDAY MORNING PEAK HOUR



SITE

	Existing Trips	New Trips	Total Trips
In	178	51	229
Out	141	39	180
Total	319	90	409

WEEKDAY EVENING PEAK HOUR



SITE

	Existing Trips	New Trips	Total Trips
In	70	19	89
Out	128	36	164
Total	198	55	253

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

Not To Scale

Figure 7

Build Weekday
Weekday
Peak Hour Traffic Volumes

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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
Harvard Street, south of Pierce Street:				
Weekday Morning	860	887	27	3.1
Weekday Afternoon	788	802	14	2.0
Holden Street, south of Pierce Street:				
Weekday Morning	267	294	27	10.1
Weekday Afternoon	210	225	15	8.1
Aspinwall Avenue, east of Harvard Street:				
Weekday Morning	1,054	1,062	8	5.2
Weekday Afternoon	847	852	5	0.6
Harvard Street, north of School Street:				
Weekday Morning	1,122	1,145	23	2.0
Weekday Afternoon	1,062	1,076	14	1.3
School Street, west of Drop-Off Area:				
Weekday Morning	1,120	1,125	5	0.4
Weekday Afternoon	938	945	7	0.3

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 0.3 to 10.1 percent during the peak periods.

PIERCE SCHOOL TRAFFIC OPERATIONS ANALYSIS

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.[1] 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.

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[1]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.*[2] 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 (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; 2000; page 19-2.

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

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*. 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 (Seconds Per Vehicle)
$v/c \leq 1.0$	$v/c > 1.0$	
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.

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 8 and 9.

Unsignalized Intersection Analysis Results

Pierce Street at Holden Street

Under the all conditions, Holden Street operates at LOS B during both the weekday morning and weekday afternoon peak hours.

Pierce Street at Harvard Street

Under Existing and No-Build conditions, Pierce Street operates at LOS C during both the weekday morning and weekday afternoon peak hours. Under Build conditions, Pierce Street operates at LOS D during the weekday morning peak hour and LOS C during the weekday afternoon peak hour.

School Street at School Driveway (Parking)

Under all conditions, the School Driveway operates at LOS C during the weekday morning peak hour, and at LOS B during the weekday afternoon peak hour.

School Street at Service Driveway

Under all conditions, the Student Drop-Off operates at LOS C during the weekday morning peak hour, and at LOS B during the weekday afternoon peak hour.

Signalized Intersection Analysis Result

Harvard Street at School Street and Aspinwall Avenue

Under all conditions, this intersection operates at an overall LOS D during both the weekday morning and weekday afternoon peak hours.

Table 8
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
Pierce Street at Holden Street												
Weekday Morning:												
Holden Street NB LT/RT	109	13.8	B	28	117	14.3	B	31	132	17.2	C	45
Weekday Afternoon:												
Holden Street NB LT/RT	49	10.2	B	6	53	10.2	B	7	59	10.7	B	8
Pierce Street at Harvard Street												
Weekday Morning :												
Pierce Street EB LT/RT	120	22.5	C	63	128	23.3	C	70	152	30.2	D	105
Weekday Afternoon:												
Pierce Street EB LT/RT	66	15.9	C	23	70	16.4	C	26	80	16.7	C	30
School Street at School Driveway												
Weekday Morning :												
School Driveway NB LT/RT	12	15.7	C	4	12	16.5	C	3	15	17.7	C	4
Weekday Afternoon:												
School Driveway NB LT/RT	58	14.2	B	15	58	14.2	B	12	75	14.5	B	16
School Street at Service Driveway												
Weekday Morning :												
Drop-Off/Pick-Up NB LT/RT	2	15.5	C	1	2	16.1	C	1	2	16.1	C	1
Weekday Afternoon:												
Drop-Off/Pick-Up NB LT/RT	4	12.4	B	1	4	12.5	B	1	4	12.5	B	1

[a]Demand in vehicles per hour
[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 9
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] $50^{th}/95^{th}$	V/C	Delay	LOS	Queue $50^{th}/95^{th}$	V/C	Delay	LOS	Queue $50^{th}/95^{th}$
Harvard Street at Aspinwall Street and School Street												
Weekday Morning:												
School Street EB LT	0.84	60.2	E	69/191	1.01	>80.0	F	77/246	1.02	>80.0	F	78/249
School Street EB TH/RT	0.85	47.2	D	268/571	0.90	54.0	D	291/624	0.90	54.0	D	291/624
Aspinwall Street WB LT	0.73	67.6	E	34/127	0.94	>80.0	F	36/140	1.03	>80.0	F	41/153
Aspinwall Street WB TH/RT	0.83	54.5	D	192/426	0.90	65.2	E	213/477	0.91	67.0	E	216/485
Harvard Street NB LT	0.10	22.0	C	13/43	0.12	23.4	C	14/46	0.12	24.0	C	14/46
Harvard Street NB TH/RT	0.46	23.8	C	137/291	0.51	24.8	C	156/329	0.52	25.2	C	163/343
Harvard Street SB LT	0.42	19.3	B	59/136	0.48	20.0	B	63/147	0.49	20.2	C	63/147
Harvard Street SB TH/RT	0.59	24.8	C	205/413	0.63	25.9	C	224/466	0.65	26.5	C	234/487
Overall	**0.66**	**38.1**	**D**	--	**0.74**	**47.1**	**D**	--	**0.76**	**48.9**	**D**	--
Weekday Evening:												
School Street EB LT	1.03	>80.0	F	86/229	1.02	>80.0	F	82/264	1.07	>80.0	F	84/282
School Street EB TH/RT	0.63	33.6	C	183/322	0.59	32.4	C	175/345	0.60	32.6	C	178/350
Aspinwall Street WB LT	0.55	41.1	D	51/138	0.53	39.7	D	54/139	0.55	40.6	D	55/146
Aspinwall Street WB TH/RT	0.86	57.2	E	198/443	0.88	59.7	E	212/476	0.88	59.7	E	212/476
Harvard Street NB LT	0.09	21.8	C	11/38	0.10	24.5	C	12/39	0.11	24.8	C	12/39
Harvard Street NB TH/RT	0.44	22.3	C	134/286	0.48	23.5	C	146/309	0.48	23.6	C	146/311
Harvard Street SB LT	0.22	17.6	B	29/77	0.26	18.5	B	32/83	0.26	18.5	B	32/83
Harvard Street SB TH/RT	0.59	24.8	C	207/430	0.66	27.2	C	235/486	0.66	27.4	C	239/494
Overall	**0.73**	**40.3**	**D**	--	**0.76**	**40.7**	**D**	--	**0.79**	**42.4**	**D**	--

[a]Volume-to-capacity ratio.
[b]Percentile delay per vehicle in seconds.
[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

PIERCE SCHOOL SUMMARY AND RECOMMENDATIONS

SUMMARY

VAI has completed a detailed assessment of the impacts associated with the potential Pierce Elementary School expansion. 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 90 new vehicle trips (51 entering/ 39 exiting) expected during the weekday morning peak-hour and 55 vehicle trips (19 entering/36 exiting) expected during the weekday afternoon peak-hour;
- A review of accident data researched from MassDOT indicates that area intersections experience accident rates below state averages indicating safe operations.
- Pierce School is primarily a walking school with up to 80 percent of students walking.
- Crossing guards are located at area intersections to ensure safe crossing of area roadways.

Overall, the school expansion will increase delays and queues slightly during limited periods of the day.

RECOMMENDATIONS

The following improvements have been recommended as a part of this evaluation and will be completed in coordination with the Town.

School Zone Signage

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

Transit Usage

Transit usage for staff should be encouraged.

School Drop-Off and Pick-Up Traffic Management Plan

School drop-off and pick-up procedures should be continuously 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 and pedestrians.

Overall, a Pierce school expansion is expected to have minimal impact with respect to delays and queues, and will be limited to short periods in the morning and afternoon.