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Transportation Impact Assessment

Proposed Baldwin Elementary School

Brookline, Massachusetts

Prepared for:

Jonathan Levi Architects
Boston, Massachusetts

February 2017

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

PROPOSED BALDWIN ELEMENTARY SCHOOL
BROOKLINE, MASSACHUSETTS

Prepared for:

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EXECUTIVE SUMMARY

VAI has completed a detailed assessment of the potential impacts on the transportation infrastructure associated with the proposed Baldwin Elementary School to be located off Heath Street in Brookline, Massachusetts. 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. The following specific areas have been evaluated as they relate to the Project: i) access requirements; ii) potential off-site improvements; and iii) safety considerations; under existing and future conditions, both with and without the Project. Based on this assessment, we have concluded the following with respect to the Project:

- The Project is expected to generate approximately 776 vehicle trips (437 entering/ 339 exiting) expected during the weekday morning peak-hour and 481 vehicle trips (216 entering/265 exiting) expected during the weekday afternoon peak-hour;
- A review of accident data researched from MassDOT indicates that area intersections (with the exception of the Horace James Circle) experience accident rates below state averages indicating safe operations.
- The proposed driveway off Heath Street has adequate sight distances for safe and efficient operations.
- While the projected pedestrian traffic to the school is expected to be minimal, safe conditions can be achieved with sidewalks, crosswalks and crossing guards at appropriate locations.
- The Project will increase traffic in the morning and afternoon periods with increased delays and queues at locations within the study area. These delays and queues will be confined to limited and distinct periods during the morning drop-off and afternoon pick-up periods (20-25 minutes at peaks) and these periods are non-coincident with the peak periods of the adjacent roadways.

In summary, the proposed site is a good location for a new school and a safe environment can be maintained with traffic conditions maintained at manageable levels. While the school can be safely accommodated and will increase delays and queues during limited period of the day (20-25 minutes at peaks), improvements will be necessary to minimize the impacts and enhance safety conditions.

RECOMMENDATIONS

A detailed transportation improvement program has been developed that is designed to maintain safe and efficient access to the school and address any deficiencies identified at off-site locations evaluated in conjunction with this study. The following improvements have been recommended as a part of this evaluation and will be completed in coordination with the Town.

Project Access

The school driveways were planned such that traffic impacts to the area are minimized and safe and efficient access and egress is provided. While a two-way driveway was considered along Woodland Road and two-way travel on Woodland Road was reviewed, this option was eliminated due to Woodland Road impacts. Based upon the evaluation three driveways are proposed:

- ➢ The main driveway off Heath Street is located at the approximately location of the Soule Recreation Center rear access. This driveway will provide two exit lanes and one entering lane.
- ➢ A left-turn entering only driveway is proposed off Woodland Road which minimizes the amount of turning traffic onto Heath Street and at the Heath Street main driveway.
- ➢ A bus/service driveway is proposed off Heath Street and is designed such that buses can arrive in either direction from Heath Street.

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

- ➢ The main driveway should have a minimum 20-foot entrance and two 12-foot exit lanes under STOP-control. The intersection should be illustrated.
- ➢ Both Entrance-Only drives 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 provided along Heath Street for and Woodland Road.
- ➢ 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).[1]
- ➢ In order to provide the required lines of sight approaching and departing the Project site driveway intersection with Heath Street, the area to the east of the driveway must be regraded for sufficient lines of sight.
- ➢ Signs and landscaping adjacent to the Project site driveway intersections should be designed and maintained so as not to restrict lines of sight.

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[1] Ibid 4

Pedestrian Improvements

New crosswalks are proposed along Heath Street, Hammond Street and Woodland Road. Crossing guards should be placed at the Hammond Street crosswalk and at the main Heath Street driveway. Sidewalks entering the site will be provided along the bus/service drive, main Heath Street drive and Woodland Road drive. In addition, all of the existing pedestrian deficiencies should be addressed by the Town to provide the area with continuous ADA-complaint sidewalks.

As part of the Woodland Road traffic calming improvements, the following should be implemented:

- A raised crosswalk at the new School driveway
- Bicycle lane considerations along Woodland Road
- Continuous sidewalk along the north side of Woodland Road.

Off-Site

Hammond Street at Route 9 and Hammond Street at Heath Street

This intersection should be retimed and coordinated. It is proposed that the Heath Street traffic signal cycle length be one-half of the Route 9 traffic signal cycle such that additional capacity can be allocated to Heath Street to facilitate traffic movements exiting Heath Street.

Heath Street at Woodland Road

This intersection should be realigned with reduced pavement width to better define traffic flow. Woodland Road should be stripped for a two-lane approach to Heath Street.

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 Heath Street and Woodland 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 and the site access and off-site improvements detailed herein have been developed to facilitate access to the school campus for pedestrians, bicyclists, school buses and parents/caregivers in a safe and efficient manner. The traffic and parking management plan has been designed to build-upon this created infrastructure and will consist of the following major elements, all of which are overseen by school staff:

- Police detail officer should be initially located at the main entrance and exit driveway serving the Project site in order to manage the flow of vehicles and pedestrians entering and exiting the site, and pedestrians crossing Heath 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, police detail at the main driveway, and evaluate the level of student busing and make adjustments, as necessary.

Overall, a safe environment to the school can be maintained and the increased traffic conditions with respect to delays and queues will be limited to short periods in the morning and afternoon.

INTRODUCTION

Vanasse & Associates, Inc. (VAI) has prepared this Transportation Impact Assessment (TIA) in order to identify the potential traffic impacts associated with the proposed Baldwin Elementary School located on the South side of Heath Street, between Hammond Street and Woodland Road 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 provide a safe environment for the school children, while minimizing the impacts to the surrounding neighborhood. 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 Baldwin Elementary School will consist of an 800 student elementary school with 125 staff to be located on Heath Street, between Hammond Street and Woodland Road in Brookline, MA. The anticipated school hours will be Monday – Thursday 8:00 AM to 2:30 PM and Friday 8:00 AM to 1:40 PM. Careful consideration has been made with respect to site access and egress. The school will be serviced by two driveways on Heath Street and one driveway on Woodland Road. The primary school driveway is located at the appropriate location of the Soule Recreation Center rear access. This driveway will service both entering and exiting traffic. Located off Heath Street to the west of Dunster Road will be the bus and service driveway. This driveway will be an entrance-only. The third driveway will be located off Woodland Road, which will be a left-turn entrance only driveway. The site will accommodate 130 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.

The scope of the Transportation Assessment was review with Town officials and expanded based upon public comments.

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 roadway providing access to the project site, Heath Street, as well as 13 intersections located near the site:

1. Boylston Street at Hammond Street
2. Hammond Street at Heath Street
3. Hammond Street at Soule Recreation Drive and Private Drive
4. Hammond Street at Woodland Road
5. Heath Street at Oak Street
6. Heath Street at Dunster Road
7. Boylston Street at Dunster Road
8. Heath Street at Cary Road
9. Heath Street at Soule Recreation Drive
10. Heath Street at Woodland Road
11. Heath Street at Randolph Road
12. Heath Street at Warren Street
13. Horace James Circle: Newton Street at Hammond Street, Hammond Pond Parkway and LaGrange Street

The following describes the study area roadways and intersections. Figure 1 provides a Study Location Map and Figure 2 depicts the study area intersections.

GEOMETRY

Roadways

Heath Street

Heath Street, in the vicinity of the site, is a roadway under local jurisdiction that generally travels in an east/west orientation in Brookline Massachusetts. Heath Street accommodates a two-lane roadway in each direction with travel separated by a double yellow centerline. Concrete sidewalks are generally provided along Heath Street within the study area. Land use along Heath Street consists primarily of residential, school and recreational properties. There is no posted speed limit on Heath Street in the vicinity of the site.

Transportation Impact Assessment - Proposed Baldwin Elementary School - Brookline, Massachusetts

Figure 1

Site Location Map

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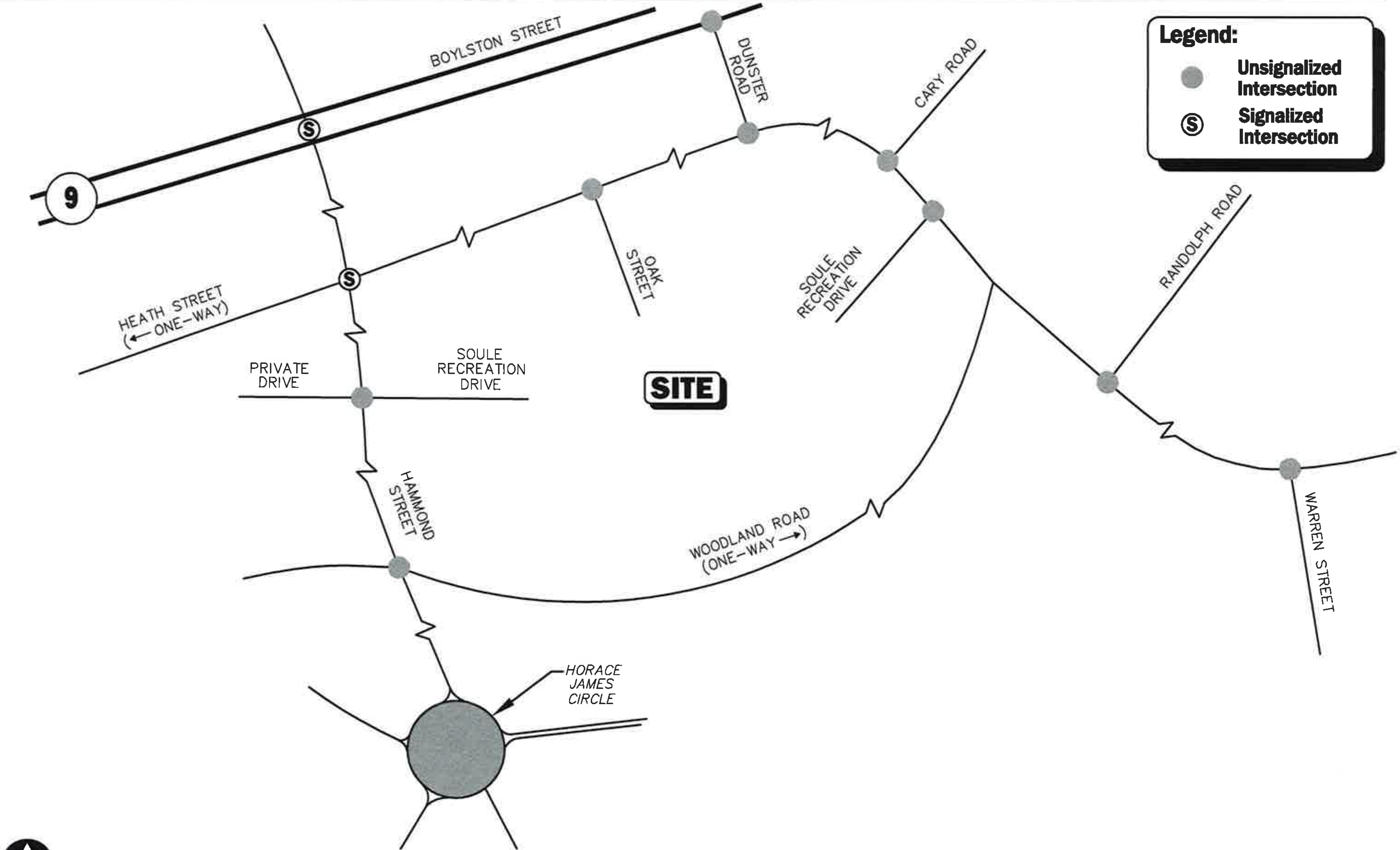

Figure 2

Study Area Intersection

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Intersections

Figure 3 summarizes lane use and lane widths at the study area intersections as observed in November 2016.

EXISTING TRAFFIC VOLUMES

In order to determine existing traffic-volume demands and flow patterns within the study area, automatic traffic recorder (ATR) counts, manual turning movement counts (TMCs) and vehicle classification counts were completed in November 2016 and January 2017. The ATR counts were conducted on Heath Street in the vicinity of the Project site in order to record weekday daily traffic conditions over an extended period, with weekday morning (7:00 to 9:00 AM) and weekday afternoon (2:00 to 5:00 PM) peak period manual TMCs performed 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, November traffic volumes are typically 3 percent higher than average monthly conditions and, therefore, were not adjusted downward in order to provide a conservative (above-average) analysis condition. The 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 nearest MassDOT permanent count stations in the area are located on the I-90 and I-95, and therefore were not deemed appropriate for use in the seasonal adjustment. A review of traffic counts at the nearby Baker School, indicate that the weekday morning peak hour of the school generally occurs between 7:15 and 8:15 AM while the weekday afternoon peak hour of the school generally occurs between 2:15 and 3:15 PM. In all instances, these peak hours of the school were utilized for analysis purposes. Afternoon traffic, after the identified peak, will be significantly less than the release period and was not further evaluated. The temporal daily distribution of traffic on Heath Street is depicted in Figure 4. As shown, the morning peak hour is 8:00 to 9:00 AM, after the expected school peak, and the afternoon peak hour is after 3:00 PM, which is after the expected school released time. The 2016 Existing traffic volumes are summarized in Table 1 and graphically depicted on Figures 5 and 6, respectively.

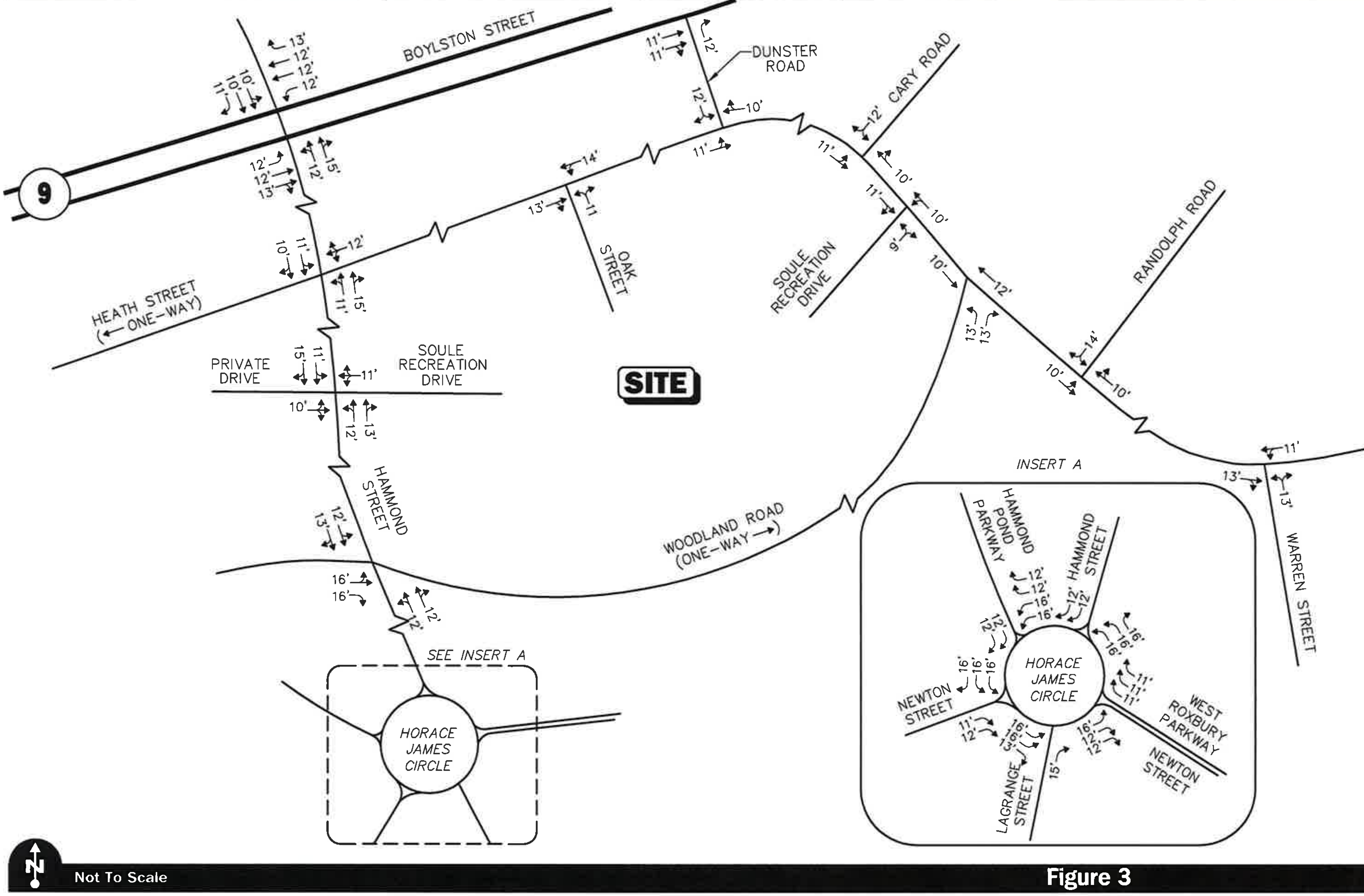

Figure 3

Existing Intersection Lane and Travel Lane Width

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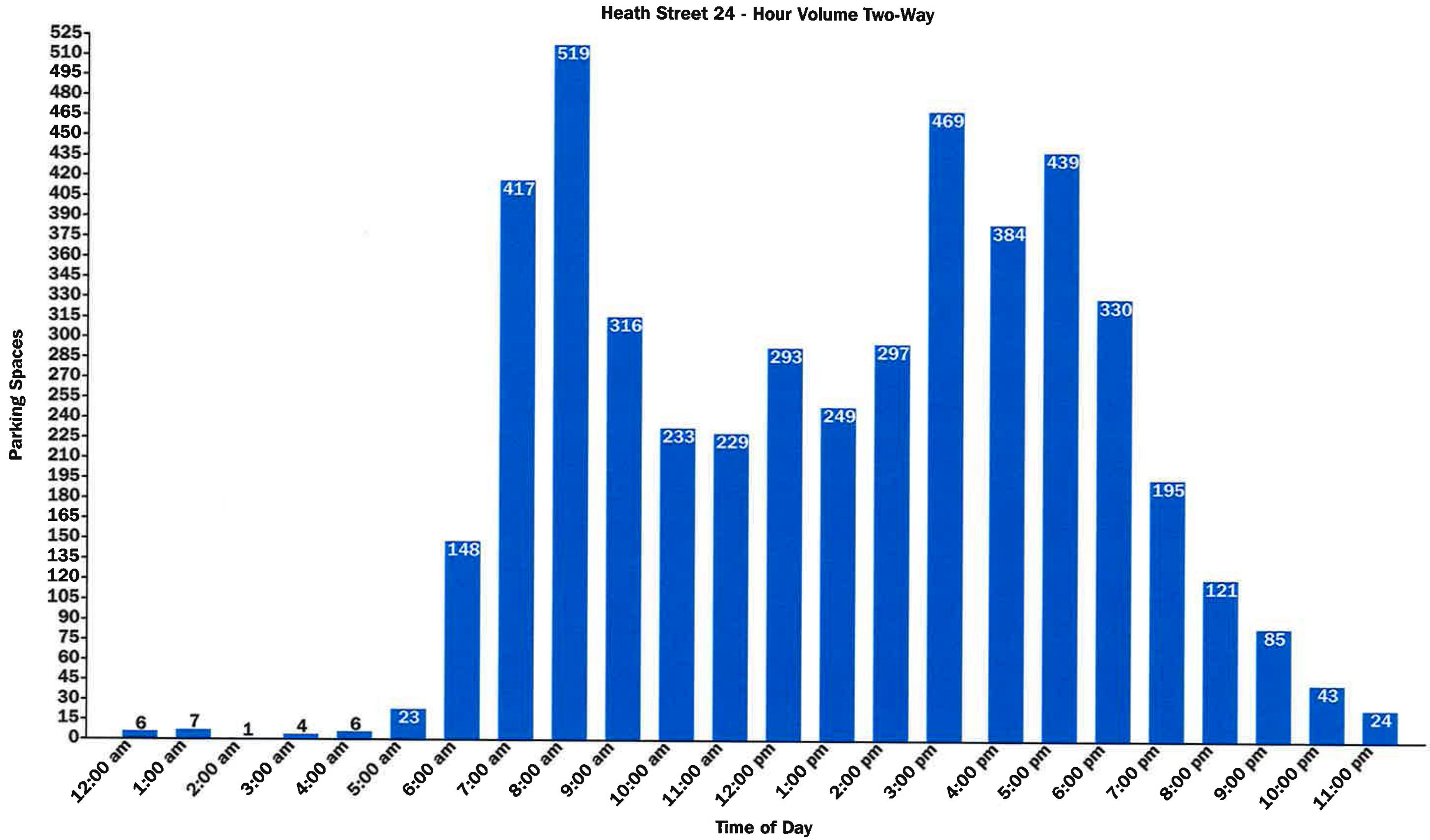

Figure 4

Heath Street ATR Count
Tuesday, November 11, 2016

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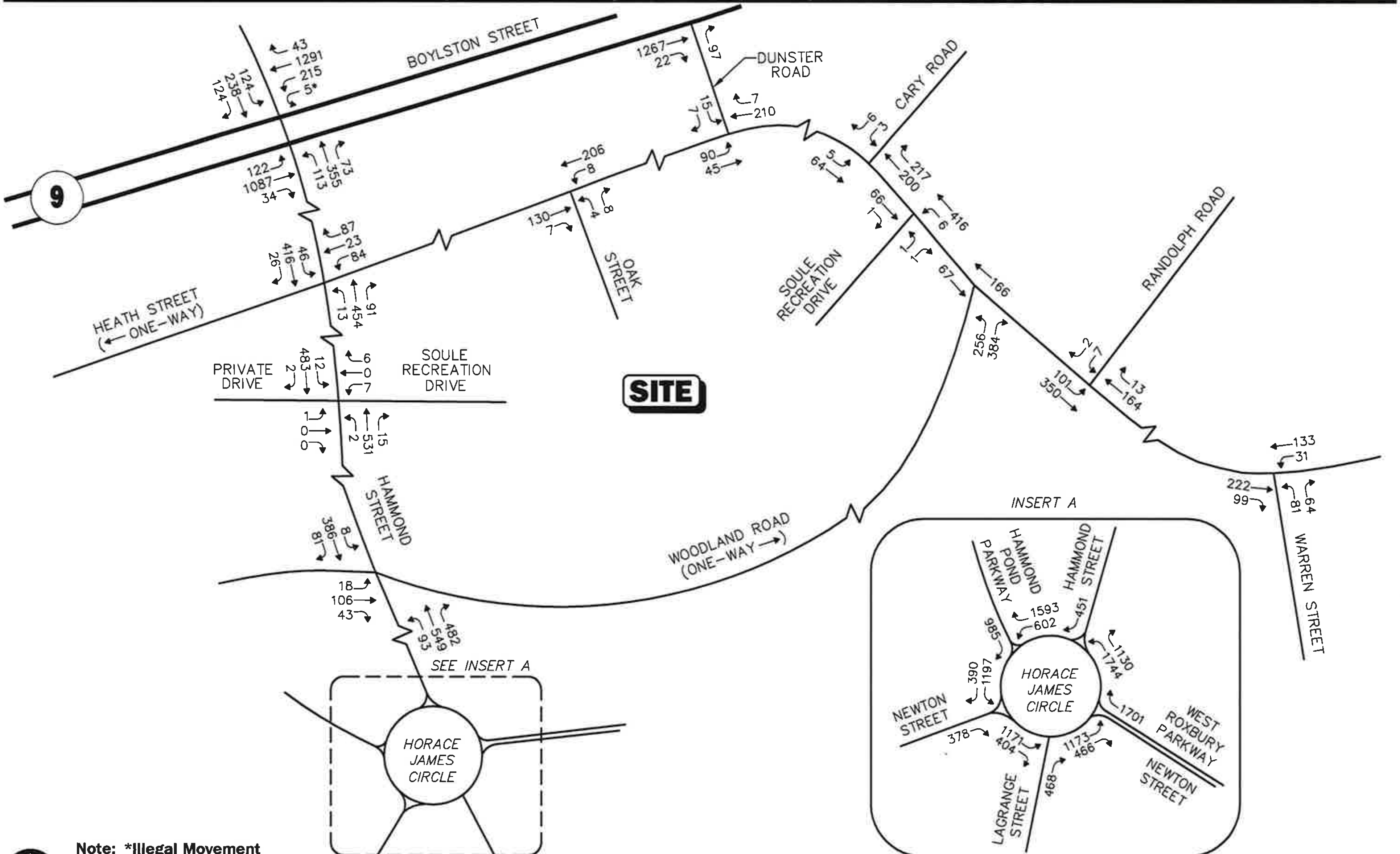

Note: *Illegal Movement
Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

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Figure 5

2016 Existing
Weekday Morning
School Peak Hour Traffic Volumes
(7:15 AM - 8:15 AM)

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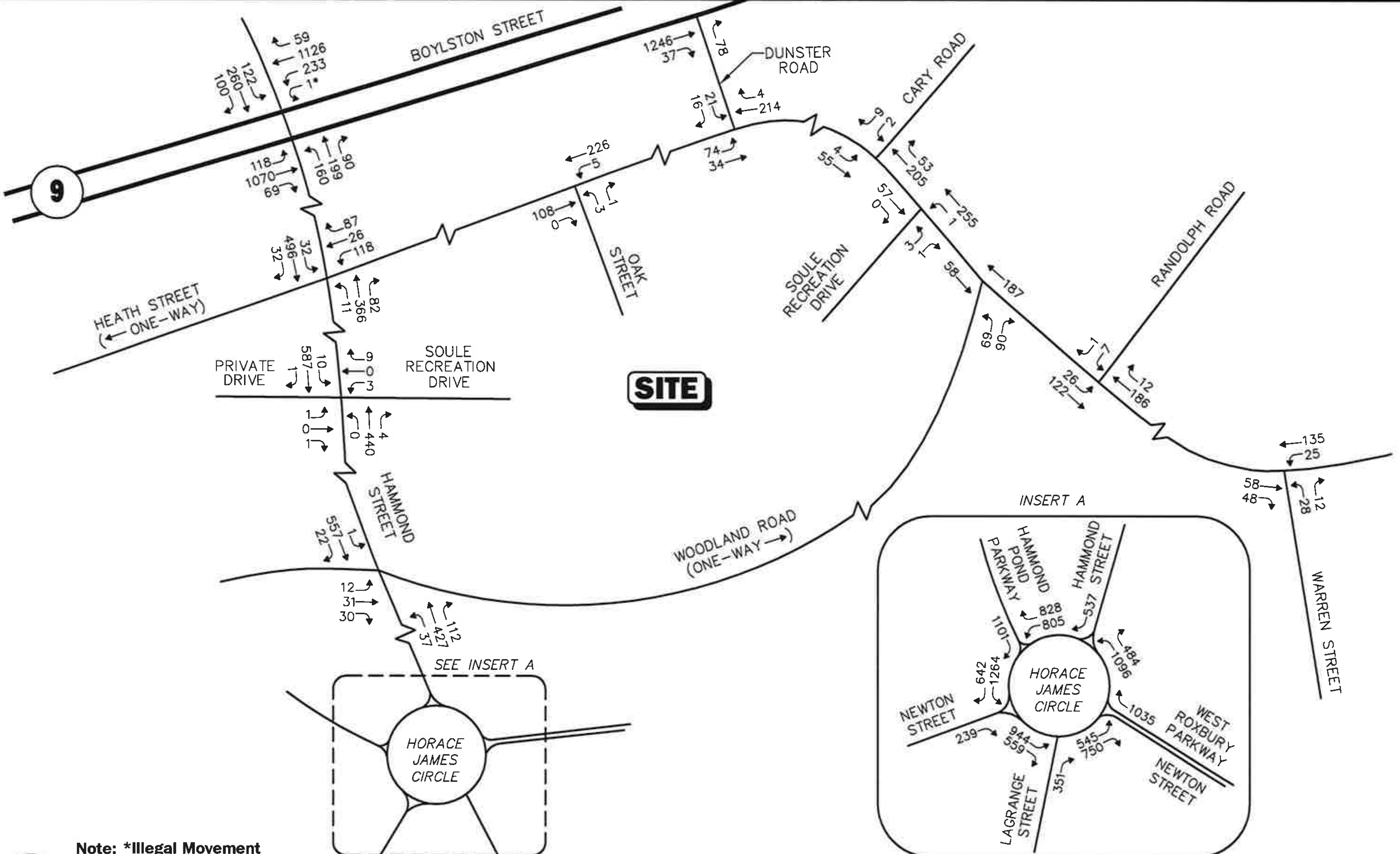

Note: *Illegal Movement
Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

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Figure 6

2016 Existing
Weekday Afternoon
School Peak Hour Traffic Volumes
(2:15 PM - 3:15 PM)

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Table 1
EXISTING ROADWAY TRAFFIC-VOLUME SUMMARY

		Weekday Morning Peak Hour			Weekday Afternoon Peak Hour		
Location	Daily Volume (vpd)[a]	Volume (vph)[b]	Percent of Daily Traffic[c]	Predominant Flow	Volume (vph)	Percent of Daily Traffic	Predominant Flow
Heath Street, east of Soule Recreation Driveway	4,850	489	10.1	86% WB	314	6.5	82% WB

[a]Two-way daily traffic expressed in vehicles per day; from ATR Counts November 2016.
[b] Manual turning movement counts conducted in November 2016.
[c]The percent of daily traffic that occurs during the peak hour.
WB = westbound

As can be seen in Table 1, Heath Street was found to accommodate approximately 4,850 vehicles per day (vpd) with 489 vehicles per hour (vph) during the weekday morning school peak hour and 314 vph during the weekday afternoon school peak hour. Directional traffic during both the morning and afternoon periods is heavily directional in the westbound direction.

Observation of delays and queues were made in the area to obtain a better understanding of existing conditions. Figure 7 depicts critical areas of existing delay and queues. As shown, the longest delays and queues were noted at the Horace James Circle where 185-second delay and a maximum 24-vehicle queue were noted on LaGrange Street. Hammond Street northbound experienced a 212-second delay and an 18-vehicle queue noted. Less significant were delays and queues were observed on the Heath Street approach to Hammond Street and minimal delays were noted at the Woodland Road approach to Heath Street although this street accommodates heavy cut-through traffic volumes.

PEDESTRIAN AND BICYCLE FACILITIES

A comprehensive field inventory of pedestrian and bicycle facilities within the study area was undertaken in November 2016. 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 bicycle facilities. Sidewalks are provided along the north and south sides of Boylston Street and Heath Street. On Hammond Street sidewalks are generally provided along both the east and west sides of the roadway. Marked crosswalks are provided along each approach to the Boylston Street at Hammond Street intersection, and nearby the Baldwin School on Heath Street and Hammond Street. No bicycle facilities were noted in the area. Figures 8 and 9 graphically depict the pedestrian volumes recorded in the area during the weekday morning and weekday afternoon school peak hours. Figure 10 graphically depicts the existing pedestrian facilities.

Figure 11 depicts existing deficiencies along the pedestrian routes within the study area. Deficiencies included non-ADA compliant ramps, utilities in sidewalks, non-compliant sidewalks and missing crosswalks.

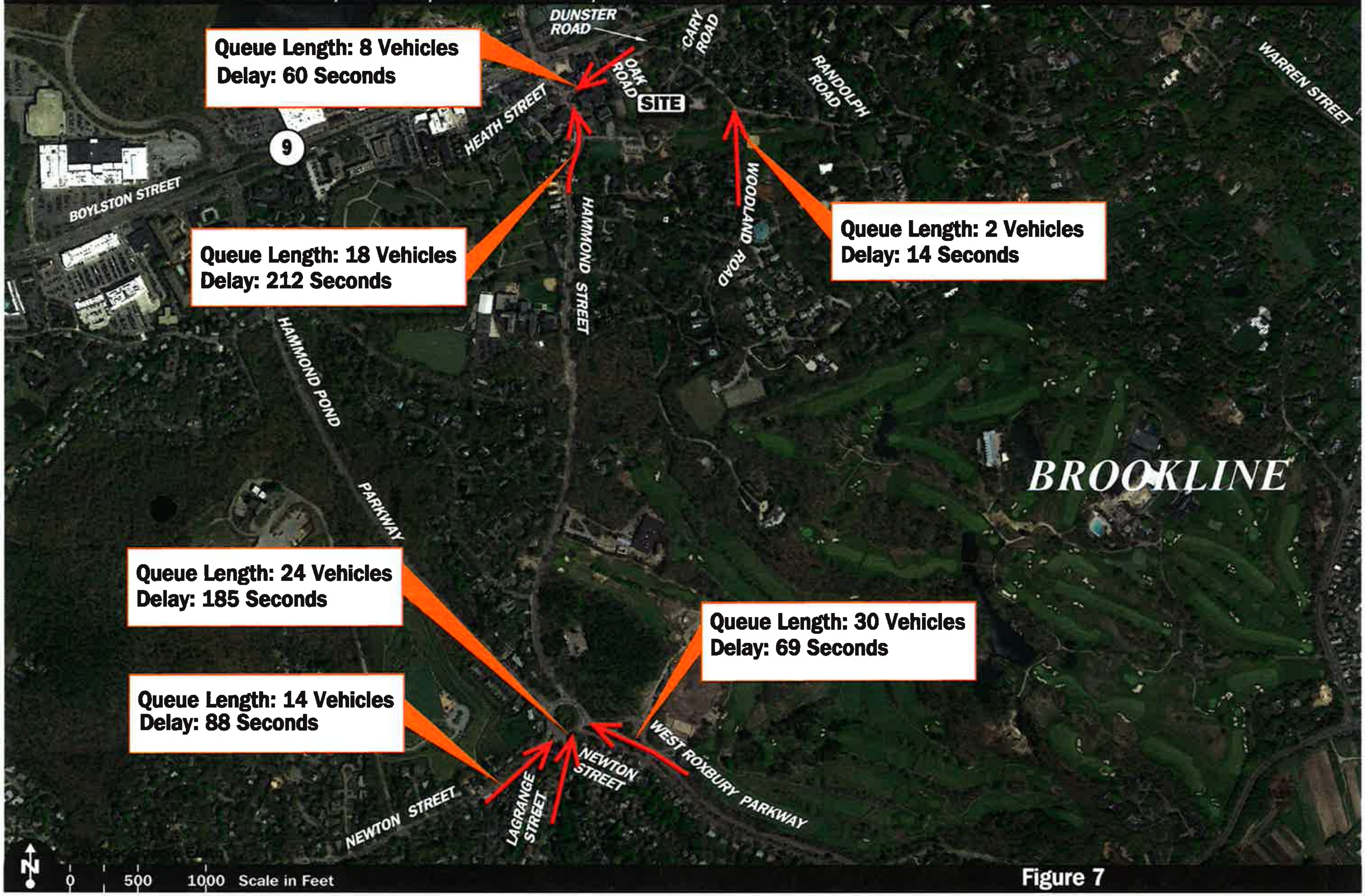

Figure 7

Existing
Weekday Morning
Delays and Queue Length

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PUBLIC TRANSPORTATION

Public transportation services are provided within the study area by the Massachusetts Bay Transit Authority (MBTA). The MBTA operates fixed-route bus services in the vicinity. Bus Route 60 – Chestnut Hill – Kenmore Station via Brookline Village and Cypress Street stops at the intersection of Boylston Street at Hammond Street. The MBTA Green Line D Branch Chestnut Hill Station is located off of Hammond Street approximately 0.3 miles north of the Project site, less than a ten minute walk. For purposes of this study, it was assumed no staff-use of public transportation will occur, although some utilization is expected.

SPOT SPEED MEASUREMENTS

Vehicle travel speed measurements were performed on Heath Street 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

	Heath Street		Woodland Road
	Eastbound	Westbound	Northbound
Mean Travel Speed (mph)	28	27	30
85th Percentile Speed (mph)	32	30	33
Posted Speed Limit (mph)	N/A	N/A	25

mph = miles per hour.

As can be seen in Table 2, the mean (average) vehicle travel speed along Heath Street in the vicinity of the Project site was found to be approximately 28 mph in the eastbound direction and 27 mph in the westbound direction. The measured 85th percentile vehicle travel speed, or the speed at which 85th percent of the observed vehicles traveled at or below, was found to be 32 mph in the eastbound direction and 30 mph in the westbound direction. On Woodland Road, where the posted speed limit is 25 mph, the mean speed was observed to be 30 mph and the 85th percentile speed was observed at 33 mph. 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. There is no posted speed limit on Heath Street in the vicinity of the project site.

SIGHT DISTANCE EVALUATION

Sight distance measurements were performed at the proposed school driveway intersections with Heath Street in accordance with MassDOT and American Association of State Highway and Transportation Officials (AASHTO)[2] standards. In brief, SSD is the distance required by a vehicle traveling at the design speed of a roadway, on wet pavement, to stop prior to striking an

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

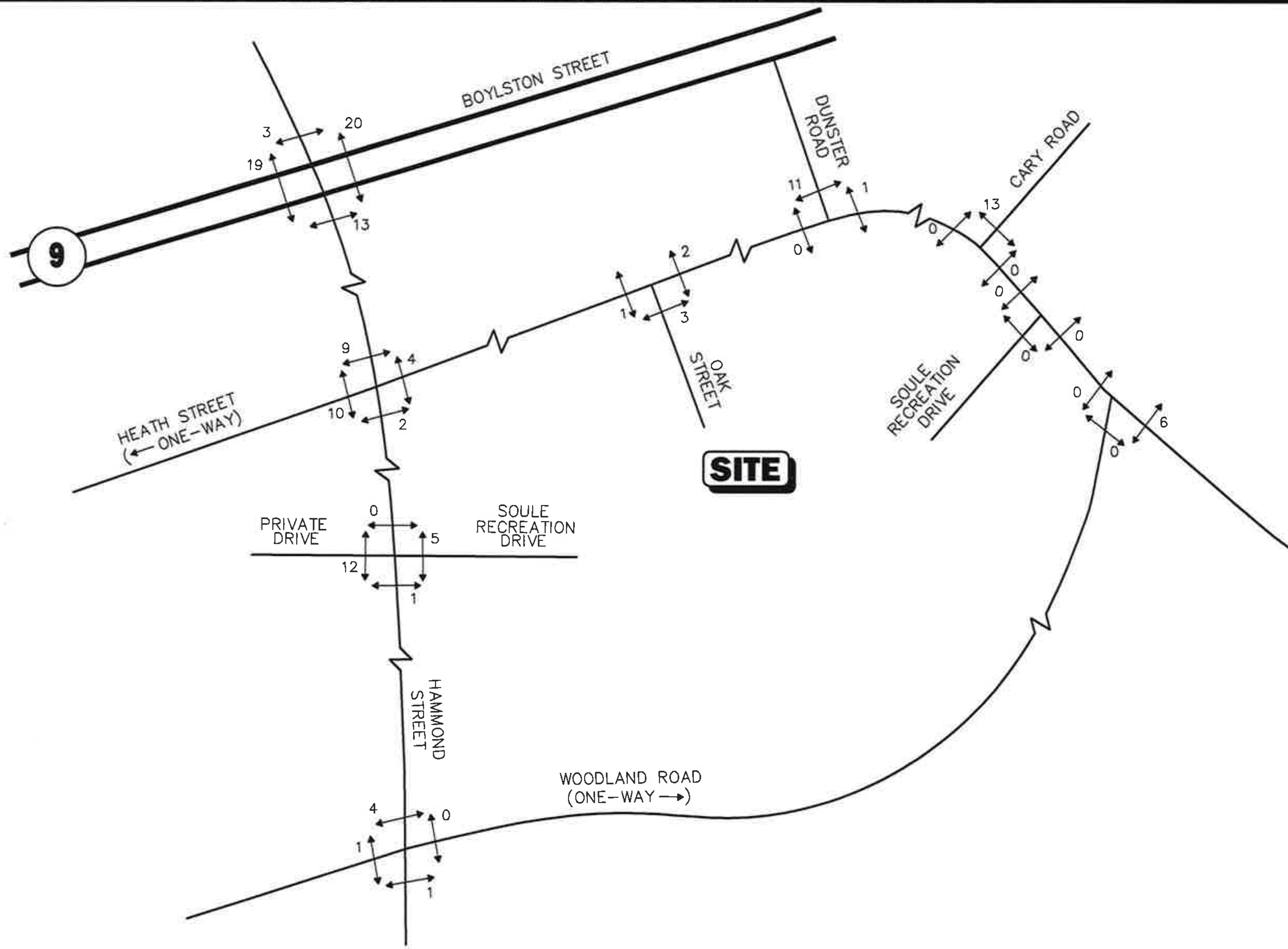

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Figure 8

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2016 Existing Weekday Morning Pedestrian Peak Hour Volumes

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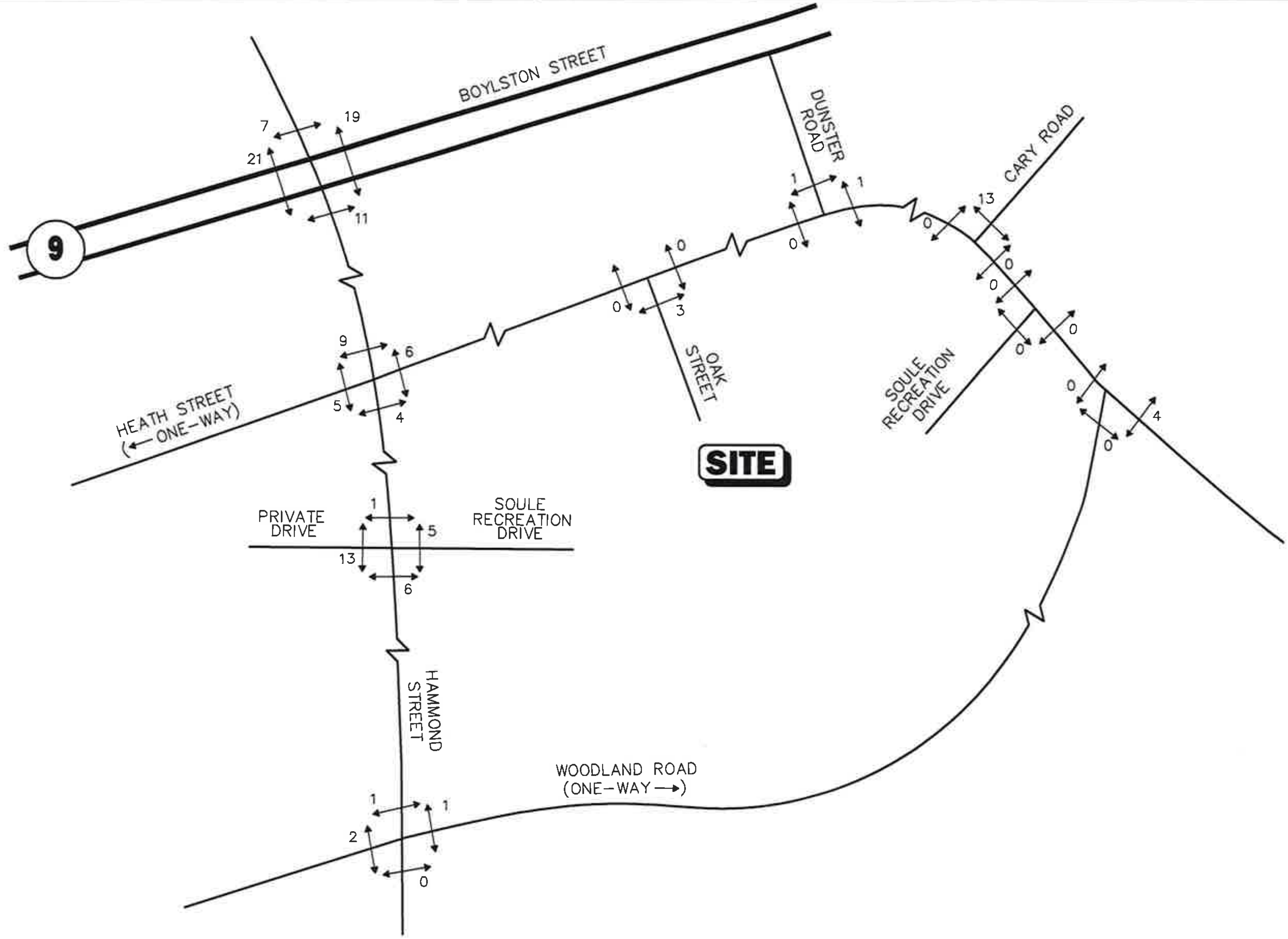

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Figure 9

2016 Existing Weekday Afternoon Pedestrian Peak Hour Volumes

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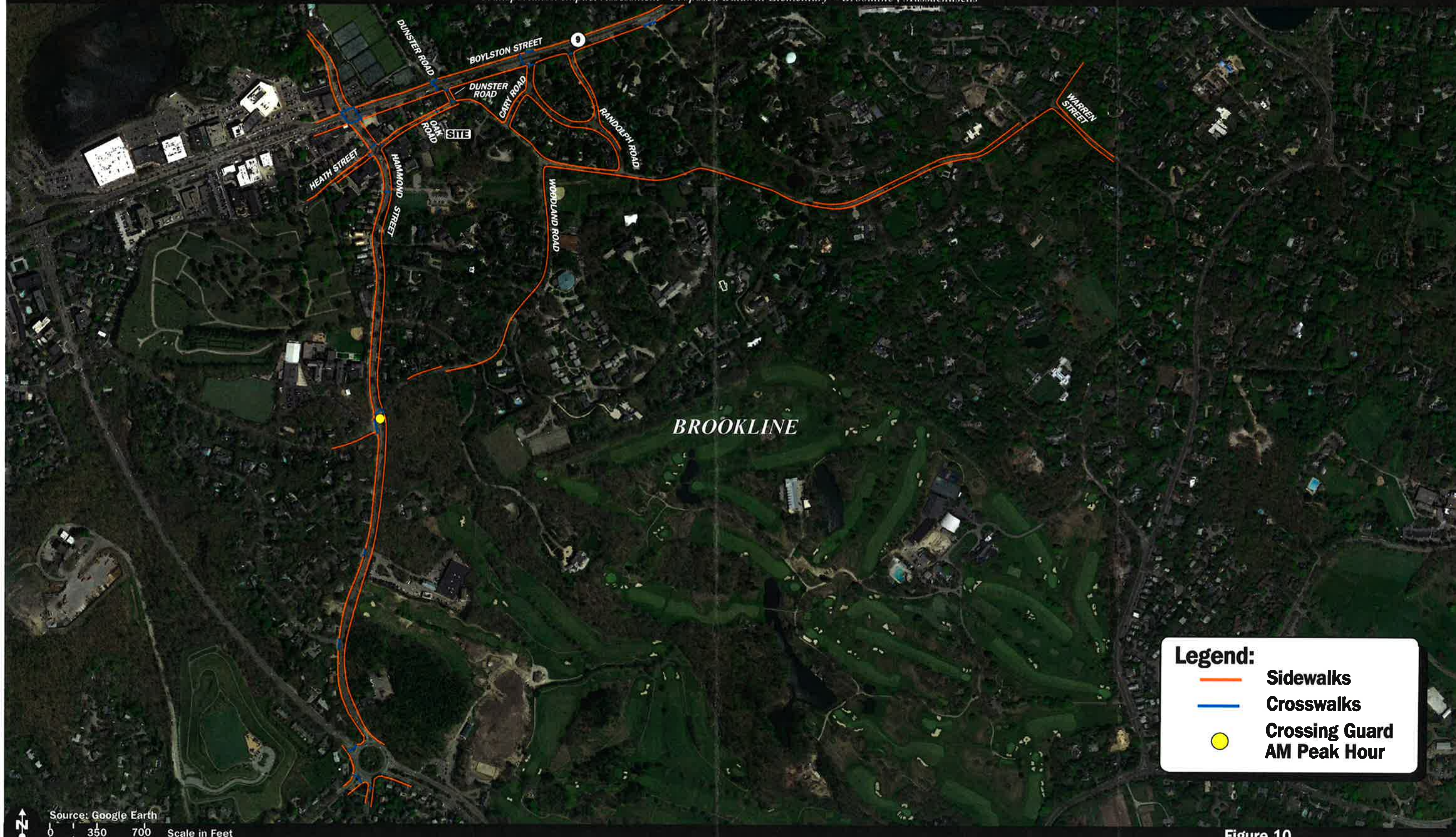

Figure 10

Existing Pedestrian and Bicycle Facilities

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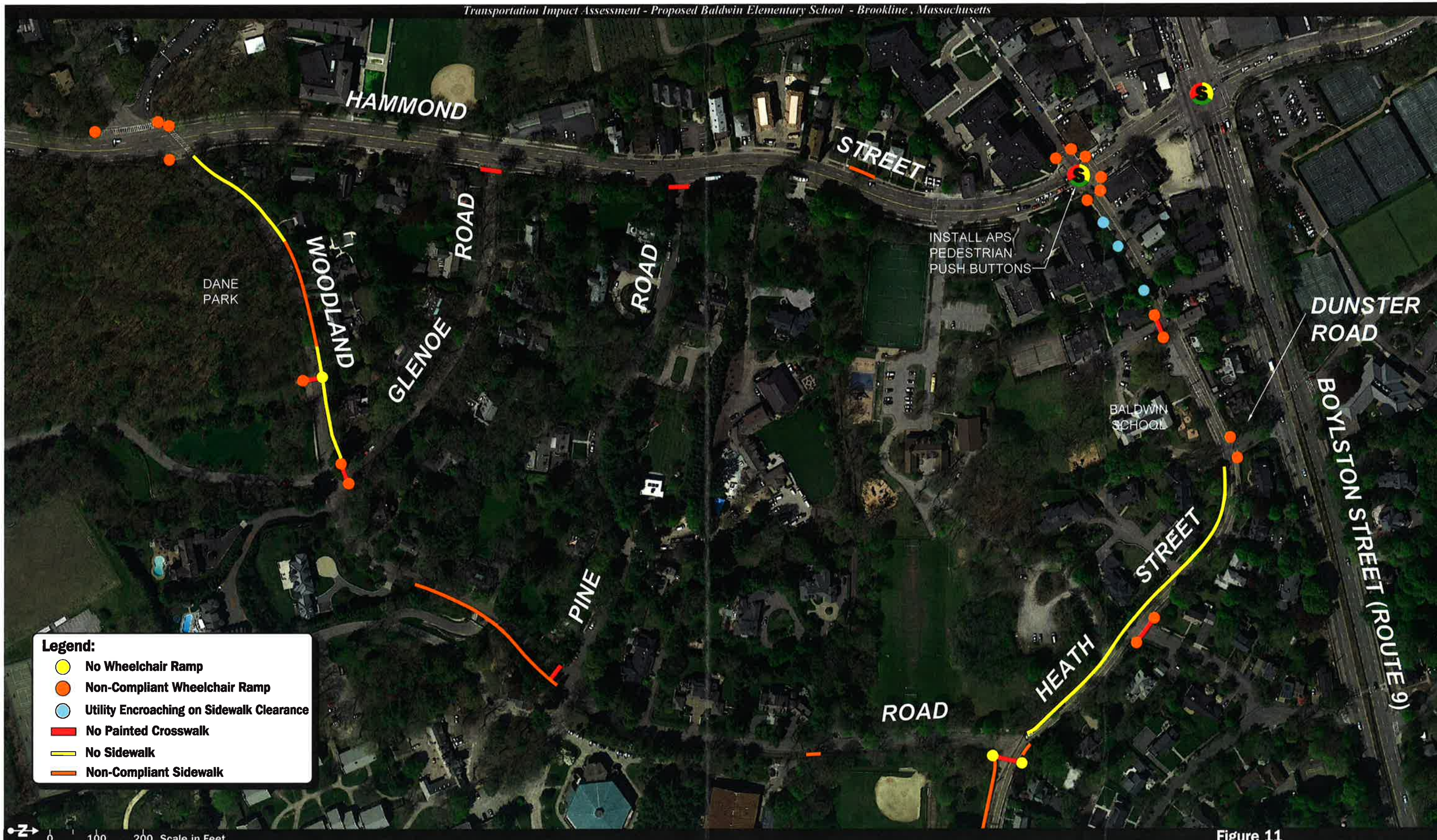

Figure 11

Pedestrian Facility Deficiencies

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object in its travel path. In accordance with AASHTO and MassDOT standards, at a minimum, sufficient stopping sight distances must be provided at an intersection. Table 3 presents the measured sight distances at the proposed school driveways intersecting with Heath Street.

Table 3
SIGHT DISTANCE MEASUREMENTS

Intersection/Sight Distance Measurement	Required Minimum (Feet)[a] 30 mph	35 mph	40 mph	Measured (Feet)
Proposed School Drive at Heath Street Exiting Sight Distance:				
Looking to the east from the driveway	200	250	305	375
Looking to the west from the driveway	200	250	305	315

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

As shown in Table 3, the proposed school driveway has acceptable sight distances for over 30 mph. It should be noted that the ledge and grade to the east of the driveway will be required for regrading to obtain the required sight distance. Figure 12 depicts the sight distances measured at the driveway.

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 (2010 through 2014) 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 4. Figure 13 graphically depicts the Accident Data at each study area intersection, by number of accidents, accidents per year and crash rate.

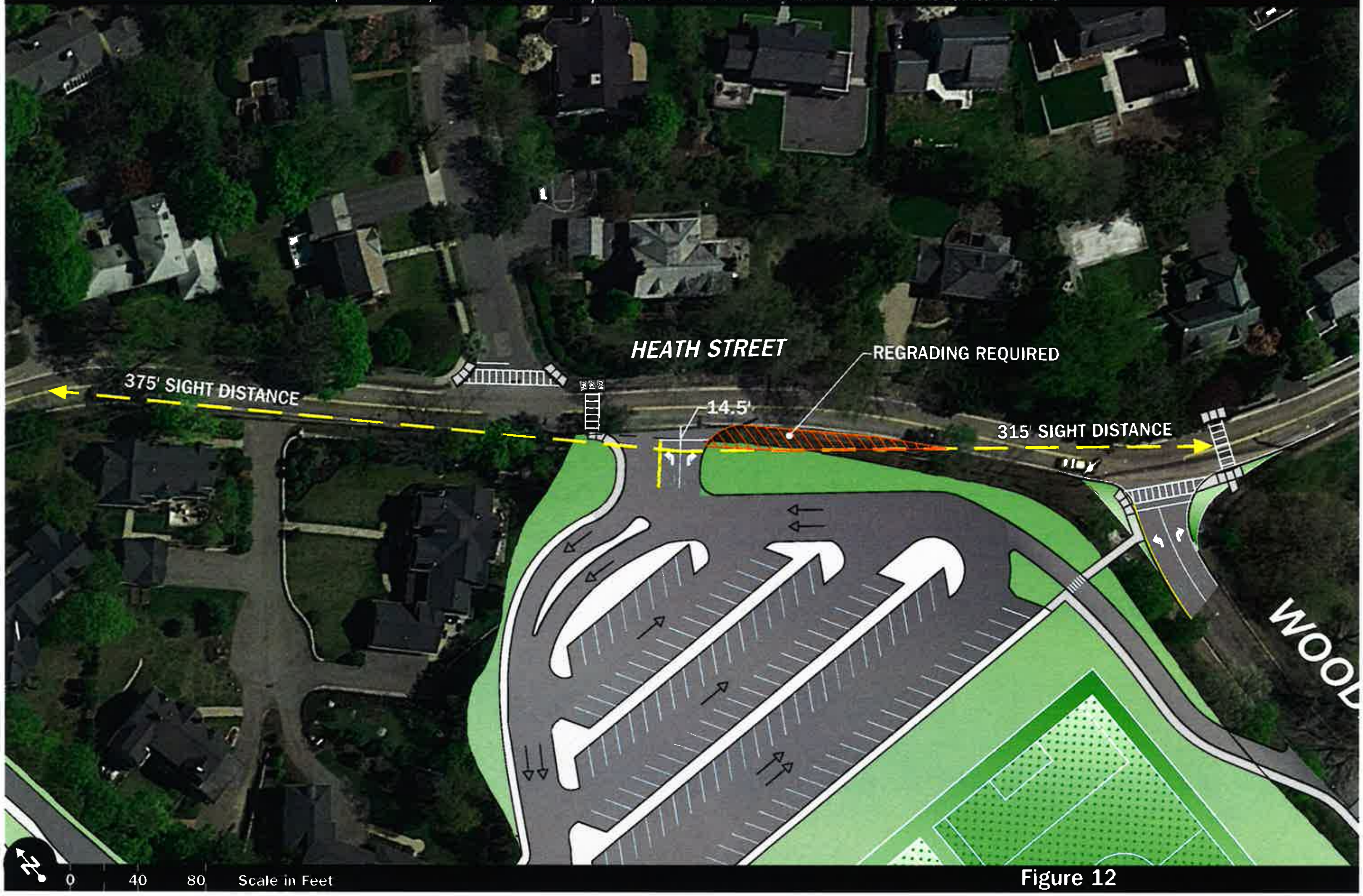

Figure 12

Site Distance Plan

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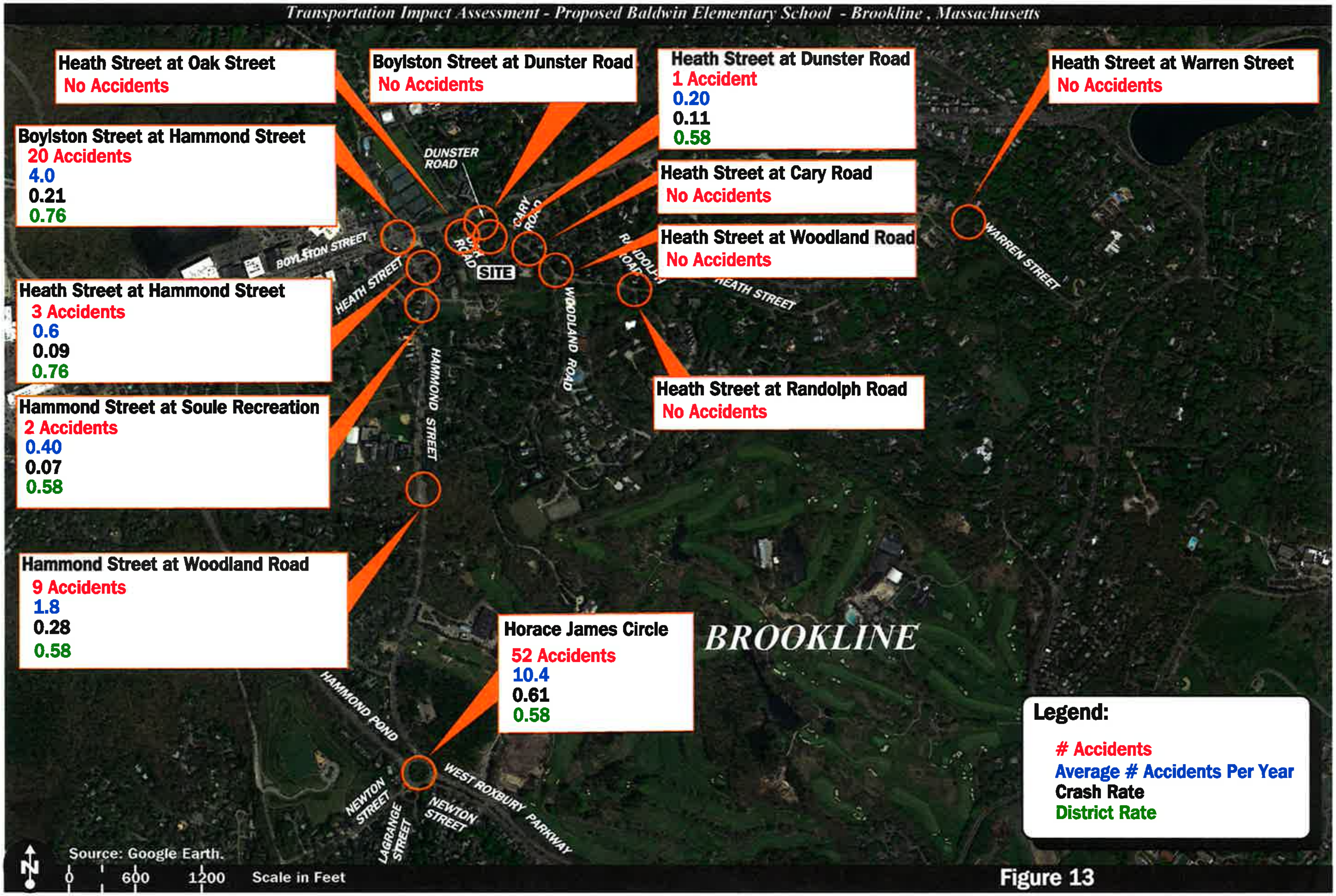

Figure 13

Accident Data

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Table 4
MOTOR VEHICLE CRASH DATA SUMMARY[a]

Scenario	Boylston Street at Hammond Street	Hammond Street at Heath Street	Heath Street at Dunster Road	Hammond Street at Soule Rec Drive	Hammond Street at Woodland Road	Horace James Circle
Year:						
2010	1	1	0	0	0	11
2011	7	1	0	0	0	11
2012	6	0	0	0	3	5
2013	3	1	0	0	1	11
2014	3	0	1	2	5	14
Total	20	3	1	2	9	52
Average[a]	4.0	0.6	0.2	0.4	1.8	10.4
Crash Rate[b]	0.21	0.09	0.11	0.07	0.28	0.61
Significant	No	No	No	No	No	Yes
Type:						
Angle	6	0	0	1	5	19
Rear-End	10	0	0	0	0	13
Head-On	0	0	0	0	1	0
Sideswipe	2	2	0	0	0	15
Fixed Object	2	1	1	1	3	5
Other	0	0	0	0	0	0
Total	20	3	1	2	9	52
Pavement Conditions:						
Dry	16	1	0	1	6	42
Wet	4	1	0	1	3	8
Snow/Ice	0	0	1	0	0	1
Unknown/ Other	0	1	0	0	0	1
Total	20	3	1	2	9	52
Severity:						
Property Damage Only	11	2	1	1	5	37
Personal Injury	9	0	0	1	4	15
Fatality	0	0	0	0	0	0
Unknown	0	1	0	0	0	0
Total	20	3	1	2	9	52

[a]Average crash over five-year period.
[b]Crash rate per million entering vehicles (mev).
Source: MassDOT Crash Data, 2010 through 2014.

As can be seen in Table 4, the intersection of Horace James Circle experienced a total of 52 accidents reported at the intersection over the five-year review period, averaging 10.4 accidents per year. All other intersections experienced less than 4 crashes per year. No fatalities were reported at the study area intersections over the five-year review period. All of the study intersections were 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), with the exception of Horace James Circle which had a crash rate of 0.61, which is slightly above the District average. 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.

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 2024. 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 2024. Inclusion of these factors resulted in the development of 2024 No-Build traffic volumes. Anticipated site-generated traffic volumes were then superimposed upon these No-Build traffic-flow networks to develop the 2024 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 and the City of Newton 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 five projects were identified:

1240 Boylston Street. No traffic study was required for the project and the 1.0 percent general background growth rate will account for the new trips generated by this project.

1180 Boylston Street. This project consists of the development of 45 age-restricted (55+) apartments and 7,000 sf of retail. The Site Generated volumes from the traffic study were added to the No-Build volumes.

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

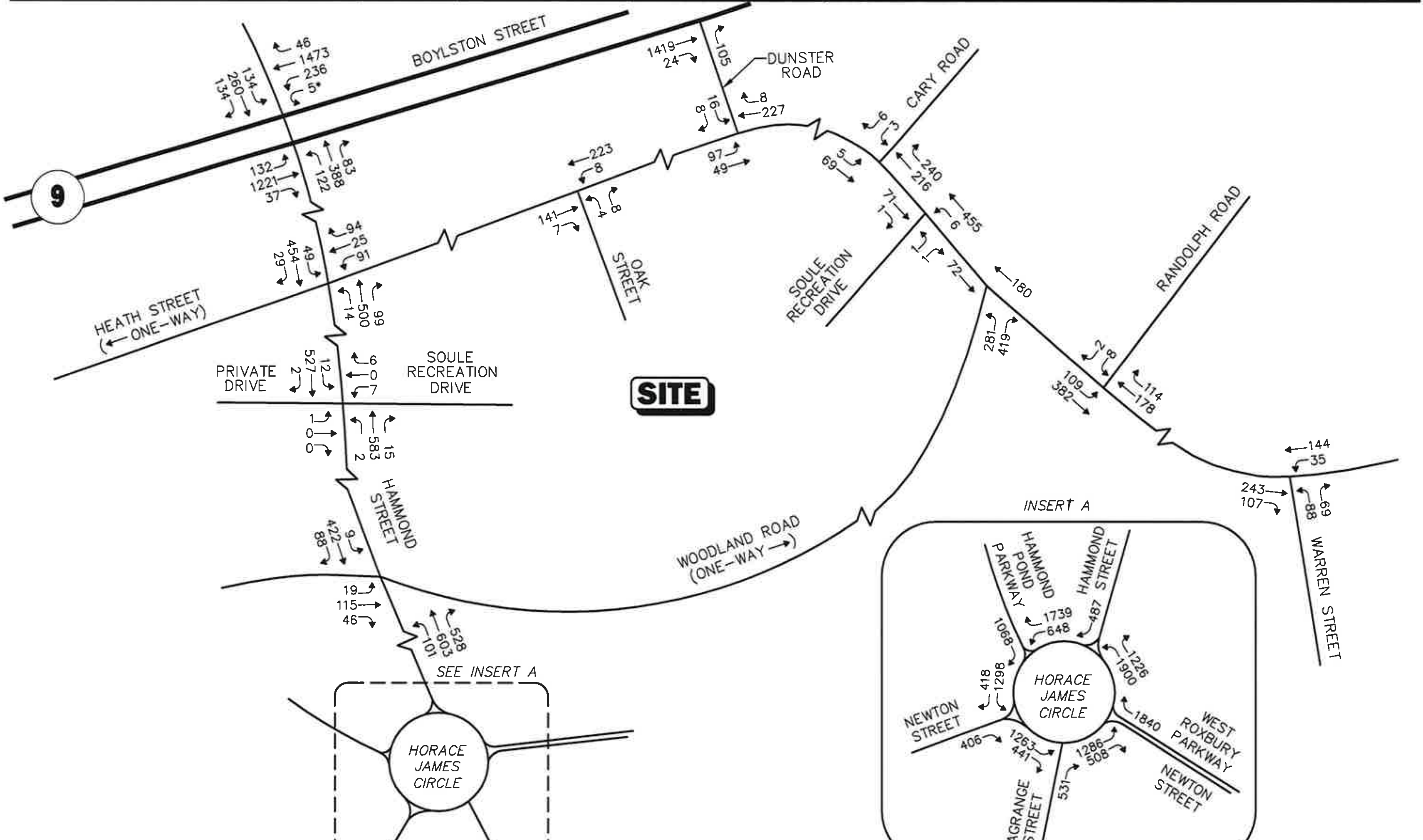
The Town of Brookline was contacted in order to determine if there are any planned roadway improvement projects expected to be completed within the study area. Based on these discussions, two projects were identified:

- ***Hammond Street at Woodland Road Intersection Improvement Study.*** Intersection alternatives have been evaluated by the team and their consultant. The preferred alternative is traffic signalization.

- ***Woodland Road Traffic Calming Study.*** The Town is currently assessing traffic calming measures for Woodland Road.

No-Build Traffic Volumes

The 2024 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 2024 No-Build weekday morning and weekday afternoon peak-hour traffic volume networks are shown on Figures 14 and 15.



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

Not To Scale

Figure 14

2024 No-Build Weekday Morning Peak Hour Traffic Volumes

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Transportation Engineers & Planners

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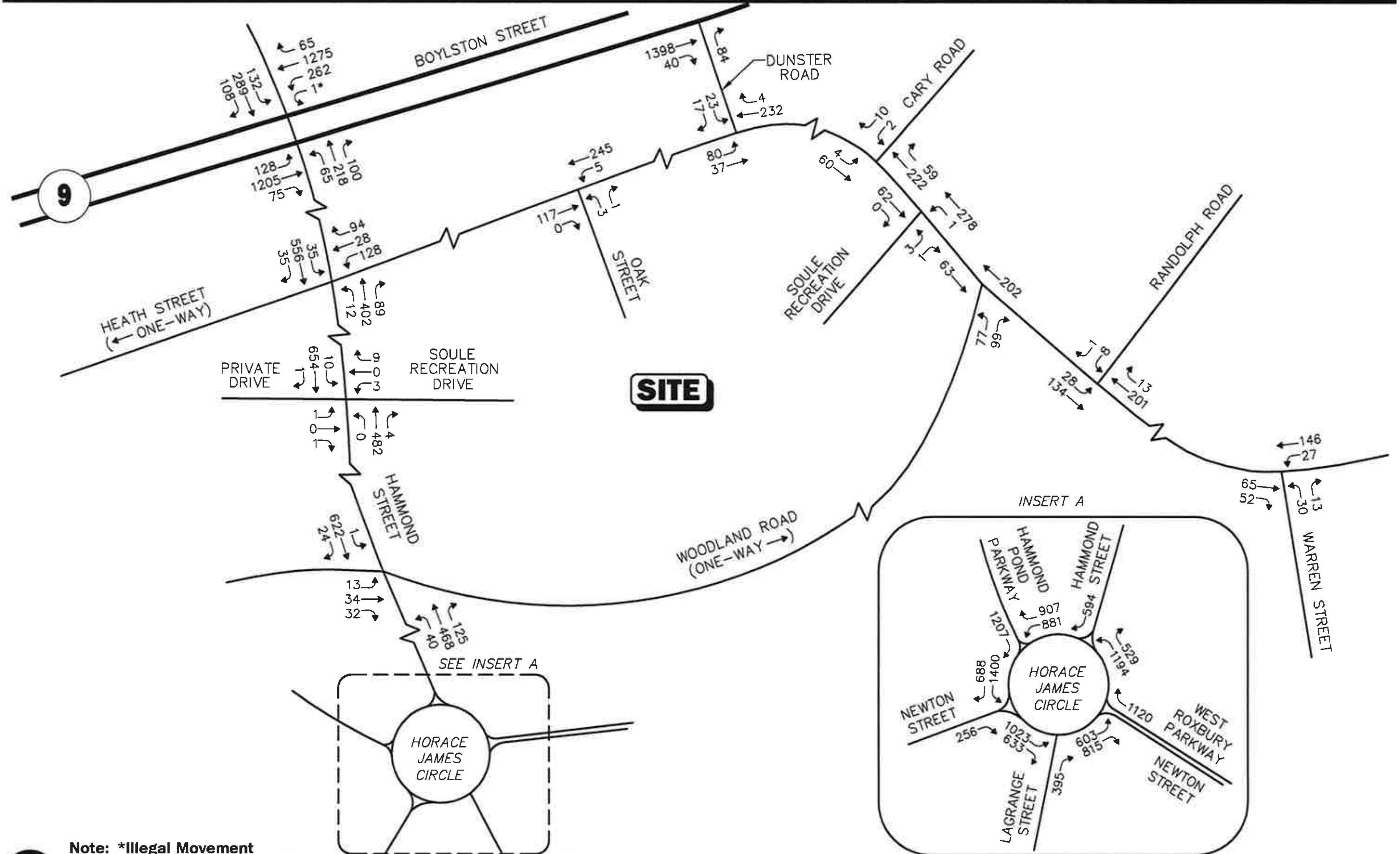

Note: *Illegal Movement
Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

Not To Scale

Figure 15

2024 No-Build
Weekday Afternoon
Peak Hour Traffic Volumes

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Transportation Engineers & Planners

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PROJECT-GENERATED TRAFFIC

Design year (2024 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 an 800-student elementary school. Teacher and staff levels are estimated at 125.

In order to develop the traffic characteristics of the Project, trip-generation statistics published by the ITE[3] 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 800. 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 5 summarizes the anticipated characteristics of the Project based upon Industry Standards.

Table 5
BALDWIN ELEMENTARY SCHOOL
TRIP GENERATION SUMMARY[a]

Time Period/Direction	Vehicle Trips[a]: Elementary School (800 Students)[a]
Average Weekday Daily:	
Entering	516
Exiting	516
Total	1,032
Weekday Morning Peak Hour:	
Entering	198
Exiting	162
Total	360
Weekday Afternoon Peak Hour:	
Entering	101
Exiting	123
Total	224

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

[3]Ibid 2.

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.

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

Afternoon traffic volumes were estimated based upon the reduced traffic percentage from the ITE data.

A summary of expected vehicle trip generation is summarized in Table 6 based upon the above assumptions.

Table 6
TRIP GENERATION SUMMARY

Time Period	Staff	Buses	Drop-off/ Pick-up	Total Trips
Weekday Morning Peak Hour:				
Entering	98	9	330	437
Exiting	0	9	330	339
Total	98	18	660	776
Weekday Afternoon Peak Hour:				
Entering	0	9	207	216
Exiting	0	9	256	265
Total	0	18	463	481

As can be seen in Table 6, the Project is expected to generate approximately 776 vehicle trips (437 vehicles entering and 339 exiting) expected during the weekday morning peak-hour. During the weekday afternoon peak hour the Project is expected to generate approximately 481 vehicle trips (216 vehicles entering and 265 exiting). The above estimates were utilized for analysis purposes in assessing the overall impacts.

Alternative Trip Generation scenarios were developed but were not included as part of the detailed analysis. Trip generation estimates were provided for the following three alternate scenarios.

1. 800-student school – only METCO – 25 students bused
2. 600-student school – only METCO – 25 students bused
3. 600-student school – METCO – 25 students bused plus 150 additional bused students

These trip estimates are provided in Tables 7-9.

Table 7
TRIP GENERATION SUMMARY: ALTERNATE SCENARIO #1
800 STUDENTS/25 BUSED

Time Period	Staff	Buses	Drop-off/ Pick-up	Total Trips
Weekday Morning Peak Hour:				
Entering	98	1	468	567
Exiting	0	1	468	469
Total	98	2	936	1,036
Weekday Afternoon Peak Hour:				
Entering	0	1	288	289
Exiting	0	1	352	353
Total	0	2	640	642

Table 8
TRIP GENERATION SUMMARY: ALTERNATE SCENARIO #2
600 STUDENTS/25 BUSED

Time Period	Staff	Buses	Drop-off/ Pick-up	Total Trips
Weekday Morning Peak Hour:				
Entering	74	1	335	410
Exiting	0	1	335	336
Total	74	2	670	746
Weekday Afternoon Peak Hour:				
Entering	0	1	214	208
Exiting	0	1	261	254
Total	0	2	475	462

Table 9
TRIP GENERATION SUMMARY: ALTERNATE SCENARIO #2
600 STUDENTS/150 BUSED

Time Period	Staff	Buses	Drop-off/ Pick-up	Total Trips
Weekday Morning Peak Hour:				
Entering	74	7	232	313
Exiting	0	7	232	239
Total	74	14	464	552
Weekday Afternoon Peak Hour:				
Entering	0	7	147	154
Exiting	0	7	181	188
Total	0	14	328	342

As shown, at 800 students and no busing in the morning peak hour traffic generation increases to 1,036 vehicle trips (567 entering/469 exiting). Overall, this emphasizes that busing is an important element to reducing the overall impacts. In addition, the 600-student alternatives show the small school reduced traffic generation.

TRIP DISTRIBUTION AND ASSIGNMENT

Separate trip distributions were developed for staff and students. The directional distribution of the site-generated trips to the proposed development by the staff was determined based on a review of origin to workplace data for Brookline. The directional distribution for the drop-offs and pick-ups was based on existing travel patterns at the study area intersections, directional data provided by the architect and it was further assumed that 30 percent of parents dropping-off students would be traveling on to work. The weekday morning trip distribution for staff is depicted on Figure 16 and the drop-off (morning) and pick-up (afternoon) patterns are depicted in Figures 17 and 18. The weekday morning and weekday afternoon peak-hour traffic volumes expected to be generated by the school are shown on Figures 19 and 20.

FUTURE TRAFFIC VOLUMES – BUILD CONDITION

The 2024 Build condition networks consist of the 2024 No-Build traffic volumes with the anticipated site-generated traffic added to them. The 2024 Build weekday morning and weekday afternoon traffic-volume networks are graphically depicted on Figures 21 and 22.

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 10. These volumes are based on the expected increases from the project.

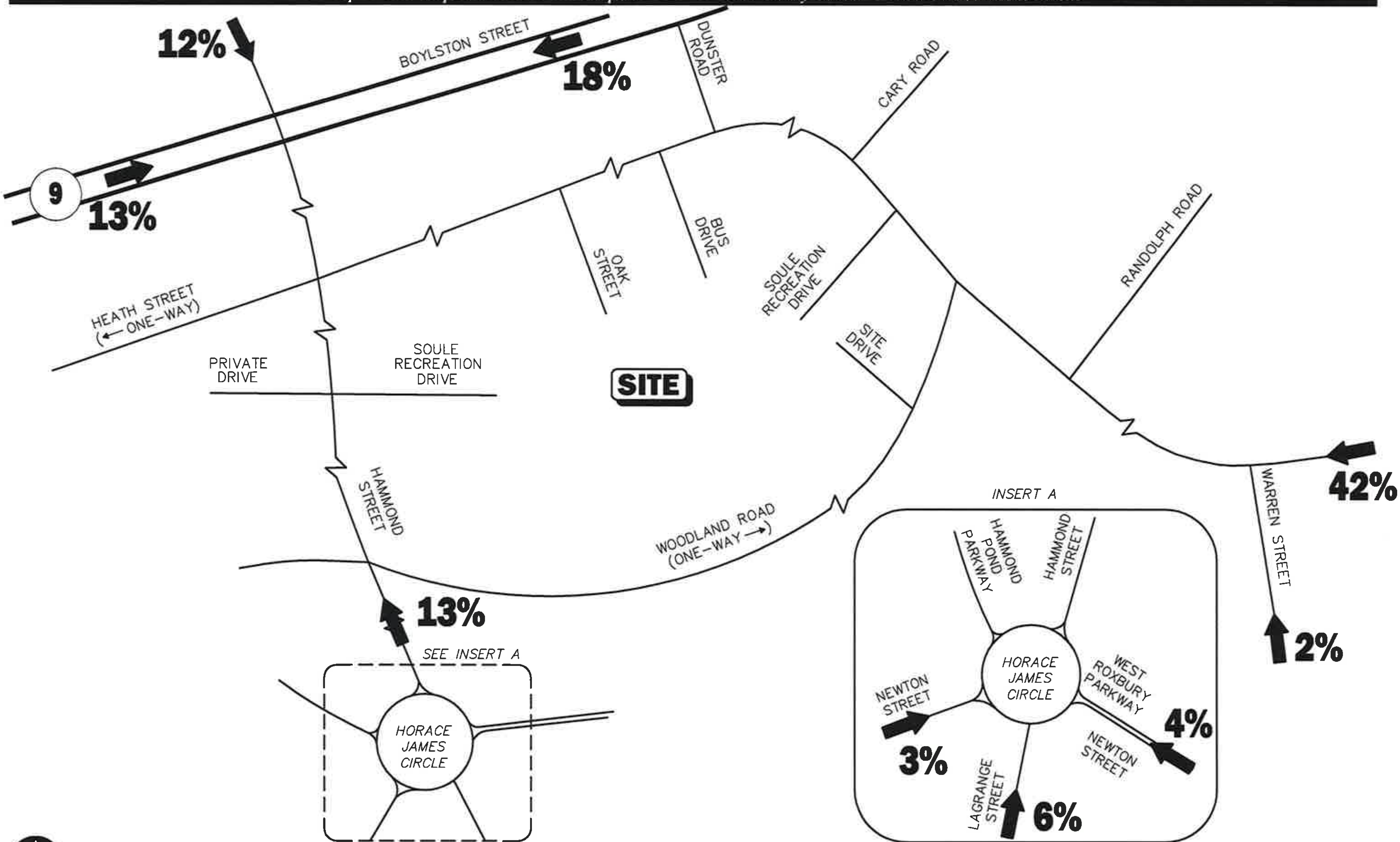

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Figure 16

Trip Distribution Staff
Weekday Morning

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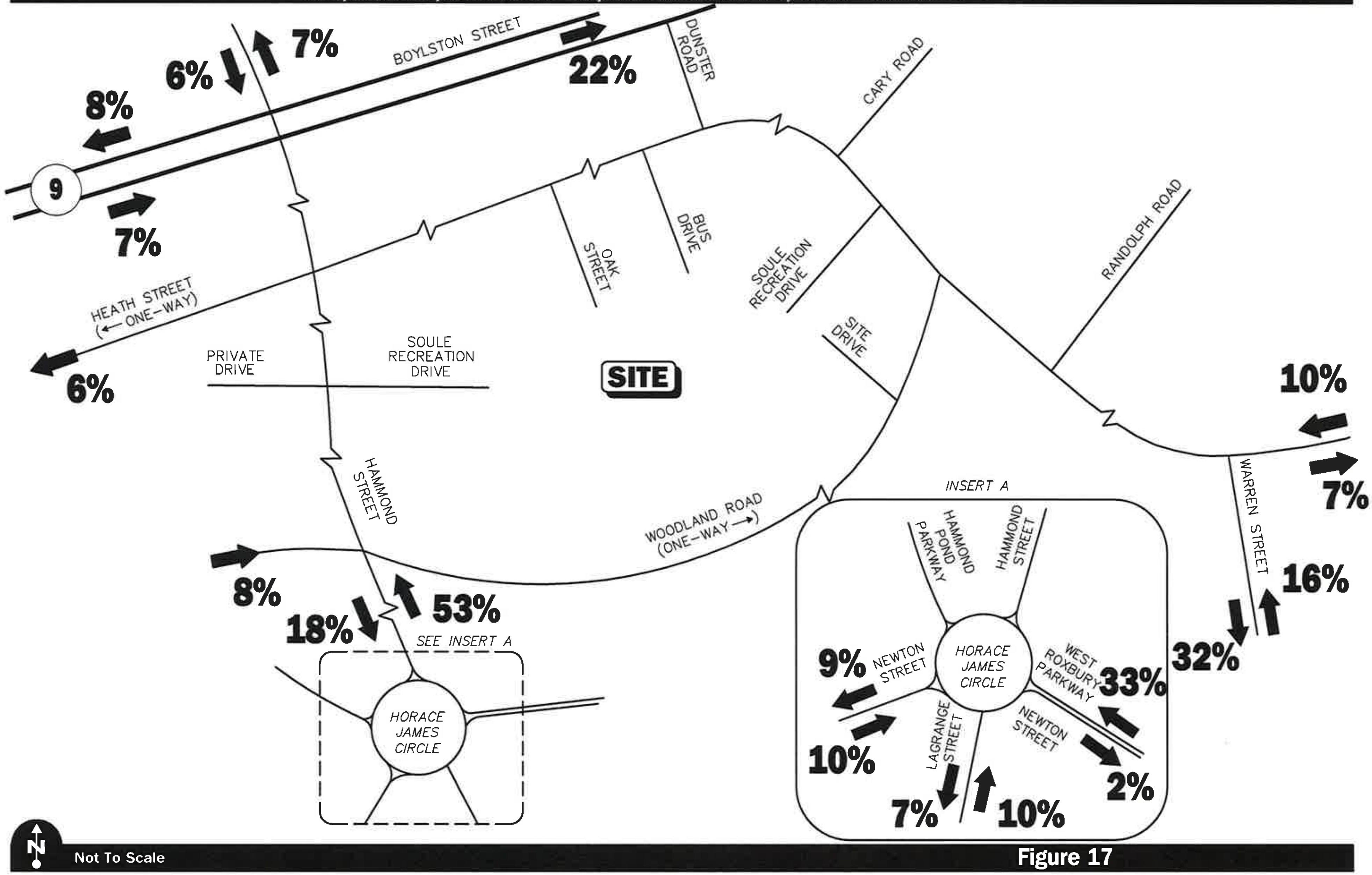

Figure 17

Trip Distribution
Student Drop-off
Weekday Morning

Vanasse & Associates, Inc.
Transportation Engineers & Planners

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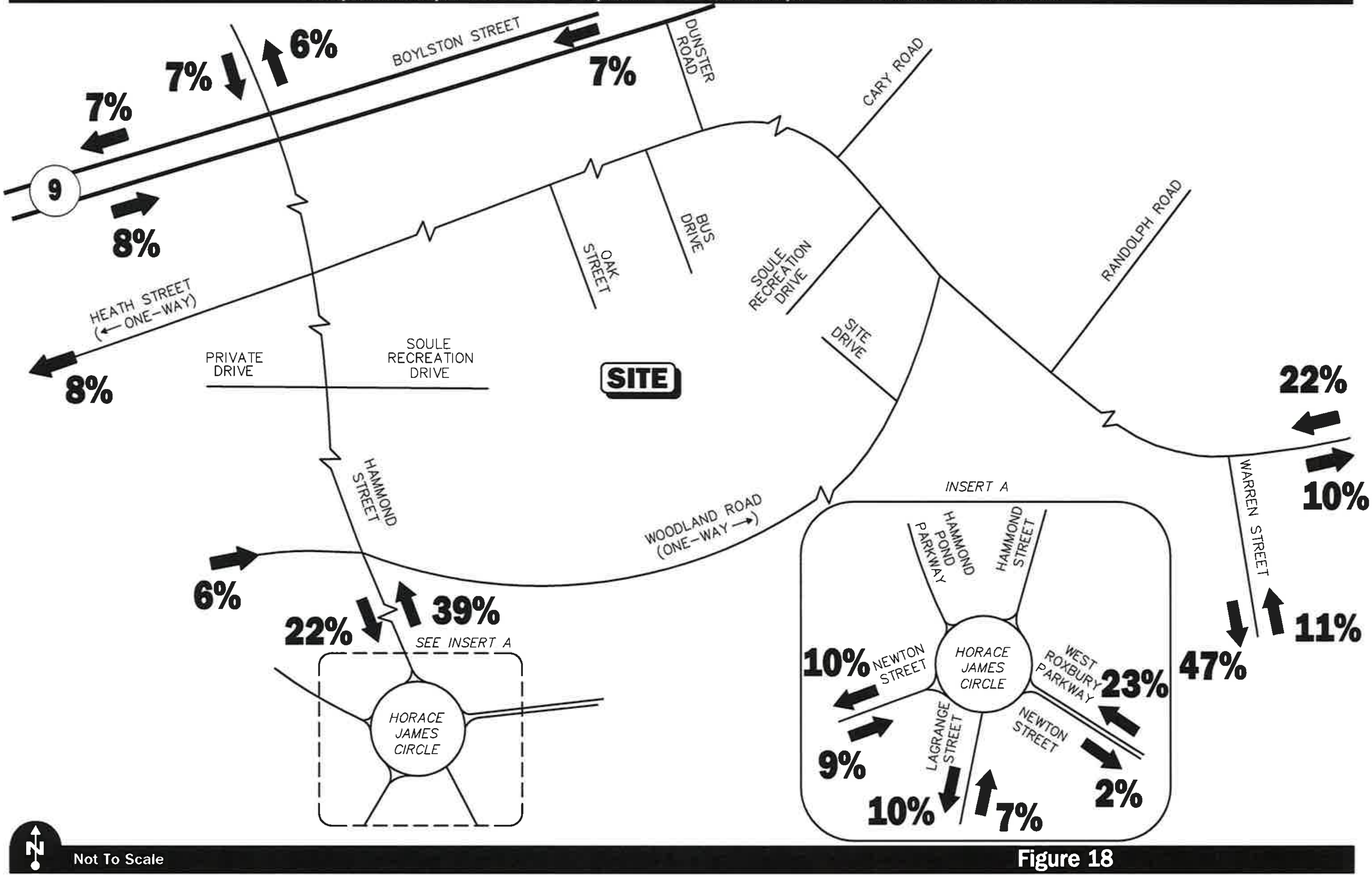

Figure 18

Trip Distribution
Student Pick-up
Weekday Evening

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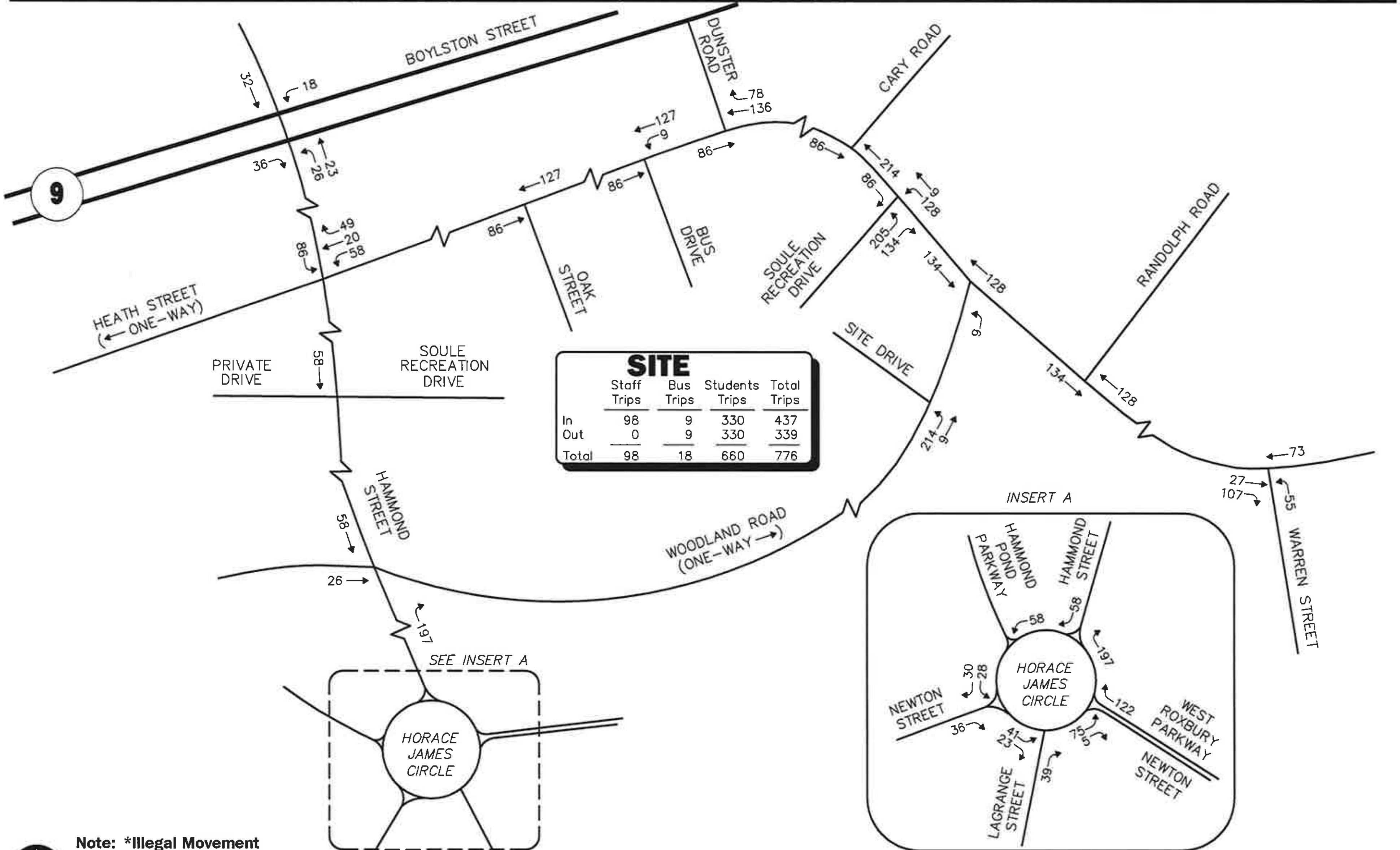

SITE

	Staff Trips	Bus Trips	Students Trips	Total Trips
In	98	9	330	437
Out	0	9	330	339
Total	98	18	660	776

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

Not To Scale

Figure 19

Site Generated Weekday Morning Peak Hour Traffic Volumes

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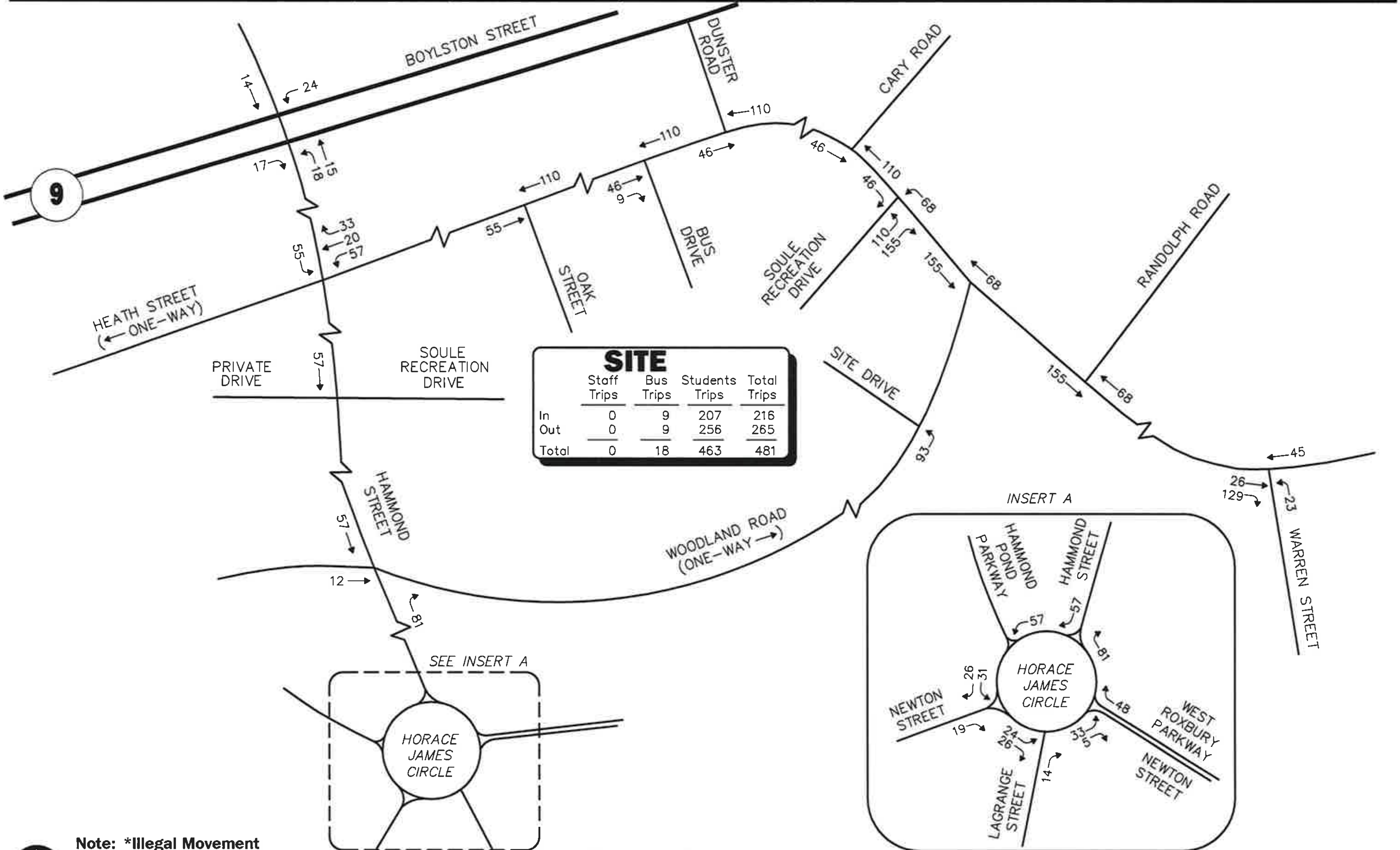

	Staff Trips	Bus Trips	Students Trips	Total Trips
In	0	9	207	216
Out	0	9	256	265
Total	0	18	463	481

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

Not To Scale

Figure 20

Site Generated Weekday Afternoon Peak Hour Traffic Volumes

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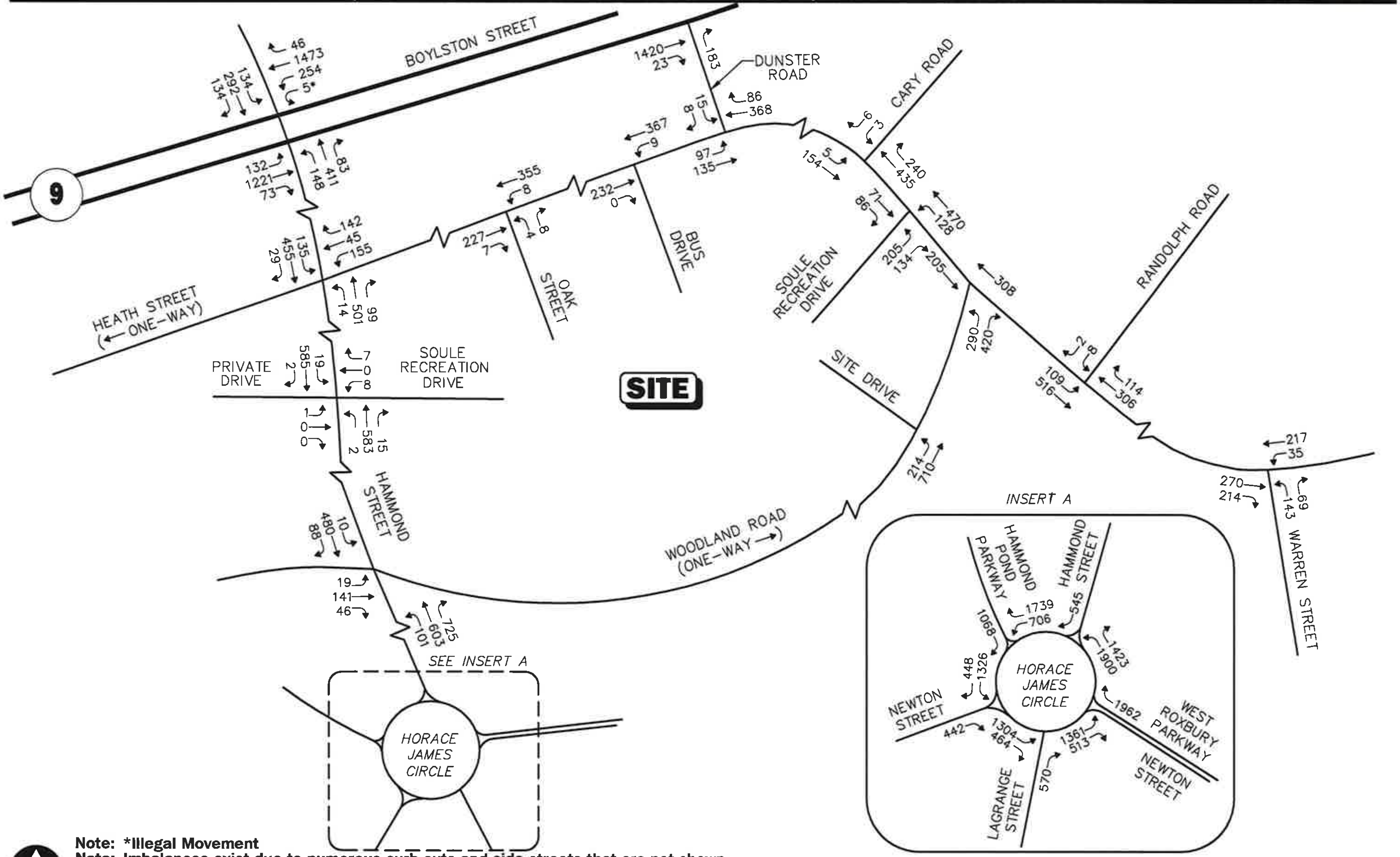

Figure 21

2024 Build
Weekday Morning
Peak Hour Traffic Volumes

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Transportation Engineers & Planners

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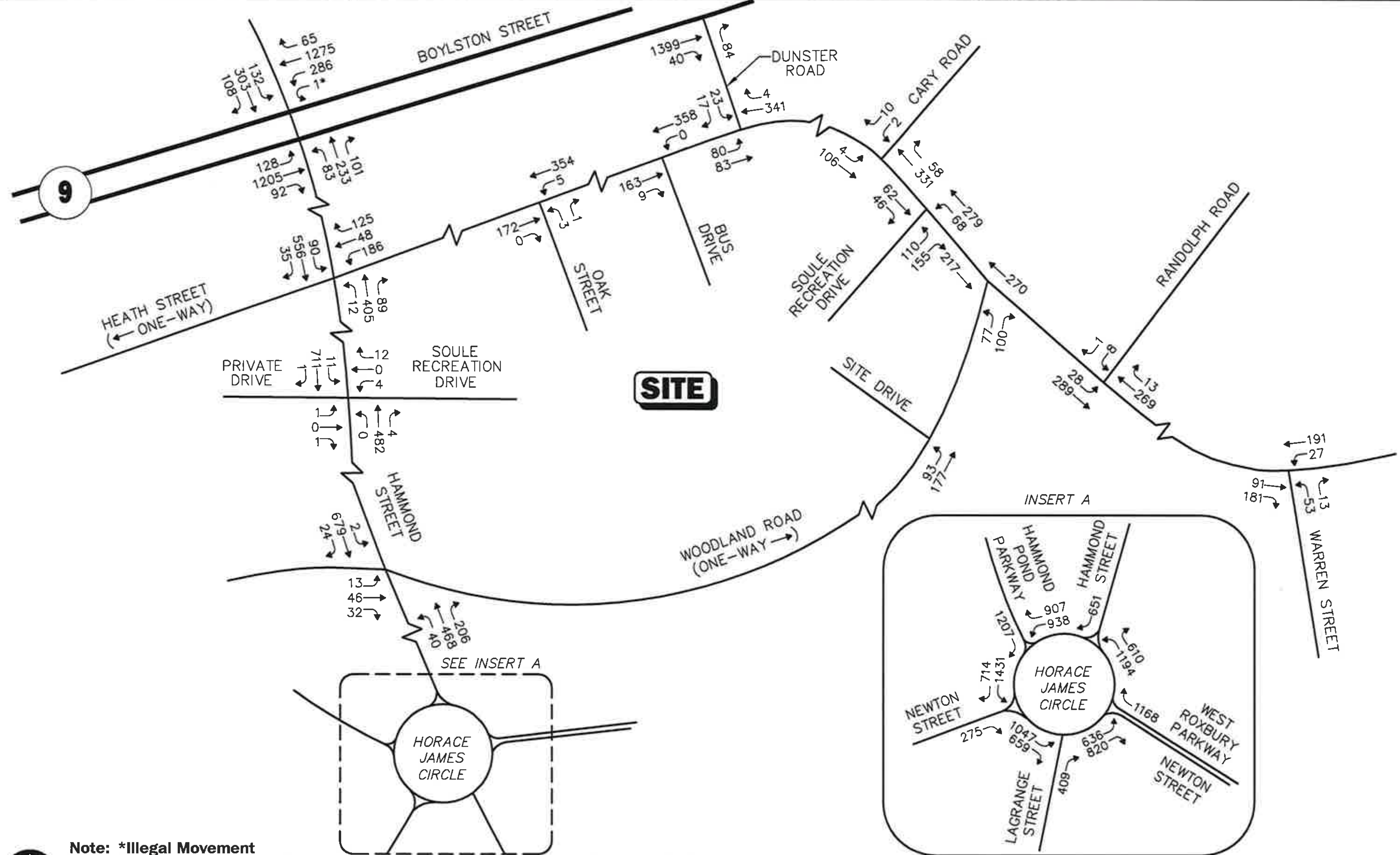

Note: *Illegal Movement
Note: Imbalances exist due to numerous curb cuts and side streets that are not shown.

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Figure 22

2024 Build
Weekday Afternoon
Peak Hour Traffic Volumes

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Table 10
PEAK-HOUR TRAFFIC-VOLUME INCREASES

Location/Peak Hour	2024 No-Build	2024 Build	Traffic Volume Increase Over No-Build	Percent Increase Over No-Build
Heath Street, east of Warren Street:				
Weekday Morning	671	933	262	39.0
Weekday Afternoon	364	587	223	61.3
Boylston Street, west of Hammond Street:				
Weekday Morning	3,119	3,181	62	2.0
Weekday Afternoon	2,856	2,891	35	1.2
Heath Street, east of Hammond Street:				
Weekday Morning	358	576	218	60.9
Weekday Afternoon	374	538	164	43.9
Woodland Road, east of Hammond Street:				
Weekday Morning	652	876	224	34.4
Weekday Afternoon	160	254	94	58.8

As shown in Table 10, project-related traffic-volume increases external to the study area relative to 2024 No-Build conditions are anticipated to range from 1.2 to 61.3 percent during the peak periods.

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.[4] 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.

[4]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 2010 *Highway Capacity Manual.*[5] 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 *2010 Highway Capacity Manual.* Table 11 summarizes the relationship between level of service and average control delay for two way stop controlled and all-way stop controlled intersections.

Table 11
LEVEL-OF-SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS[a]

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

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

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

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 2010 *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 12 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 12
LEVEL-OF-SERVICE CRITERIA
FOR SIGNALIZED 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 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; 2010; 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*.[6] 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 13.

Table 13
LEVEL-OF-SERVICE CRITERIA FOR ROUNDABOUTS[a]

Level-Of-Service by Volume-to-Capacity Ratio		Control Delay Per Vehicle (Seconds)
$v/c \leq 1.0$	$v/c > 1.0$	
A	F	$\leq$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.

ANALYSIS RESULTS

Level-of-service analyses were conducted for Baseline, 2024 No-Build, and 2024 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 14 and 15. The results of the SIDRA Rotary Capacity Analysis are summarized in Table 16.

Unsignalized Intersection Analysis Results

Hammond Street at Soule Recreation Drive

Under the all conditions, the Soule Recreation Drive operates at LOS C during the weekday morning peak hour and LOS B during the weekday afternoon peak hour.

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

Hammond Street at Woodland Road

Under Existing conditions, Woodland Road operates at LOS F during the weekday morning peak hour and LOS D during the weekday afternoon peak hour. Under No-Build and Build conditions, Woodland Road operates at LOS F during the weekday morning peak hour and LOS E during the weekday afternoon peak hour. This intersection is expected to be signalized under future conditions.

Heath Street at Oak Street

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

Heath Street at Dunster Road

Under Existing and No-Build conditions, Dunster Road operates at LOS B during the weekday morning and weekday afternoon peak hours. Under Build conditions, Dunster Road operates at LOS D during the weekday morning peak hour and LOS B during the weekday afternoon peak hour.

Heath Street at Cary Road

Under Existing and No-Build conditions, Cary Road operates at LOS B during the weekday morning and weekday afternoon peak hours. Under Build conditions, Cary Road operates at LOS C during the weekday morning peak hour and LOS B during the weekday afternoon peak hour.

Heath Street at Soule Recreation Drive/Site Drive

Under Existing and No-Build conditions, the Soule Recreation Drive operates at LOS B during the weekday morning and weekday afternoon peak hours. Under Build conditions, left-turns from the Site Drive operates at LOS F during the weekday morning peak hour and LOS C during the weekday afternoon peak hour. Under Build conditions, right-turns from the Site Drive operates at LOS B during both the weekday morning and weekday afternoon peak hours. During the morning peak period, officer control is expected to control operations.

Heath Street at Woodland Road

During the weekday morning hour, the Woodland Road left-turn operates at LOS B under Existing conditions, at LOS C under No-Build conditions and at LOS F under Build conditions. During the morning peak period, delay increases of slightly over 100 seconds are expected. During the weekday morning hour, the Woodland Road right-turn operates at LOS B under Existing and No-Build conditions, and at LOS D under Build conditions.

During the weekday afternoon peak hour, the Woodland Road left-turn operates at LOS B and the Woodland Road right-turn operates at LOS A, under all conditions.

Heath Street at Randolph Road

Under Existing and No-Build conditions, Dunster Road operates at LOS C during the weekday morning peak hour and at LOS B during the weekday afternoon peak hour. Under Build conditions, Dunster Road operates at LOS F during the weekday morning peak hour and LOS C during the weekday afternoon peak hour. During the weekday morning peak period, delay increases of 34 seconds are expected.

Heath Street at Warren Street

During the weekday morning peak hour, Warren Street operates at LOS B under Existing conditions, at LOS C under No-Build conditions and at LOS F under Build conditions. Delay increases of up to 90 seconds are expected during the morning peak period. During the weekday afternoon peak hour, Warren Street operates at LOS B under all conditions.

James Horace Circle

Under all conditions, James Horace Circle operates at LOS F, during both the weekday morning and weekday evening peak hours. Delays increases of up to one minute can be expected during the critical morning period.

Boylston Street at Dunster Road

During the both the weekday morning and weekday evening hours, Dunster Road operates at LOS C under Existing and No-Build conditions. Under Build conditions, Dunster Road operates at LOS F during the weekday morning hour and at LOS C during the weekday evening peak hour.

<u>Signalized Intersection Analysis Result</u>

Boylston Street at Hammond Street

Under Existing conditions, this intersection operates at an overall LOS E during both the weekday morning and weekday afternoon peak hours. Under No-Build conditions, this intersection operates at an overall LOS F during both the weekday morning and weekday afternoon peak hours. Under Build conditions with mitigated timings, this intersection operates at an overall LOS F during the weekday morning peak hour and at LOS E during the weekday afternoon peak hour. It should be noted that the overall delay at this intersection decreases with signal optimization from the project.

Hammond Street at Heath Street

Under Existing conditions, this intersection operates at an overall LOS D during the weekday morning peak hour and at LOS C during the weekday afternoon peak hour. Under No-Build conditions, this intersection operates at an overall LOS D during both the weekday morning and weekday afternoon peak hours. Under Build conditions, this intersection operates at an overall LOS B during both the weekday morning and weekday afternoon peak hours. It should be noted that the overall delay at this intersection decreases with signal optimization from the project and the modified shorter cycle length.

Hammond Street at Woodland Road

The Town has created a concept plan for the signalization of Hammond Street at Woodland Road. The Town's concept plan was analyzed, with the addition of an exclusive right-turn lane on the Hammond Street northbound approach, in order to accommodate the proposed school. Under all conditions, this signalized intersection operates at LOS B or better, during both the weekday morning and weekday afternoon peak hours.

Table 14
UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

	2016 Existing				2024 No-Build				2024 Build			
Unsignalized Intersection Movements	Demand[a]	Delay[b]	LOS[c]	Queue[d]	Demand	Delay	LOS	Queue	Demand	Delay	LOS	Queue
Hammond Street at Soule Recreation Drive and Private Drive												
Weekday Morning :												
Private Drive EB LT/TH/RT	1	22.2	C	0	1	25.0	D	0	1	32.3	D	0
Soule Rec Drive WB LT/TH/RT	13	17.6	C	0	13	19.5	C	0	15	22.3	C	0
Weekday Afternoon:												
Private Drive EB LT/TH/RT	2	16.0	C	0	2	17.7	C	0	2	18.1	C	0
Soule Rec Drive WB LT/TH/RT	12	12.5	B	0	12	13.3	B	0	16	13.5	B	0
Hammond Street at Woodland Road												
Weekday Morning :												
Woodland Road EB LT/TH	124	>50.0	F	14	134	>50.0	F	20	160	>50.0	F	22
Woodland Road EB RT	43	10.7	B	0	46	11.0	B	0	46	11.8	B	0
Hammond Street SB LT	8	10.9	B	0	9	11.5	B	0	10	13.7	B	0
Weekday Afternoon:												
Woodland Road EB LT/TH	43	27.8	D	1	47	35.2	E	1	59	42.6	E	2
Woodland Road EB RT	30	10.6	B	0	32	11.0	B	0	32	11.2	B	0
Hammond Street SB LT	1	8.8	A	0	1	9.0	A	0	2	9.2	A	0
Heath Street at Oak Street												
Weekday Morning :												
Heath Street WB LT	8	7.5	A	0	8	7.6	A	0	8	8.0	A	0
Oak Street NB LT/RT	12	9.8	A	0	12	9.9	A	0	12	12.8	B	0
Weekday Afternoon:												
Heath Street WB LT	5	7.4	A	0	5	7.5	A	0	5	7.6	A	0
Oak Street NB LT/RT	4	10.6	B	0	4	10.9	B	0	4	11.8	B	0
Heath Street at Dunster Road												
Weekday Morning :												
Heath Street EB LT	90	7.9	A	0	97	8.0	A	0	97	10.2	B	1
Dunster Road SB LT/RT	22	12.0	B	0	24	12.4	B	0	23	26.2	D	1
Weekday Afternoon:												
Heath Street EB LT	74	8.0	A	0	80	8.0	A	0	80	8.3	A	0
Dunster Road SB LT/RT	37	11.5	B	0	40	12.0	B	0	40	13.4	B	0
Heath Street at Cary Road												
Weekday Morning :												
Cary Road SB LT/TH/RT	9	10.7	B	0	9	11.0	B	0	9	17.8	C	0
Weekday Afternoon:												
Cary Road SB LT/TH/RT	11	10.0	B	0	12	10.2	B	0	12	11.3	B	0

See notes at end of table.

Table 14 (Continued)
UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

	2016 Existing				2024 No-Build				2024 Build			
Unsignalized Intersection Movements	Demand[a]	Delay[b]	LOS[c]	Queue[d]	Demand	Delay	LOS	Queue	Demand	Delay	LOS	Queue
Heath Street at Site Drive												
Weekday Morning :												
Soule Rec. Drive NB LT/TH/RT	2	10.6	B	0	2	10.9	B	0	--	--	--	--
Site Drive NB LT*	--	--	--	--	--	--	--	--	205	>50.0	F	44
Site Drive NB RT*	--	--	--	--	--	--	--	--	134	11.6	B	2
Weekday Afternoon:												
Soule Rec. Drive NB LT/TH/RT	4	10.3	B	0	4	10.5	B	0	--	--	--	--
Site Drive NB LT*	--	--	--	--	--	--	--	--	110	19.4	C	2
Site Drive NB RT*	--	--	--	--	--	--	--	--	155	10.6	B	1
Heath Street at Woodland Road												
Weekday Morning :												
Woodland Road NB LT	256	14.1	B	2	281	15.4	C	3	290	>50.0	F	14
Woodland Road NB RT	384	12.4	B	3	419	13.3	B	3	420	29.9	D	8
Weekday Afternoon:												
Woodland Road NB LT	69	10.7	B	0	77	11.0	B	0	77	12.9	B	1
Woodland Road NB RT	90	8.9	A	0	99	9.0	A	0	100	9.9	A	0
Heath Street at Randolph Road												
Weekday Morning :												
Heath Street EB LT	101	7.9	A	0	109	8.3	A	0	109	9.5	A	1
Randolph Road SB LT/RT	9	16.5	C	0	10	19.6	C	0	10	>50.0	F	1
Weekday Afternoon:												
Heath Street EB LT	26	7.9	A	0	28	8.0	A	0	28	8.1	A	0
Randolph Road SB LT/RT	8	11.6	B	0	9	12.0	B	0	9	15.6	C	0
Heath Street at Warren Street												
Weekday Morning :												
Heath Street WB LT	31	8.1	A	0	35	8.2	A	0	35	9.4	A	0
Warren Street NB LT/RT	145	14.9	B	2	157	16.6	C	2	212	>50.0	F	13
Weekday Afternoon:												
Heath Street WB LT	25	7.6	A	0	27	7.6	A	0	27	8.3	A	0
Warren Street NB LT/RT	40	10.3	B	0	43	10.5	B	0	66	12.9	B	0
Boylston Street at Dunster Street												
Weekday Morning :												
Dunster Street NB RT	97	18.7	C	1	105	22.2	C	2	183	>50.0	F	10
Weekday Afternoon:												
Dunster Street NB RT	78	16.9	C	1	84	19.4	C	1	84	19.4	C	1

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

Table 15
SIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

	2016 Existing				2024 No-Build				2024 Build			
Signalized Intersection Movements	V/C[a]	Delay[b]	LOS[c]	Queue	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Boylston Street at Hammond Street												
Weekday Morning:												
Boylston Street EB LT	0.72	59.7	E	110/202	0.74	63.8	E	120/226	0.89	>80.0	F	145/288
Boylston Street EB TH/RT	0.94	58.8	E	604/746	1.08	>80.0	F	747/889	1.08	>80.0	F	844/987
Boylston Street WB LT	1.05	>80.0	F	214/405	1.19	>80.0	F	259/449	1.02	>80.0	F	293/479
Boylston Street WB TH	0.98	56.1	E	700/839	1.18	>80.0	F	877/1017	1.00	65.6	F	813/975
Boylston Street WB RT	0.05	12.6	B	0/4	0.06	13.7	B	0/4	0.05	12.1	B	0/6
Hammond Street NB LT/TH/RT	0.79	49.5	D	52/102	0.83	51.4	D	56/106	1.04	>80.0	F	382/498
Hammond Street SB LT/TH	0.72	51.2	D	167/217	0.75	54.0	D	184/237	0.84	77.1	E	253/302
Hammond Street SB RT	0.33	34.8	C	0/43	0.34	34.8	C	7/52	0.38	45.0	D	30/78
Overall	--	**58.1**	**E**	--	--	**>80.0**	**F**	--	--	**>80.0**	**F**	--
Weekday Afternoon:												
Boylston Street EB LT	0.74	57.4	E	104/164	0.76	56.6	E	113/176	0.91	>80.0	F	139/286
Boylston Street EB TH/RT	1.08	>80.0	F	680/822	1.20	>80.0	F	824/966	1.07	>80.0	F	855/998
Boylston Street WB LT	0.84	62.8	E	223/372	0.92	75.8	E	251/435	1.03	>80.0	F	385/526
Boylston Street WB TH	0.91	42.8	D	627/811	1.03	66.7	F	770/973	0.91	44.3	D	748/766
Boylston Street WB RT	0.07	11.3	B	0/9	0.08	10.6	B	0/11	0.08	10.1	B	4/14
Hammond Street NB LT/TH/RT	0.76	48.5	D	48/114	0.72	47.5	D	64/101	0.79	66.0	E	174/239
Hammond Street SB LT/TH	0.73	50.3	D	178/230	0.75	50.5	D	196/253	0.82	70.6	E	240/314
Hammond Street SB RT	0.27	34.7	C	0/37	0.27	32.9	C	4/40	0.30	43.8	D	3/52
Overall	--	**62.7**	**E**	--	--	**>80.0**	**F**	--	--	**73.9**	**E**	--
Hammond Street at Heath Street												
Weekday Morning:												
Heath Street WB LT/TH.RT	0.82	60.8	E	161/225	0.84	63.3	E	176/245	0.89	30.7	C	197/159
Hammond Street NB LT/TH/RT	0.83	56.2	E	251/325	0.87	62.7	E	284/387	0.41	10.7	B	142/195
Hammond Street SB LT/TH/RT	0.41	5.1	A	11/14	0.45	5.7	A	12/14	0.67	13.2	B	192/198
Overall	--	**36.1**	**D**	--	--	**39.5**	**D**	--	--	**16.1**	**B**	--
Weekday Afternoon:												
Heath Street WB LT/TH.RT	0.86	58.6	E	211/258	0.87	61.3	E	230/282	0.85	34.1	C	158/232
Hammond Street NB LT/TH/RT	0.80	52.8	D	225/256	0.84	58.6	E	244/285	0.32	7.4	A	103/128
Hammond Street SB LT/TH/RT	0.45	6.9	A	33/83	0.51	8.2	E	39/92	0.63	10.3	B	165/149
Overall	--	**34.9**	**C**	--	--	**37.8**	**D**	--	--	**14.5**	**B**	--

See notes at end of table.

Table 15 (Continued)
SIGNALIZED INTERSECTION CAPACITY ANALYSIS SUMMARY

	2016 Existing				2024 No-Build				2024 Build			
Signalized Intersection Movements	V/C[a]	Delay[b]	LOS[c]	Queue[d]	V/C	Delay	LOS	Queue	V/C	Delay	LOS	Queue
Hammond Street at Woodland Road												
Weekday Morning:												
Woodland Road EB LT/TH/RT	--	--	--	--	0.86	27.0	C	80/134	0.91	38.0	D	138/157
Hammond Street NB LT	--	--	--	--	0.22	9.4	A	16/60	0.30	15.9	B	25/81
Hammond Street NB TH	--	--	--	--	0.55	5.6	A	121/314	0.57	7.2	A	175/340
Hammond Street NB RT*	--	--	--	--	0.56	5.8	A	13/65	0.80	12.5	B	122/308
Hammond Street SB TH/RT	--	--	--	--	0.54	5.5	A	108/248	0.64	8.1	A	199/309
Overall	--	--	--	--	--	**8.7**	**A**	--	--	**13.4**	**B**	--
Weekday Afternoon:												
Woodland Road EB LT/TH/RT	--	--	--	--	0.82	27.6	C	17/41	0.80	26.5	C	22/53
Hammond Street NB LT	--	--	--	--	0.08	4.6	A	3/14	0.08	5.0	A	4/15
Hammond Street NB TH	--	--	--	--	0.43	2.5	A	53/113	0.41	2.5	A	55/122
Hammond Street NB RT	--	--	--	--	0.13	1.8	A	0/12	0.21	2.0	A	0/16
Hammond Street SB TH/RT	--	--	--	--	0.56	3.0	A	77/184	0.58	3.2	A	91/216
Overall	--	--	--	--	--	**4.4**	**A**	--	--	**4.4**	**A**	--

[a]Volume to Capacity
[b]Delay in seconds per vehicle.
[c]Level of service.
[d]Queue Length in Feet (50[th]/95[th] percentile)
NB = northbound; SB = southbound; EB = eastbound; WB = westbound; LT = left-turning movements; TH = through movements; RT = right-turning movements.
*Assume Concept Plan has Northbound Right Turn Lane on Hammond Street

Table 16
SIDRA ROTARY CAPACITY ANALYSIS SUMMARY

	2016 Existing				2024 No-Build				2024 Build			
Critical Movement/Peak Hour	Demand[a]	Delay[b]	LOS[c]	Queue[d]	Demand	Delay	LOS	Queue	Demand	Delay	LOS	Queue
James Horace Circle												
Weekday Morning:												
Hammond Street SWB	451	33.9	D	113	487	41.9	E	152	545	81.1	F	568
Hammond Pond Parkway SEB	985	15.9	C	123	1068	19.8	C	164	1068	23.5	C	188
Newton Street EB	378	26.4	D	91	406	38.5	E	127	442	60.9	F	236
LaGrange Street NB	468	214.5	F	1453	531	354.9	F	2311	570	420.2	F	2573
Newton Street NB	1701	135.5	F	1647	1840	172.9	F	2167	1962	197.5	F	2641
Overall	--	**95.6**	**F**	--	--	**133.8**	**F**	--	--	**159.9**	**F**	--
Weekday Afternoon:												
Hammond Street SWB	537	211.1	F	77	594	309.2	F	2777	651	325.0	F	2961
Hammond Pond Parkway SEB	1101	82.6	F	25	1207	118.0	F	1070	1207	119.3	F	1082
Newton Street EB	239	15.0	B	1	256	15.8	C	35	275	16.8	C	40
LaGrange Street NB	351	122.4	F	682	395	188.3	F	1172	409	232.3	F	1472
Newton Street NB	1035	15.3	C	96	1120	17.7	C	117	1168	17.0	C	115
Overall	--	**89.7**	**F**	--	--	**130.7**	**F**	--	--	**139.8**	**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.
*Assume Concept Plan has Northbound Right Turn Lane on Hammond Street

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

VAI has completed a detailed assessment of the potential impacts on the transportation infrastructure associated with the proposed Baldwin Elementary School to be located off Heath Street in Brookline, Massachusetts. 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. The following specific areas have been evaluated as they relate to the Project: i) access requirements; ii) potential off-site improvements; and iii) safety considerations; under existing and future conditions, both with and without the Project. Based on this assessment, we have concluded the following with respect to the Project:

- The Project is expected to generate approximately 776 vehicle trips (437 entering/ 339 exiting) expected during the weekday morning peak-hour and 481 vehicle trips (216 entering/265 exiting) expected during the weekday afternoon peak-hour;

- A review of accident data researched from MassDOT indicates that area intersections (with the exception of the Horace James Circle) experience accident rates below state averages indicating safe operations.

- The proposed driveway off Heath Street has adequate sight distances for safe and efficient operations.

- While the projected pedestrian traffic to the school is expected to be minimal, safe conditions can be achieved with sidewalks, crosswalks and crossing guards at appropriate locations.

- The Project will increase traffic in the morning and afternoon periods with increased delays and queues at locations within the study area. These delays and queues will be confined to limited and distinct periods during the morning drop-off and afternoon pick-up periods (20-25 minutes at peaks) and these periods are non-coincident with the peak periods of the adjacent roadways.

In summary, the proposed site is a good location for a new school and a safe environment can be maintained with traffic conditions maintained at manageable levels. While the school can be safely accommodated and will increase delays and queues during limited period of the day

(20-25 minutes at peaks), improvements will be necessary to minimize the impacts and enhance safety conditions.

RECOMMENDATIONS

A detailed transportation improvement program has been developed that is designed to maintain safe and efficient access to the school and address any deficiencies identified at off-site locations evaluated in conjunction with this study. The following improvements have been recommended as a part of this evaluation and will be completed in coordination with the Town.

Project Access

The school driveways were planned such that traffic impacts to the area are minimized and safe and efficient access and egress is provided. While a two-way driveway was considered along Woodland Road and two-way travel on Woodland Road was reviewed, this option was eliminated due to Woodland Road impacts. Based upon the evaluation three driveways are proposed:

- The main driveway off Heath Street is located at the approximately location of the Soule Recreation Center rear access. This driveway will provide two exit lanes and one entering lane.
- A left-turn entering only driveway is proposed off Woodland Road which minimizes the amount of turning traffic onto Heath Street and at the Heath Street main driveway.
- A bus/service driveway is proposed off Heath Street and is designed such that buses can arrive in either direction from Heath Street.

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

- The main driveway should have a minimum 20-foot entrance and two 12-foot exit lanes under STOP-control. The intersection should be illustrated.
- Both Entrance-Only drives 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 provided along Heath Street for and Woodland Road.
- 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).[7]
- In order to provide the required lines of sight approaching and departing the Project site driveway intersection with Heath Street, the area to the east of the driveway must be regraded for sufficient lines of sight.
- Signs and landscaping adjacent to the Project site driveway intersections should be designed and maintained so as not to restrict lines of sight.

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[7]Ibid 4

The driveway and signage are depicted in Figure 23

Pedestrian Improvements

As depicted in Figure 12, new crosswalks are proposed along Heath Street, Hammond Street and Woodland Road. Crossing guards should be placed at the Hammond Street crosswalk and at the main Heath Street driveway. Sidewalks entering the site will be provided along the bus/service drive, main Heath Street drive and Woodland Road drive. In addition, all of the existing deficiencies depicted in Figure 11 should be addressed by the Town to provide the area with continuous ADA-complaint sidewalks.

As part of the Woodland Road traffic calming improvements, the following should be implemented:

- A raised crosswalk at the new School driveway
- Bicycle lane considerations along Woodland Road
- Continuous sidewalk along the north side of Woodland Road.

Off-Site

Hammond Street at Route 9 and Hammond Street at Heath Street

This intersection should be retimed and coordinated. It is proposed that the Heath Street traffic signal cycle length be one-half of the Route 9 traffic signal cycle such that additional capacity can be allocated to Heath Street to facilitate traffic movements exiting Heath Street.

Heath Street at Woodland Road

This intersection should be realigned with reduced pavement width to better define traffic flow. Woodland Road should be stripped for a two-lane approach to Heath Street.

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 Heath Street and Woodland Road.

Transit Usage

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

Figure 23

Summary of Improvements

Vanasse & Associates, Inc.
Transportation Engineers & Planners

DRAFT

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 and the site access and off-site improvements detailed herein have been developed to facilitate access to the school campus for pedestrians, bicyclists, school buses and parents/caregivers in a safe and efficient manner. The traffic and parking management plan has been designed to build-upon this created infrastructure and will consist of the following major elements, all of which are overseen by school staff:

- Police detail officer should be initially located at the main entrance and exit driveway serving the Project site in order to manage the flow of vehicles and pedestrians entering and exiting the site, and pedestrians crossing Heath 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, police detail at the main driveway, and evaluate the level of student busing and make adjustments, as necessary.

Overall, a safe environment to the school can be maintained and the increased traffic conditions with respect to delays and queues will be limited to short periods in the morning and afternoon.