

Indian Hill Music indicated Monday would be representative of a *Typical* peak day, as its Youth Orchestra rehearsals occur on that day of the week.

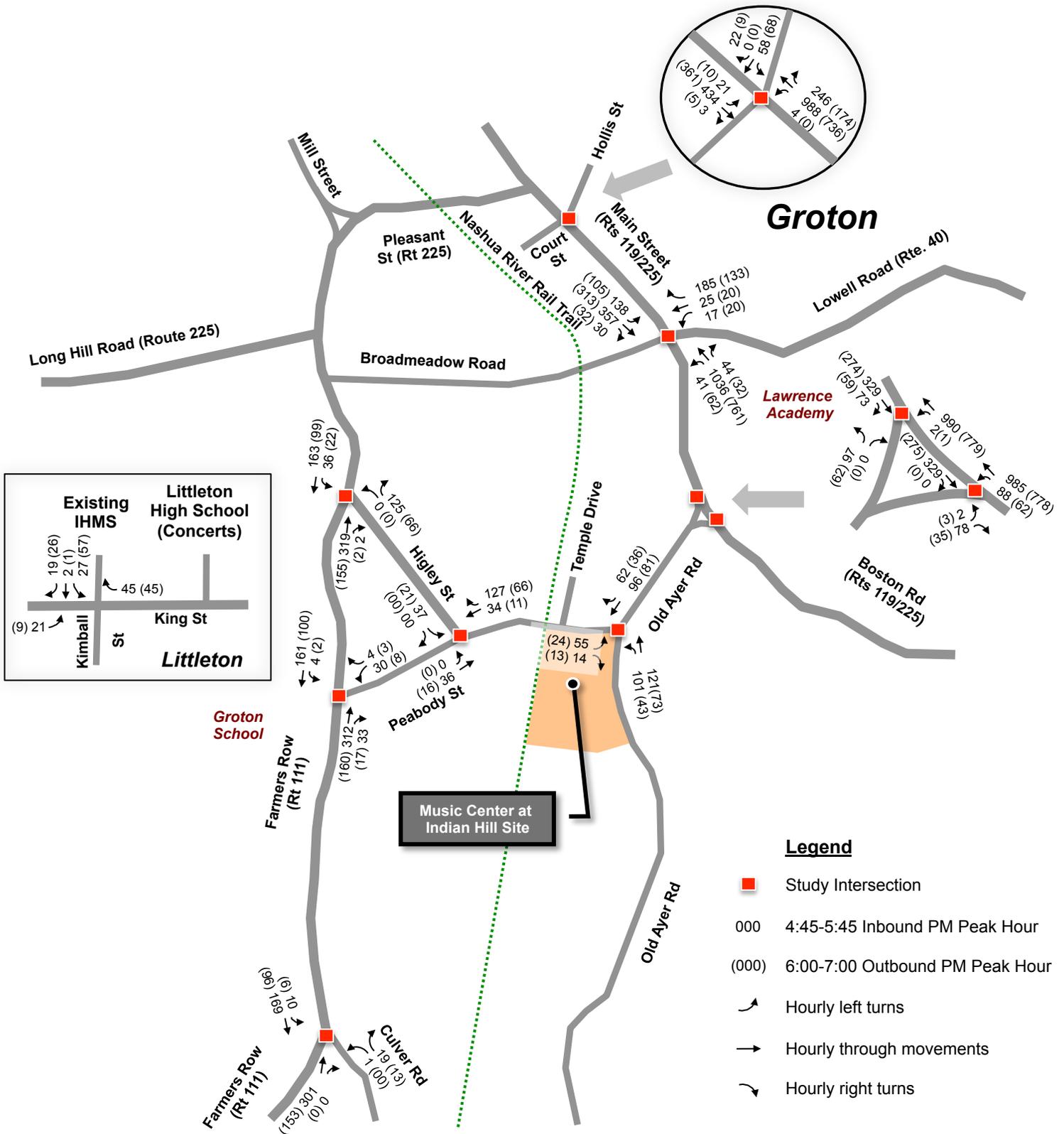
Also, a sold-out Indian Hill Music concert was counted on Saturday, March 12, 2016. Counts of the concert were performed from 5:30-7:30 PM and from 9-11 PM to obtain arrival/departure traffic characteristics for evening performances of future *Large* and *Festival* days. Indian Hill Music provided accurate information on attendance staffing and concert performers for the concert so average vehicle occupancy could be calculated for future *Large* and *Festival* days. Refer to the Technical Appendix for detailed count data. Figures 5-7 provide illustrations of existing peak hour count data concurrent with projected MCIH *Typical* school-related weekday peak hours from 4:45-5:45 PM and 6:00-7:00 PM, for *Large* Friday concert peak hours from 6:15-7:15 PM and 9:30-10:30 PM, and Saturday mid-day *Festival* peak hours were estimated to be from 11:00 AM-12 Noon. Because we project that background traffic for the Friday late peak hour concert trip generation will be slightly higher than the Saturday late peak hour concert trip generation that would typically be from 10-11 PM, it was unnecessary to evaluate the projected Saturday late peak hour for the occasional *Festival*.

Automatic Traffic Recorder Counts

On street automatic count recorder data included volume, speeds, and vehicle classifications to provide full context for traffic projections and analysis. With the Town's concurrence⁷, the following traffic automatic traffic recorder counting counts were performed:

- ❖ March 12-18, 2016 full week counts on Boston Road (Routes 119/225) south of Old Ayer Road.
- ❖ March 12- 18, 2016 full week counts on Old Ayer Road south of the MCIH site from.
- ❖ March 14- 15, 2016 two-day counts on Long Hill Road (Route 225) west of Farmers Row.

⁷ Ibid.



Schematic Diagram:
Not to Scale

Stantec Consulting Services Inc.

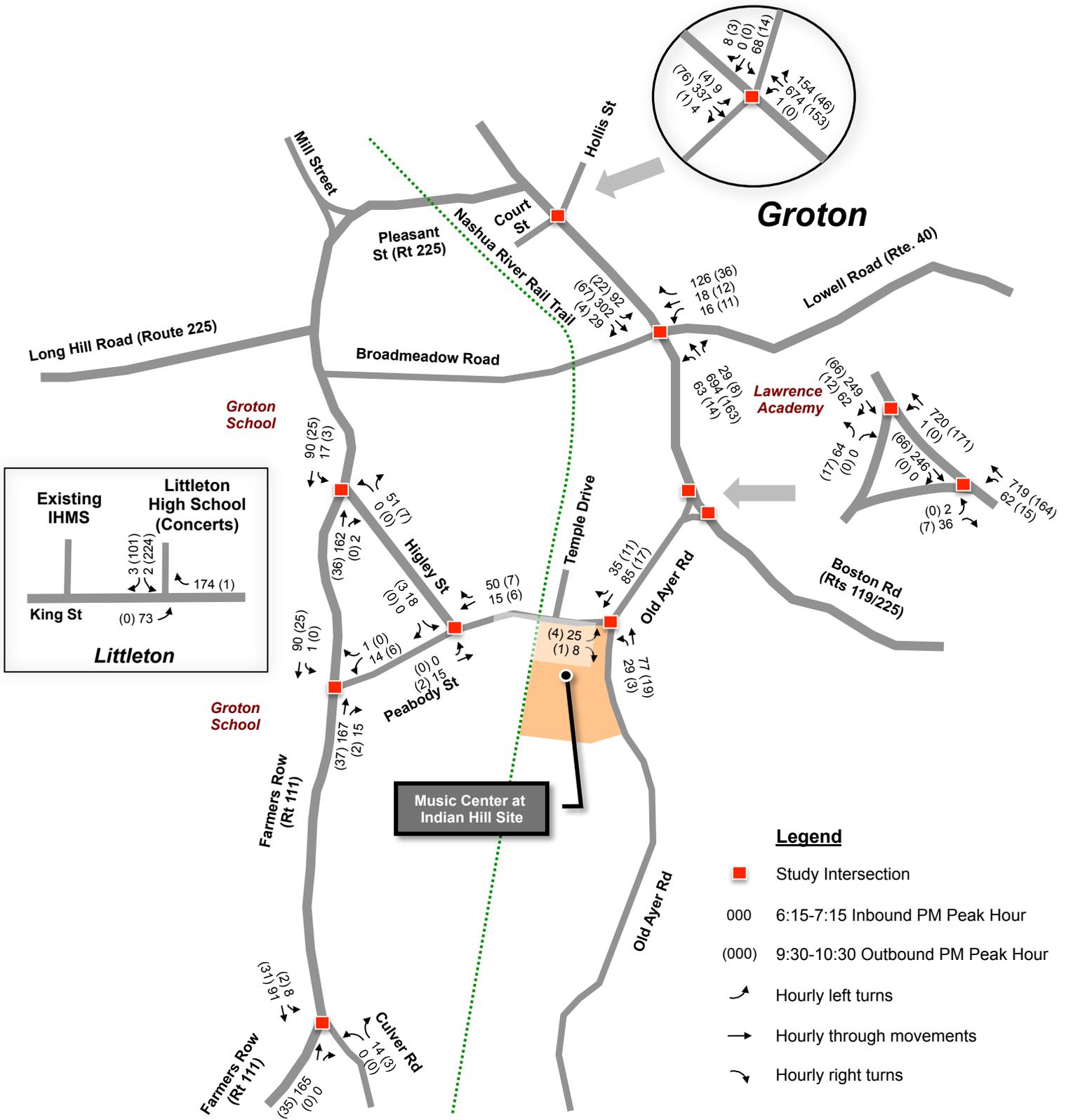


Music Center at Indian Hill
Groton, Massachusetts

Existing Year 2016 Traffic Volumes

4:45 - 5:45 PM and (6:00 - 7:00 PM)

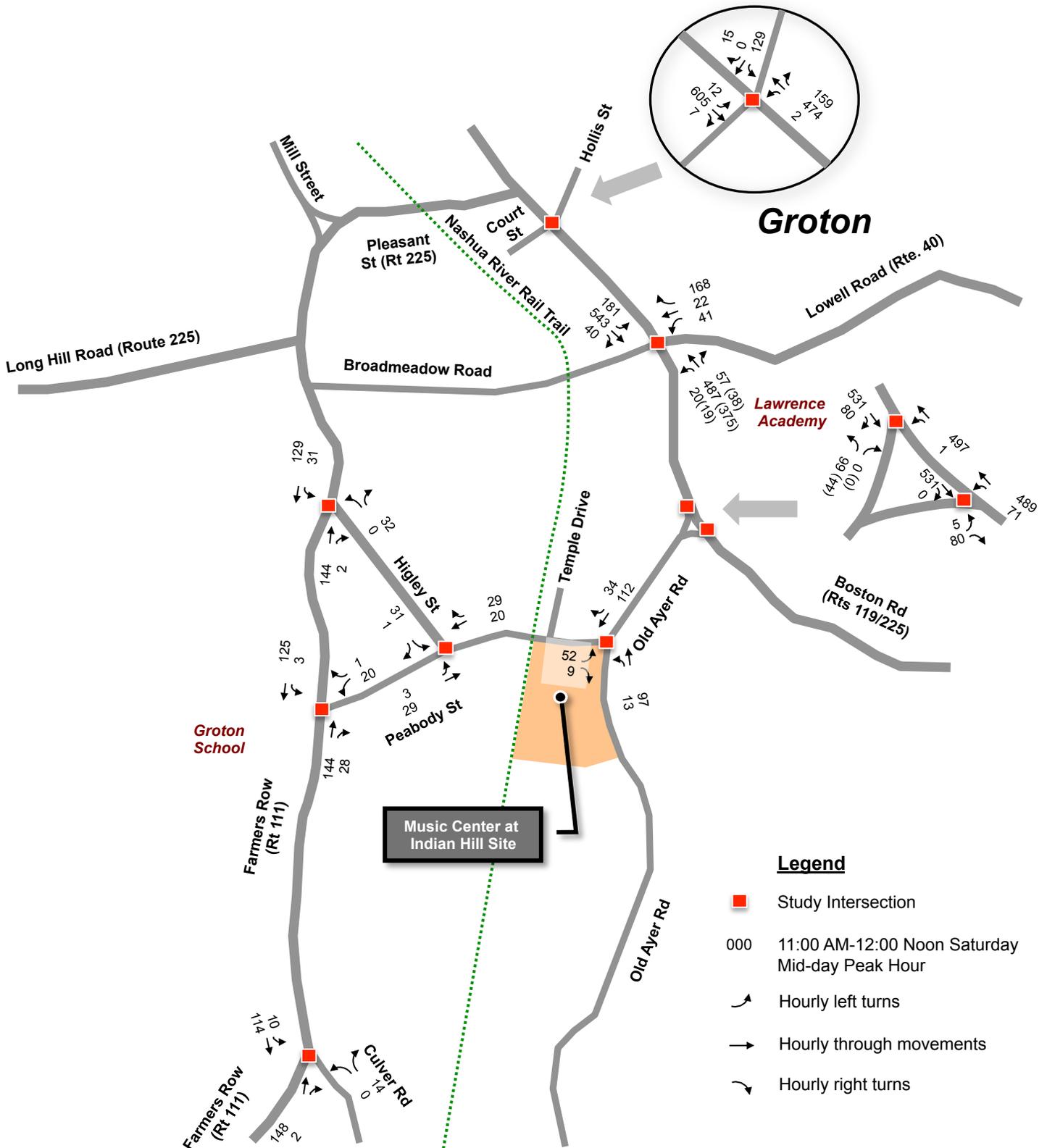
During "Typical" School Day Peak Hours



Schematic Diagram:
Not to Scale

Music Center at Indian Hill
Groton, Massachusetts

6:15 - 7:15 PM and (9:30 - 10:30 PM)
During "Large" Friday Evening Concert Peak Hours



Schematic Diagram:
Not to Scale

Stantec Consulting Services Inc.



Music Center at Indian Hill
Groton, Massachusetts

Existing Year 2016 Traffic Volumes

11:00 AM - 12:00 Noon
During "Festival" Saturday Mid-day Peak Hour

Automatic Traffic Recorder Counts (Continued)

- ❖ March 14-15, 2016 two-day counts on Peabody Street west of Old Ayer Road.
- ❖ March 14-15, 2016 two-day counts on Farmers Row (Route 111) south of Peabody Street.
- ❖ March 14-15, 2016 two-day video camera unit counts at the Indian Hill Music Driveway from March 14-15, 2016.

Table 1 summarizes results of evaluated automatic traffic recorder data including location, average weekday traffic volume, weekday peak hour 2-way volumes, K factors or percentage of peak hour to daily traffic, peak directional percentage during peak hours, and truck percentage. Table 1 incorporates MassDOT’s recommendation to round volumes over 1,000 vehicles per day to the nearest 100 vehicles.

Table 1 - Automatic Traffic Recorder Findings

Location	AWDT¹	Peak Hour²	K Factor³	Peak Direction Percentage⁴	Daily Truck Percentage⁵
Boston Road (Rt 119/225) South of Old Ayer Road ⁶	17,000	1440	8.4	69% NB	4.4%
Main Street (Rt 119/225) South of Lowell Road (Rt 40) ⁷	18,200	1720	9.5	72% NB	N/A
Old Ayer Road South of Peabody Street ⁶	4,000	315	7.8	57% NB	3.2%
Peabody Street west of Old Ayer Road ⁶	2,200	305	13.9	85% EB	4.3%
Lowell Road(Rt 40) east of Main Street (Rt 119/225) ⁷	5,400	440	8.1	58% WB	N/A
Long Hill Road (Rt 225) west of Farmers Row (Rt 111) ⁶	4,800	440	9.2	79% EB	3.8%
Farmers Row (Rt 111) south of Peabody Street ⁶	5,000	505	10.1	63% EB	9.5%

- 1– AWDT average weekday daily traffic.
- 2- Peak hour weekday average.
- 3 – K Factor – Percentage of daily traffic flow during the daily peak hour
- 4 – Peak direction percentage of peak hour traffic in the peak direction
- 5 – Percentage of trucks per day during the count period.
- 6 – Source: Stantec
- 7 – Source: Bayside Engineering

Included on Table 1 are two additional automatic traffic recorder counts within our Study Area counted during mid-September, 2015 by Bayside Engineering on behalf of Lawrence Academy.

Existing Indian Hill Music Traffic and Parking Findings

Indian Hill Music is served by a single driveway that allows traffic to enter and leave via King Street or Kimball Street, opposite the site. Video camera unit counts were needed to ensure counting accuracy, given the varying speeds that motorists enter and exit the Indian Hill Music site. Count times for the Indian Hill Music driveway counts were selected in consultation with School officials.⁸ Counts were performed over a two-day period on March 14-15, 2016 and are representative of existing *Typical* school operating conditions. On Monday, March 14, 2016, a *Typical* Peak School Day, Indian Hill Music had a total of 593 vehicle trips, of which roughly half entered and half exited. On Tuesday March 15, 2016, a *Typical* Regular School Day, a total of 339 vehicle trips, again approximately half in and half out, were measured.

Refer to Figure 8 for a graphical summary of entering and exiting traffic in 15-minute increments to and from the Indian Hill Music driveway. From Figure 8, on a Tuesday, the school produced 43% lower traffic volumes than those measured on Monday.

From the additional video camera unit counts performed on Monday from 4:45-8:45 PM, the distinct school peak hours were identified as 4:45-5:45 PM and 6:00-7:00 PM. Data from these peak hours was presented previously on Figure 5. During the 4:45-5:45 peak hour, there were 48 vehicles exiting and 66 vehicles entering, while there were 54 vehicles entering and 84 vehicles exiting during the 6:00-7:00 peak hour. Therefore, the two existing Indian Hill Music peak hours total 114 and 138 vehicle trips, respectively. Using the video camera unit automatic count data, site-related parking demands for the Indian Hill Music were calculated.

Refer to Figure 9 for a display of the hourly peak parking demands at the Indian Hill Music. From Figure 9, on Monday, March 14th, the site generated a peak parking demand of 77 vehicles parking simultaneously, while a maximum of 47 vehicles were parked simultaneously on Tuesday, March 15th.

⁸ Personal communication, 2/23/16, Susan Randazzo, Executive Director, Indian Hill Music.

Monday

3/14/16

Daily On-site Traffic:

294 Trips in

299 Trips Out

593 Total Monday Trips

Note: Tuesday 43%
lower than measured
Monday Traffic

— Entering Traffic
— Leaving Traffic

Tuesday

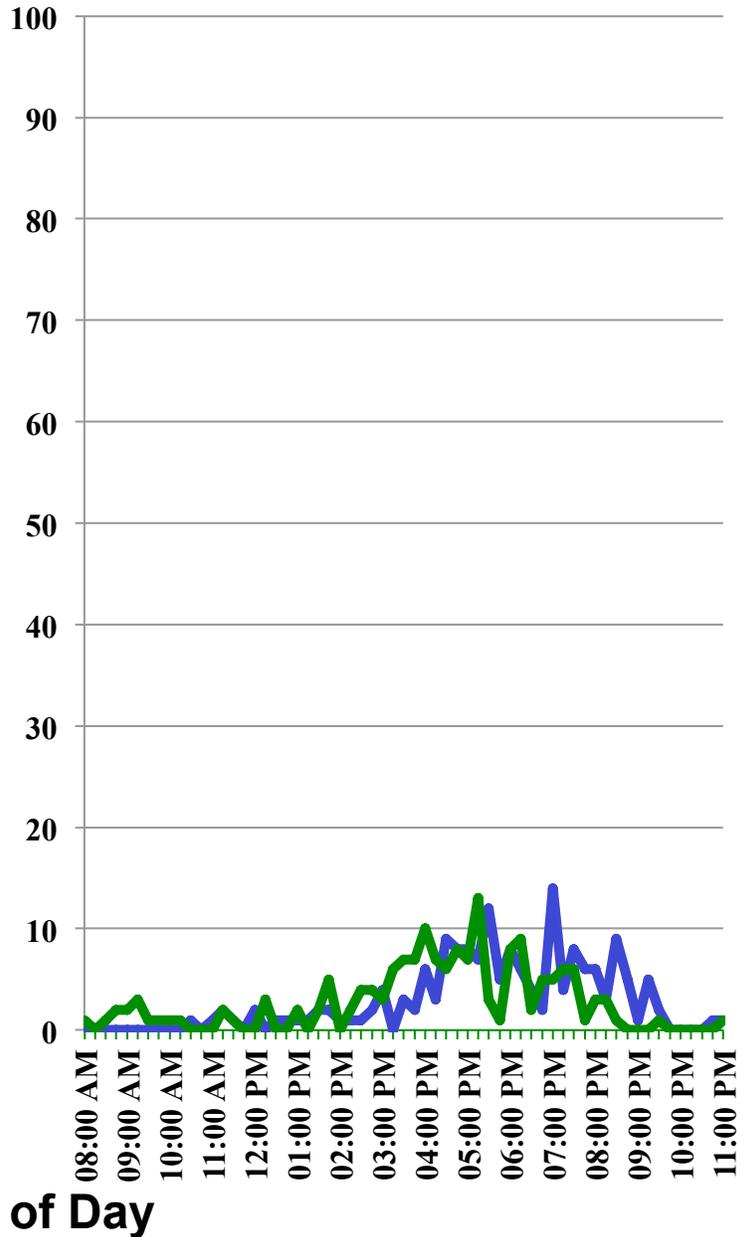
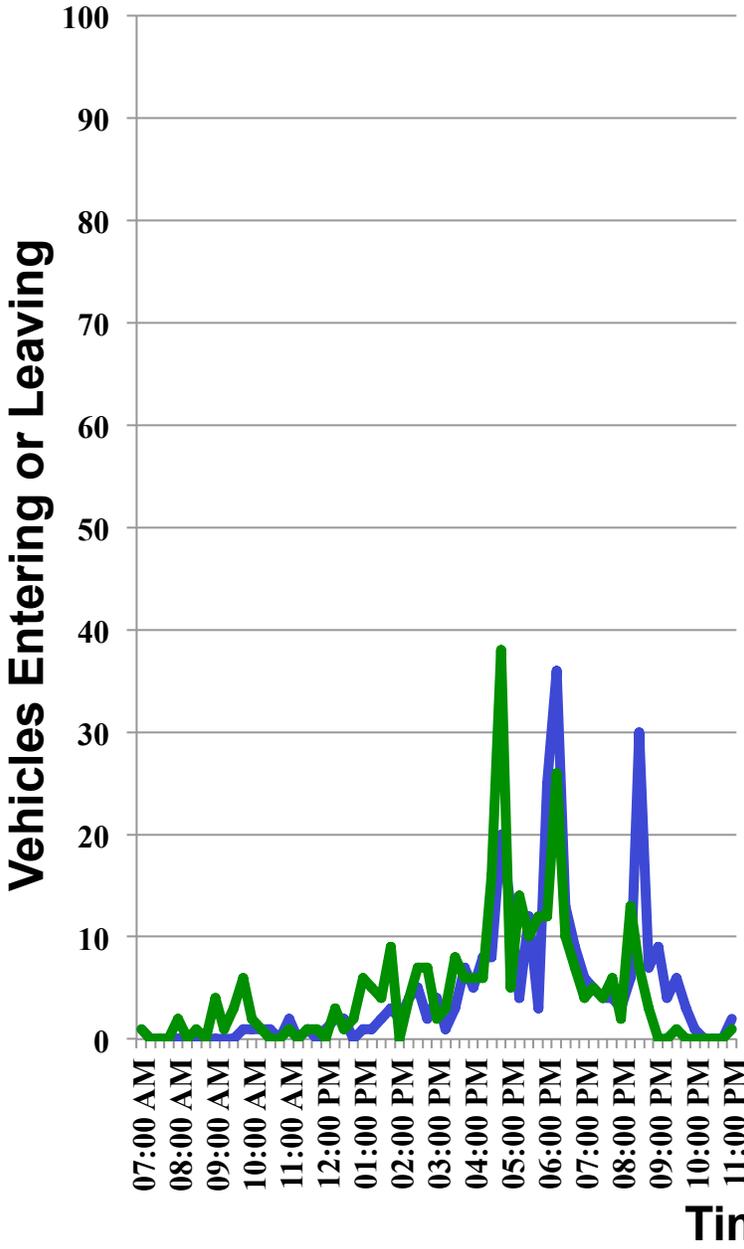
3/15/16

Daily On-site Traffic:

172 Trips in

167 Trips Out

339 Total Tuesday Trips



Music Center at Indian Hill
Groton, Massachusetts
Existing Year 2016 Indian Hill Music Traffic Volumes
March 14-15 Count Patterns – Ins/Outs in 15-minute Intervals

Monday

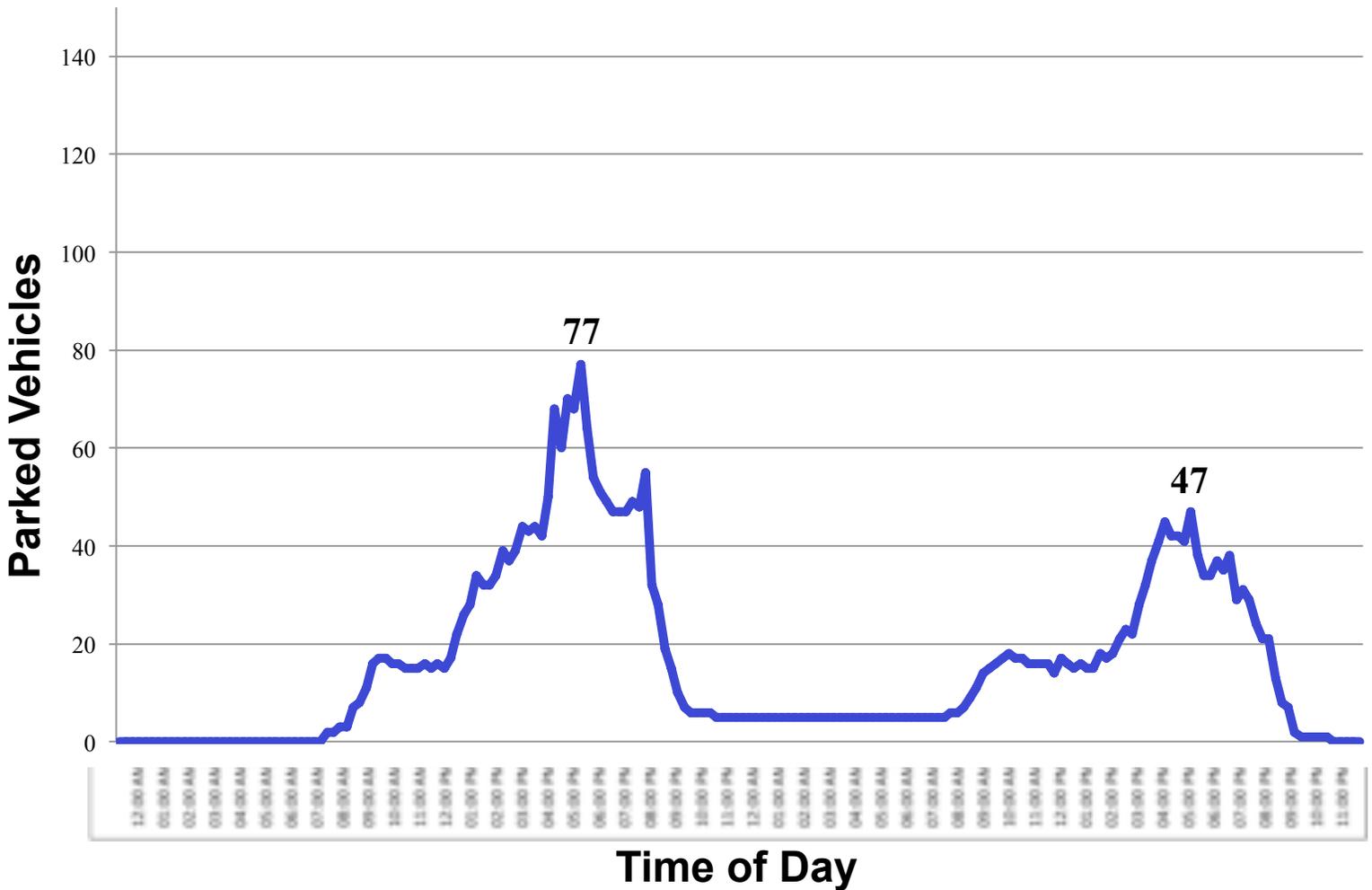
3/14/16

Peak On-site
Parking Demand
77 Vehicles @
5:45 PM

Tuesday

3/15/16

Peak On-site
Parking Demand
47 Vehicles @
5:15 PM



Music Center at Indian Hill
Groton, Massachusetts

Existing Year 2016 Indian Hill Music Parking Demands March 14–15 by Time of Day

Boston Road (Routes 119/225) Volume/Speed/Capacity Findings

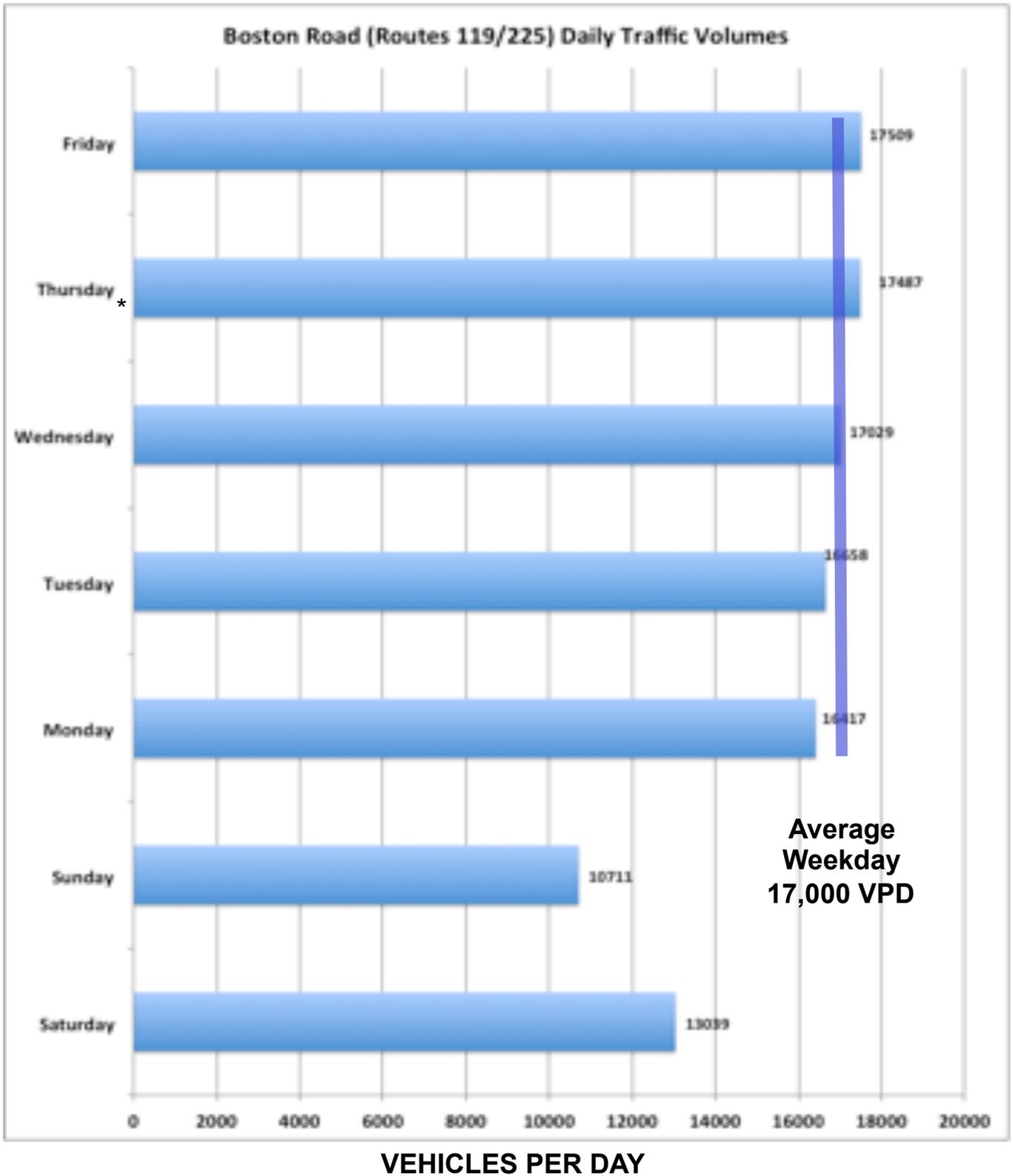
Boston Road traffic was measured for a 7-day period, as will be serving a high percentage of site-generated vehicle traffic. From Table 1, on average, it carries approximately 17,000 vehicles per day on Monday to Friday. At least 85% of the vehicles on Boston Road were travelling at or below 40-41 MPH, while its average speeds are approximately 34-35 MPH. To help appreciate how traffic speeds relate to traffic operations and its capacity, Figures 10-12 were prepared.

Figure 10 illustrates Boston Road daily traffic trends. Boston Road's measured traffic volumes tended to increase slightly day-to-day from Monday to Friday – the highest day of the week. On Saturday, it carried 13,040 vehicles per day while on Sunday, its lowest day, approximately 10,700 vehicles per day traversed it. Figures 11 and 12 show the percentage of time northbound traffic speeds are lower than its typical 35 MPH speed limit on an hourly basis during the week. In the northbound direction, lower travel speeds tend to be greatest from 2-3 PM, while in the southbound direction they occur from 7-8 AM. From Figure 12, the approximate northbound capacity of Boston Road is roughly 1,075-1,125 vehicles per hour. When capacity is reached, queuing occurs and traffic diversions to alternate routes may occur and the processed traffic volumes decline. From the collected traffic speed data, the percentage of vehicles traveling less than 20 MPH NB on Boston Road never exceeded 19% of all NB vehicles during any hour of those measured and was greater than 5% of all NB vehicles during three or fewer hours of the day.

Old Ayer Road Volume and Speed Findings

Old Ayer Road traffic volumes were also measured over a 7-day period. Unlike Boston Road, Old Ayer Road is not congested and its travel speeds do not vary significantly during the day. Its daily traffic trends, for the same period as Boston Road, are illustrated on Figure 13. Its average weekday traffic, per Table 1, is 4,025 vehicles per day. The speed data indicates that 85% of the traffic on Old Ayer Road is travelling at or below 43 miles per hour. Average travel speeds are approximately 39 miles per hour. The distribution of vehicles by travel speeds is very stable throughout the day.

DAY OF WEEK



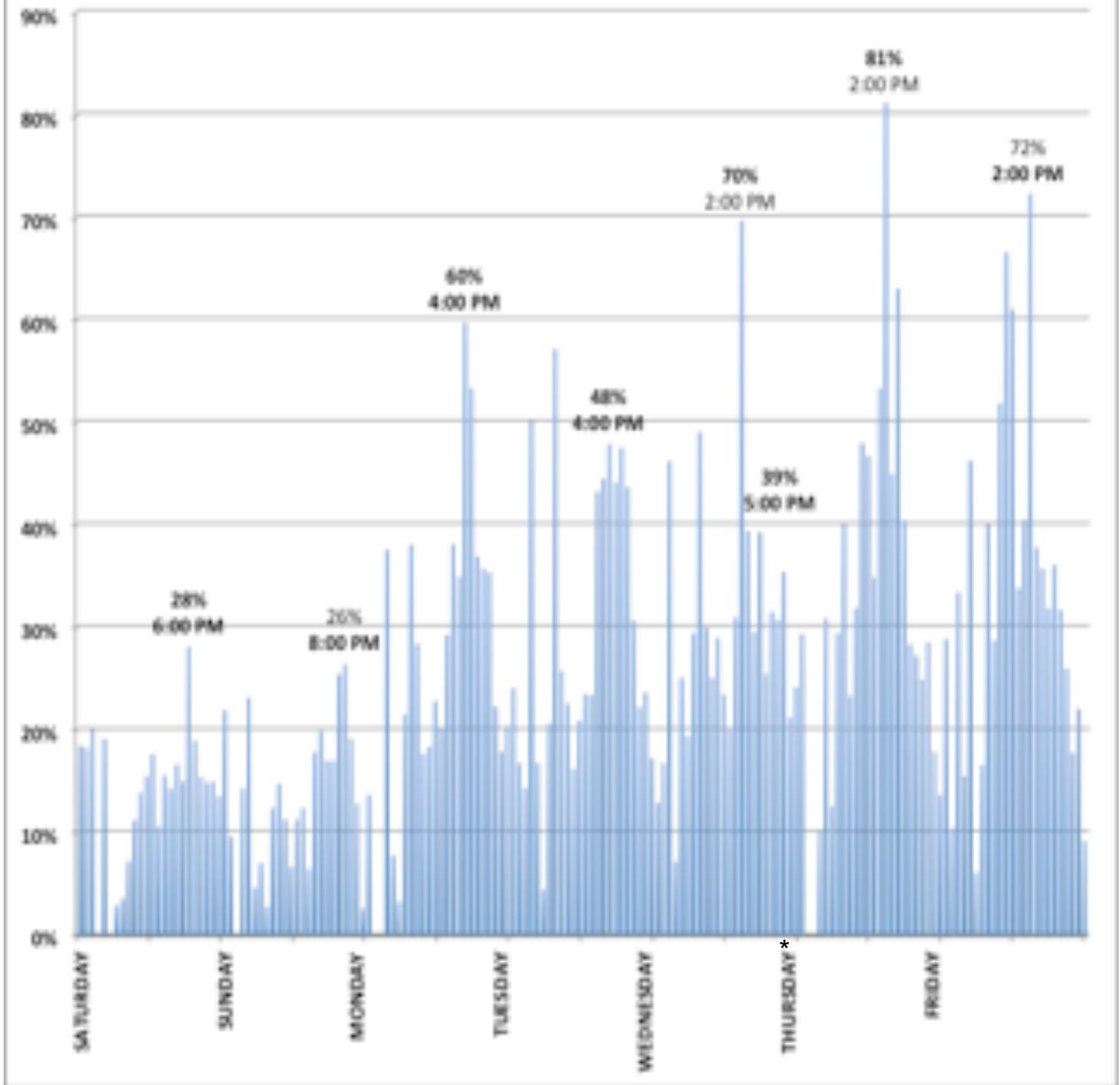
* St. Patrick's Day

*Music Center at Indian Hill
Groton, Massachusetts*

Boston Road (Routes 119/225) Daily Traffic Trends

**March 12-18, 2016
South of Old Ayer Road**

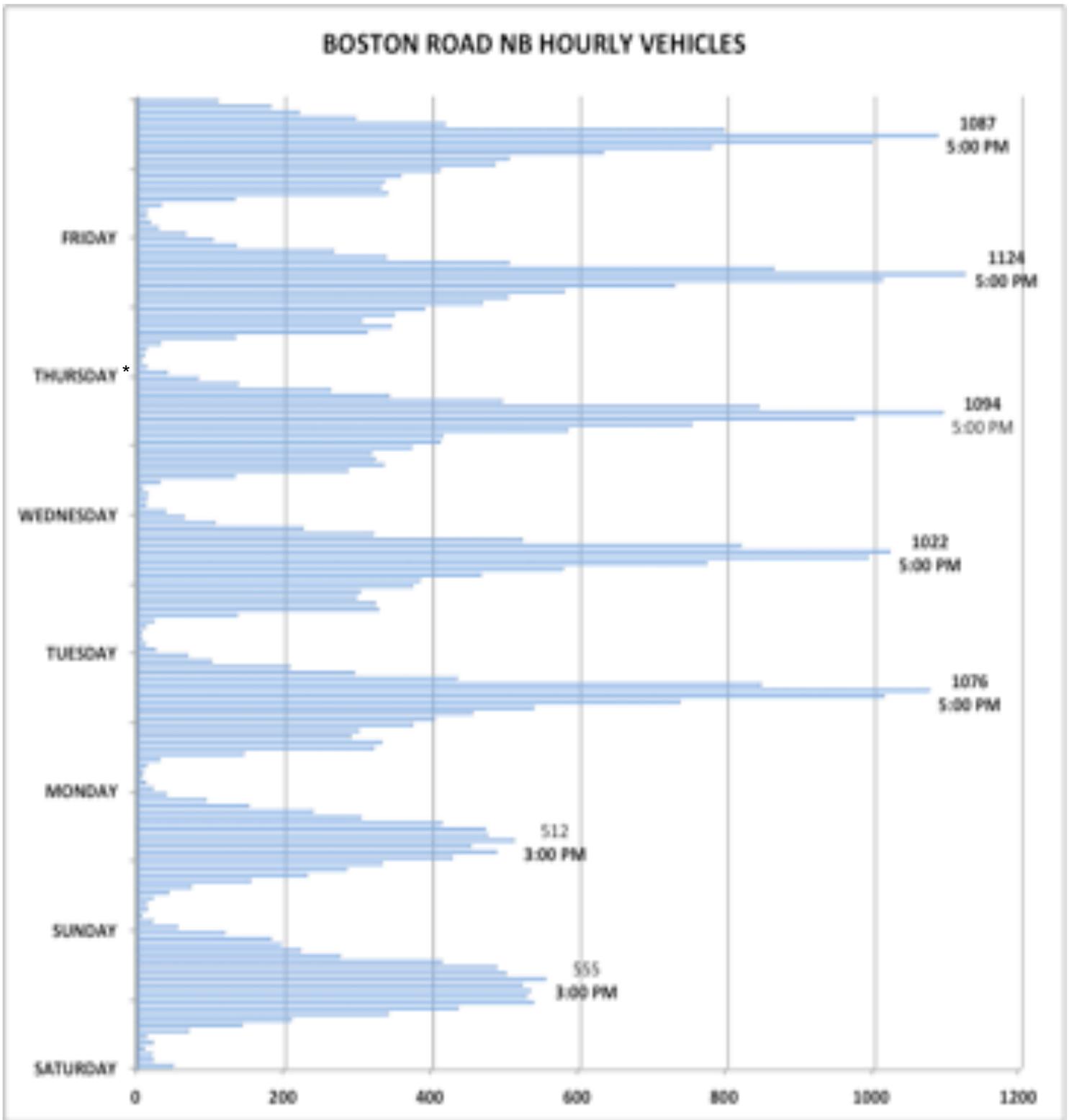
Boston Road NB - % Speeds <35 MPH



* St. Patrick's Day

*Music Center at Indian Hill
Groton, Massachusetts*

Boston Road (Routes 119/225) NB Speed Trends
 <35 MPH March 12-18, 2016
 South of Old Ayer Road



* St. Patrick's Day

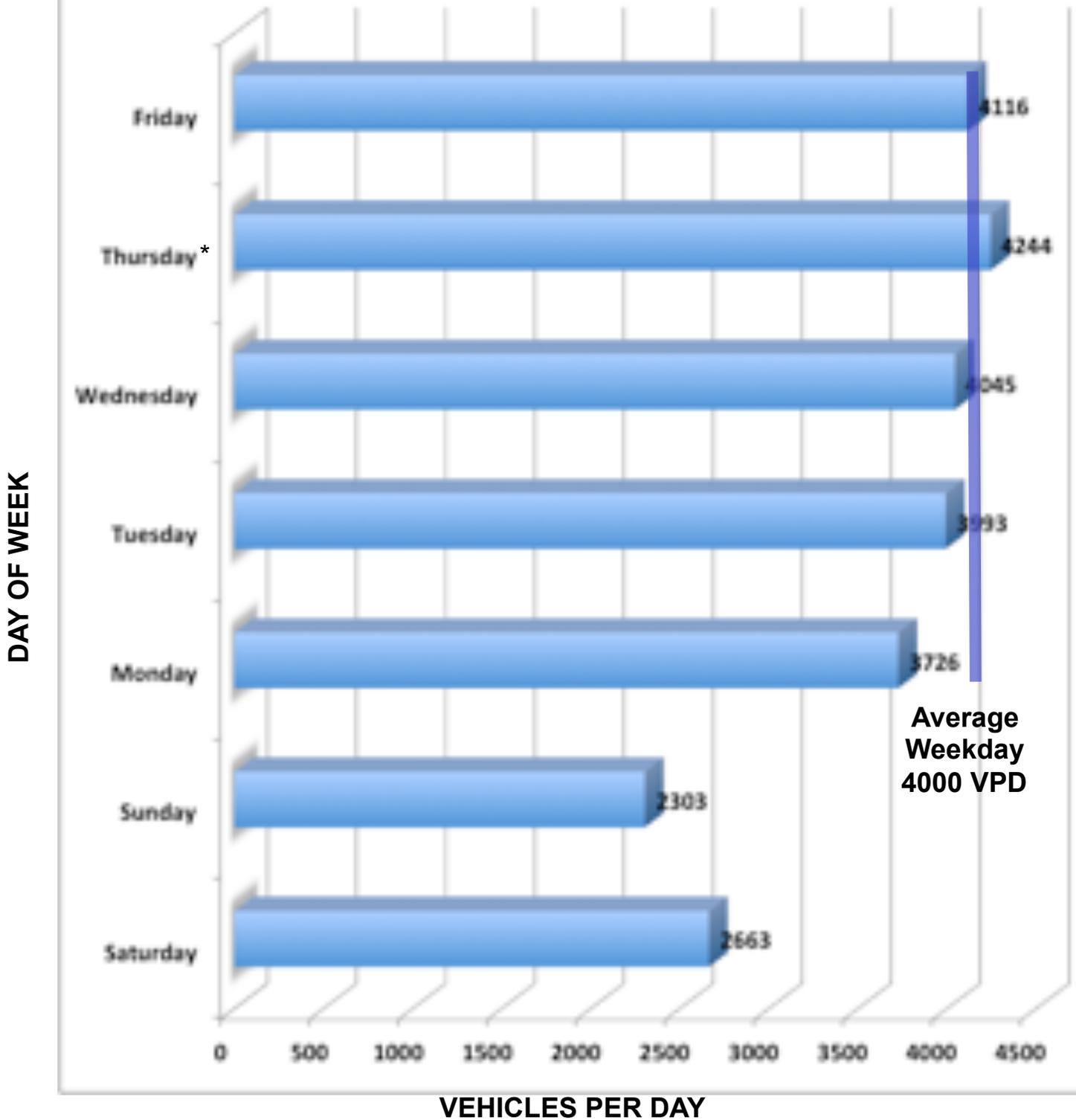
*Music Center at Indian Hill
Groton, Massachusetts*

Boston Road (Routes 119/225) NB Hourly Volume Trends

March 12-18, 2016

South of Old Ayer Road

Old Ayer Road Daily Traffic



* St. Patrick's Day

*Music Center at Indian Hill
Groton, Massachusetts*

Old Ayer Road Daily Traffic Trends

**March 12-18, 2016
South of MCIH Site**

c. Existing (2016) Levels of Service

All of the existing intersections in the study area are unsignalized. We anticipate they will all remain unsignalized for the foreseeable future, so the focus of this analysis is unsignalized intersections.

Level of service is a technical term used to describe how well traffic operates during a typical hour of interest. It takes into account such things as vehicle mix of trucks and cars, pedestrian and bicycle movements, turning movements in conflict with other traffic flows, and grades. The one thing level of service can't do is account for upstream blockages, so the traffic analyst must be aware of conditions that might cause upstream blockages, such as occurs at times on Boston Road/Main Street (Routes 119/225). As a two-lane regional highway, it is subject to occasional upstream blockages when left or right turning movements or pedestrian crossings occur, temporarily blocking through traffic flow. The Transportation Research Board defines Levels of service (LOS) similar to how report cards are graded, ranging from LOS A, best case, to LOS F, worst case. Table 2 below summarizes the nationally accepted level of service criteria for unsignalized intersections. Average total delay includes lost time due to acceleration and deceleration.

**Table 2 – Highway Capacity Manual
Unsignalized Intersection Level of Service Delay Criteria¹**

Level of Service	Average Total Delay (seconds per vehicle)
A	<10
B	>10 and ≤ 15
C	>15 and ≤ 25
D	>25 and ≤ 35
E	>35 and ≤ 50
F	>50

1 – Highway Capacity Manual, Transportation Research Board, 2010 Edition.

Table 3 provides analyses of the nine intersections for the five peak hours evaluated for evaluating future *Typical*, *Large*, and *Festival* operations.

Table 3 - Existing (2016) Conditions Peak Hour Operations Analysis

Intersection	During "Typical" School Peak Day Peak Hours				During Friday "Large" Performance Peak Hours Assuming 1,000-Patron or 2,300-Patron Events				During Saturday Mid-day Peak Hour at a "Festival" Assuming 2,300 Patrons											
	2016 Existing 4:45-5:45 PM		2016 Existing 6:00-7:00 PM		2016 Existing 6:15-7:15 PM		2016 Existing 9:30-10:30 PM		2016 Existing 11:00 AM-12:00 PM											
	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del								
1) Old Ayer Road (S) at Boston Rd																				
Old Ayer Rd EB	B	0.14	13	12	B	0.10	8	13	B	0.08	6	11	A	0.01	1	9	C	0.25	24	15
Boston Rd NB	A	0.08	7	3	A	0.06	6	2	A	0.05	4	1	A	0.01	1	1	A	0.08	7	2
2) Old Ayer Road (N) at Main St																				
Old Ayer Rd EB	F	0.78	120	87	E	0.42	47	38	D	0.33	34	27	B	0.05	4	11	D	0.38	42	31
Main St NB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
3) Lowell Road at Main St/Broadmeadow																				
Lowell Rd WB	F	1.90	553	477	F	0.84	168	67	D	0.45	58	30	B	0.06	4	11	F	0.95	221	85
Main St NB	A	0.04	3	1	A	0.06	5	2	A	0.06	4	1	A	0.01	1	1	A	0.02	2	1
Main St SB	A	0.26	26	7	A	0.16	14	4	A	0.13	11	3	A	0.02	1	2	A	0.18	17	4
4) Main Street at Hollis St																				
Hollis Street WB	F	1.15	164	242	F	0.76	106	100	F	0.57	73	53	B	0.05	4	11	F	0.94	175	109
Main St NB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
Main St SB	A	0.05	4	2	A	0.02	1	1	A	0.01	1	0	A	0.00	0	0	A	0.01	1	0
5) Farmers Row at Higley St																				
Farmers Row SB	A	0.04	3	2	A	0.02	2	2	A	0.02	1	1	A	0.00	0	1	A	0.03	2	2
Higley St NWB	B	0.21	19	12	A	0.12	10	10	A	0.07	6	10	A	0.01	1	9	A	0.05	4	9
6) Farmers Row at Peabody St																				
Farmers Row SB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
Peabody St WB	B	0.10	9	13	B	0.02	2	10	B	0.03	2	11	A	0.01	1	9	B	0.04	3	11
7) Farmers Row at Culver Rd																				
Farmers Row SB	A	0.01	1	1	A	0.01	0	1	A	0.01	1	1	A	0.00	0	0	A	0.01	1	1
Culver Rd NWB	B	0.04	3	10	B	0.02	2	10	A	0.03	2	9	A	0.00	0	9	A	0.02	2	9
8) Peabody St at Higley St																				
Higley St SB	A	0.05	5	10	A	0.03	2	9	A	0.03	2	9	A	0.00	0	9	A	0.05	4	9
Peabody St EB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	1
9) Peabody St at Old Ayer Rd																				
Peabody St EB	B	0.15	13	13	B	0.06	5	10	B	0.05	4	10	A	0.01	1	9	B	0.10	9	11
Old Ayer Rd NB	A	0.08	6	4	A	0.04	3	3	A	0.02	2	2	A	0.00	0	1	A	0.01	1	1

LOS - Level of Service from A-F; A is best, F is worst.

V/C - Proportion of volume to available capacity during analysis hour

Q - 95th percentile vehicle queue measured in feet from the intersection.

Del - Average motorist delay expressed in seconds during peak 15 minute period of the peak hour.

Over-capacity LOS F condition --V/C greater than 1.0.



Peak hours evaluated for a *Typical* Peak School Day were from 4:45-5:45 PM and 6:00 – 7:00 PM. Additionally, five different peak hours associated with *Large* and *Festival* scenarios were evaluated. They included the 6:15-7:15 PM. And 9:30-10:30 PM hours on *Large* Friday evenings under two analysis scenarios assuming 1,000 and 2,300 patron concert performances. Additionally, a Saturday *Festival* mid-day peak hour from 11:00 AM – 12 Noon assuming 2,300 patrons, overall was evaluated.

Table 3 includes the ratio of the volume processed to the calculated capacity (V/C), maximum queues behind a stop controlled movement, and the average length of delays, in feet, experienced by motorists prior to entering each intersection.

From Table 3, the analysis of existing conditions concurrent with MCIH activities, three of the nine Groton off-site intersections evaluated experience LOS E/F congestion under existing conditions. All three intersections are with Boston Road or Main Street (Routes 119/225).

They included:

- ❖ The Old Ayer Road (N) approach to Main Street during both *Typical* Peak School Day peak hours.
- ❖ The Lowell Road westbound approach to Main Street during both *Typical* Peak School Day peak hours and the early *Festival* peak hour.
- ❖ The Hollis Road approach to Main Street during both School peak hours, the early *Large* evening peak hour, and the mid-day *Festival* peak hour.

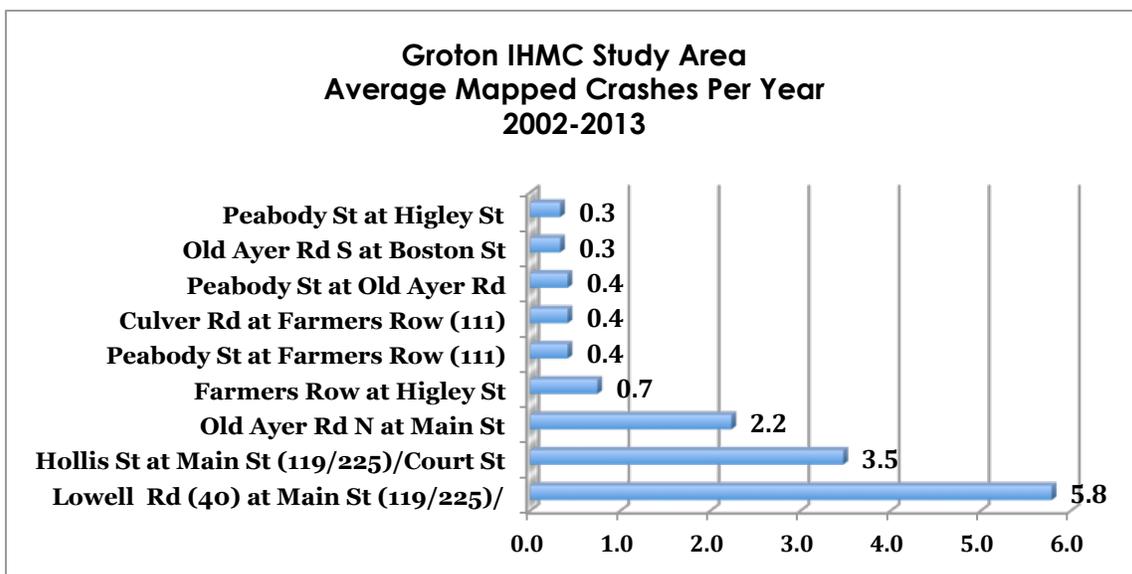
Main Street/Boston Road is the busiest road in Groton. Serving a large percentage of through traffic not originating in Groton, it is not unusual for Groton's side street approaches to encounter delays before making turns or crossing, particularly during peak traffic hours. Its traffic flows heavily southbound during the morning peak hours and heavily northbound during the afternoon/evening peak hours.

d. Historical Crash Data

Crash data was obtained from MassDOT, which summarizes data compiled by the Massachusetts Registry of Motor Vehicles based on data submitted by local police departments. Detailed data was obtained for MassDOT's three latest available years, 2011-2013. MassDOT data is used for analysis because it provides comparative information on crash rates for unsignalized intersections, both statewide and by district, in this case District 3. MassDOT data does not include all crashes, only those that exceed crash reporting requirements, so smaller crashes, or those not reported are not included.

To provide a long-term crash data frequency review, below is a summary of data extracted from MassDOT's Crash Portal service. The average number of mapped crashes at study area intersections are shown between 2002-2013.

**MCIH Study Area Intersections
Average Annual Mapped Crashes 2002-2013**



Data Source: MassDOT Crash Portal.

From the long-term MassDOT crash data, the highest number of annual crashes occurred at the intersection of Lowell Road (Route 40) at Main Street, experiencing on average nearly 6 crashes per year.

The chart on the previous page also indicates that the intersection of Old Ayer Road North at Main Street, over the long term, has experienced more crashes than the Old Ayer Road South intersection at Boston Road. Old Ayer Road North traffic approaching Main Street are mainly left turns in conflict with *both* directions of Main Street traffic volumes.

The high percentage of traffic turning left onto Main Street plus the sharp intersection skew are likely contributing factors to the higher number of crashes at Old Ayer Road North than Old Ayer Road South.

Table 4 on the page that follows provides a summary of historical crash data reviewed for the 2011-2013 three-year period, the most recently available crash data from MassDOT.

For comparison purposes, the crash rate for average MassDOT District 3 unsignalized intersections is 0.58 crashes per million entering vehicles. From the 2011-2013 data on Table 4, *none of the intersections studied exceeds either the District 3 or the statewide average crash rates for similar locations.*

The Town of Groton provided crash data for the period from 2014-2016, a 2 and 1/3 year period. A total of 23 crashes were reported at study area intersections. Of the reported 23 crashes, 17, two involving injuries, were reported at the intersection of Lowell Road at Main Street and Broadmeadow Road. This amounts to 7.3 crashes per year, compared to two crashes per year, reported by MassDOT records for the 2011-2013 period. For that intersection, the most recent 2014-2016 data is closer to the long term 12-year trend for that intersection cited on page 37. For the 5 and 1/3 year period, The 0.58 calculated crash rate is equal to the average District 3 crash rate and slightly lower than the statewide average crash rate of 0.60. Additionally, three crashes were reported at the Hollis Street/Main Street intersection, two crashes at Boston Road and Old Ayer Road South, and one crash at the intersection of Peabody Street and Old Ayer Road.

Refer to the Technical Appendix for detailed MassDOT crash data for the intersections reviewed and MassDOT intersection crash rate forms for each location where crashes were reported.

Table 4 - MCIH Area Crash History 2011-2013

Intersection	Severity ²		Type ³						Reported Crashes by Year ¹			3-yr Total	Crash Rate
	Injury	P D O	Hit Object	Other	Angle	Rear end	Head on	Ped/Bike	2011	2012	2013		
Old Ayer Road N & S at Boston Road/Main Street (119/225)	2	6	1	1	2	3	1	0	4	1	3	8	0.41
Main Street (119/225) at Hollis Street	2	4	0	2	3	1	0	0	0	2	4	6	0.29
Main Street (119/225) at Lowell Road (111) and Broadmeadow Road	0	6	1	1	4	1	0	0	3	1	2	6	0.27⁴
Peabody Street at Farmers Row (111)	0	1	0	0	1	0	0	0	0	1	0	1	0.17
Old Ayer Road at Peabody Street	0	0	0	0	0	0	0	0	0	0	0	0	0
Higley Street at Farmers Row (111)	0	0	0	0	1	1	0	0	0	1	1	2	0.29
Culver Road at Farmers Row (111)	0	0	0	0	1	1	0	0	0	1	1	2	0.37
Peabody Street at Higley Street	0	0	0	0	1	1	0	0	0	1	1	2	0.39

PDO – Property Damage Only ; Crash Rate – reported crashes per million entering vehicles.

- 1 Crash Severity is listed as a “fatal” crash, an “injury” crash, a “property only”. The data contained only “injury” and “property only” crashes for studied intersections.
- 2 Crash Type defines the orientation of the collision. “Angle” crashes involve one vehicle broad siding another, “Rear end” (Rear) crashes involve one vehicle colliding with the rear of another vehicle, and “Side swipe and Other” crashes encompass all other types of collisions.
- 3 Reported Crashes are listed in the Statewide Crash Database, as collected by the Registry of Motor Vehicles. The calculated crash rate is determined per million entering vehicles (MEV), based on conducted traffic volume counts.
- 4 When including Groton crashes between 2014-2016, Main/Lowell/Broadmeadow crash rate would be 0.58, equivalent to the District 3 average rate, but lower than the Statewide average crash of 0.60 crashes per million entering vehicles.

III. FUTURE 2024 NO-BUILD CONDITIONS

Background Traffic Growth

Without the MCIH development, we are assuming that traffic volumes in the study area will continue to grow slowly as development continues in the region and in Groton.

No-Build volumes shown are equivalent to an overall average annual traffic growth of 8%, which equivalent to a 1% average annual traffic growth per year, as they are based on March, 2016 volumes which MassDOT data suggests are typically 4% higher than average annual traffic volumes in Groton. MassDOT historical count data would also suggest a 1% average annual background traffic growth rate is a reasonable assumption. Additionally, the Groton Planner⁹ requested we account for traffic volumes generated by two Boston Road developments approved but not yet open developments -- a Temple¹⁰ at the Groton/Littleton line and a medical office building at 120 Boston Road¹¹. Both were added to assumed background traffic growth where appropriate. Because traffic volumes during the occasional events assuming up to 2,300 patrons will typically occur during the summer months, when background volumes are typically 5-8% lower than average annual conditions, the analyses provided for the most intensive *Large* and *Festival* events assuming 2,300 patrons are likely conservative, or high side.

Circulation Infrastructure Changes

By 2024, we assumed that proposed nearby circulation enhancements proposed by the

⁹ Laurie Bonavita, Groton Planning and Land Use Coordinator.

¹⁰ TEPP LLC, Traffic Impact and Access Study, Proposed New England Shridi Sai Panivaar Temple, Groton, MA, May 20, 2014.

¹¹ Bayside Engineering, Traffic Impact and Access Study, Proposed Medical Office Space, Groton, MA, August 9, 2013.

Groton School, MassDOT, and Lawrence Academy will be fully implemented.

Groton School Plans

Concept plans prepared by VAI Engineers calls for the following sidewalk enhancements:

- o Provision of sidewalk enhancements on Farmers Row, including three brick pattern crosswalks providing accessible cross road access. – Phase I
- o Reconfiguration of the Farmers Row (Route 111) intersection at Peabody Street. The plan calls for reconfiguring this intersection to narrow it eliminate an uncurbed median and simplify its operation into a normal 1 lane on each approach leg. A new +300 foot sidewalk approximately 5 feet wide will be provided on the south side of Peabody Street heading east to Higley Street. – Phase I
- o Continue the sidewalk easterly on the south side of Peabody Street to a point just east of the Higley Street intersection. A new brick pattern crosswalk will direct pedestrians to the north side of Peabody Street. A rectangular rapid flashing beacon will be installed to augment the new crosswalk and enhance the visibility of pedestrian crossings.- Phase II
- o Continue the sidewalk easterly on the north side of Peabody Street to join the existing sidewalk on the north side of Peabody Street traversing the Nashua River Rail Trail to the east side of Temple Drive. – Phase II
- o East of Temple Drive, continue the sidewalk until Old Ayer Road, where it will continue northerly to the terminus of an existing relatively new sidewalk on the north side of Old Ayer Road that continues on to Groton Center. – Phase II

MassDOT Plans

MassDOT plans to construct a 5-foot sidewalk on the west side of Boston Road between Old Ayer Road (South) and the CVS Plaza. This is a high priority sidewalk connectivity improvement called for in Groton’s most recent Master Plan (2011) and the Montachusett Regional Planning Commission Walkability Report for the Town of Groton (2012).

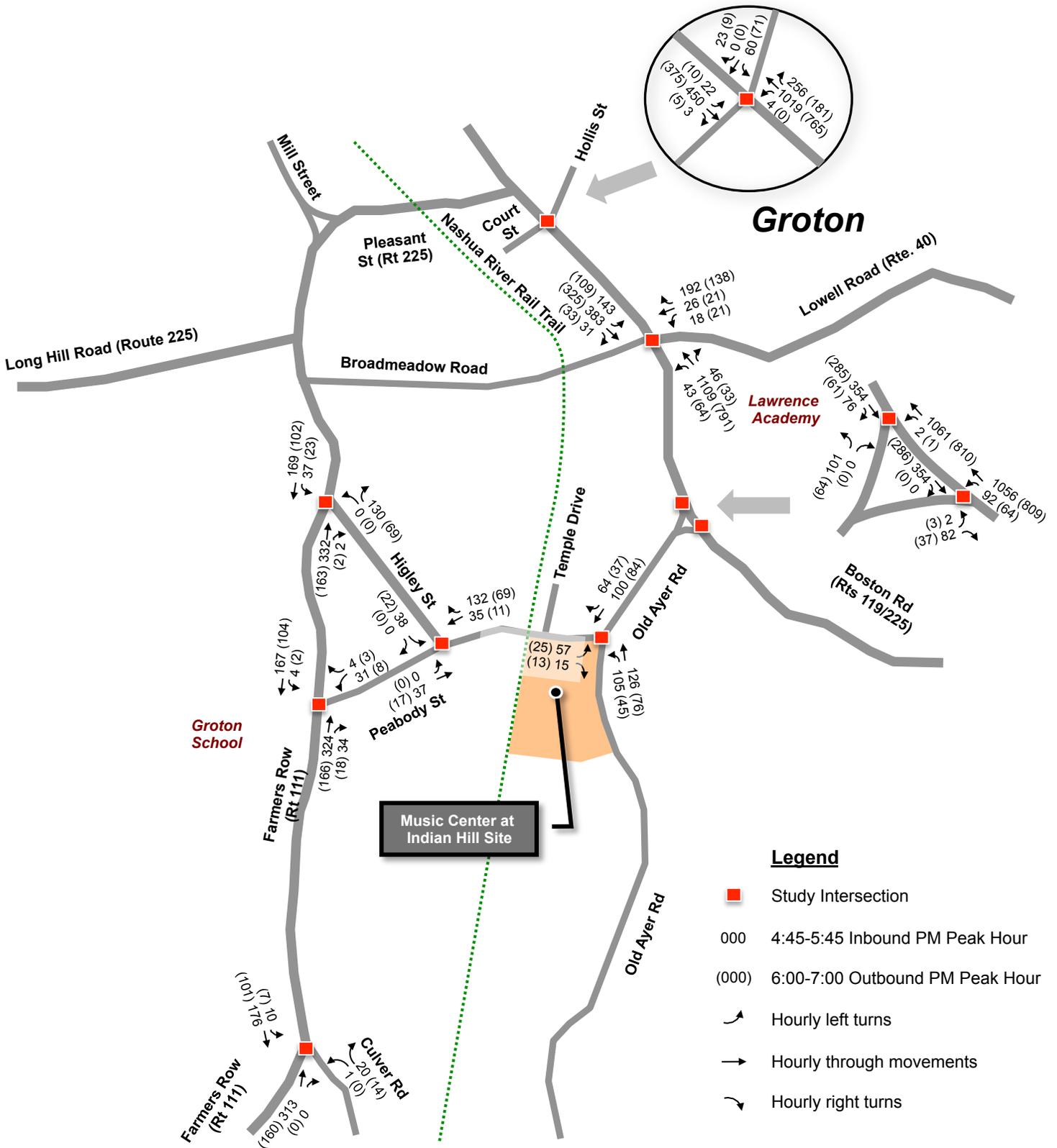
Lawrence Academy Plans

Lawrence Academy plans to relocate and reconfigure its entrance on Main Street to improve the safety of its traffic operations and pedestrian safety. Plans call for elimination of the Powder House Lane driveway. It will be relocated approximately 200 feet southerly on Main Street. Its existing crosswalk will be retained and a new on-site sidewalk will be constructed to the crosswalk with grass and landscaping within the former Powder House Lane driveway layout. The new driveway will not have sidewalks, but the plan calls for Main Street to be restriped to provide two opposing exclusive left turn lanes and a through lane in each direction to reduce Main Street traffic backups from waiting left turning vehicles.

a. Year 2024 No-Build Traffic Volumes

Based on the No-Build assumptions identified above, year 2024 No-Build traffic volumes were estimated for the MCIH Study Area. Figures 14-16 provide the No-Build traffic volumes concurrent with the *Typical Peak School Day*, *Large* early and late Friday analysis 1,000-2,300 patron concert peak hours, and analysis 2,300 patron *Festival* Saturday mid-day peak hour.

Small increases in traffic volumes can be found when comparing year 2024 No-Build volume displays from Figures 14-16 to the year 2016 comparable displays shown previously on Figures 5-7.



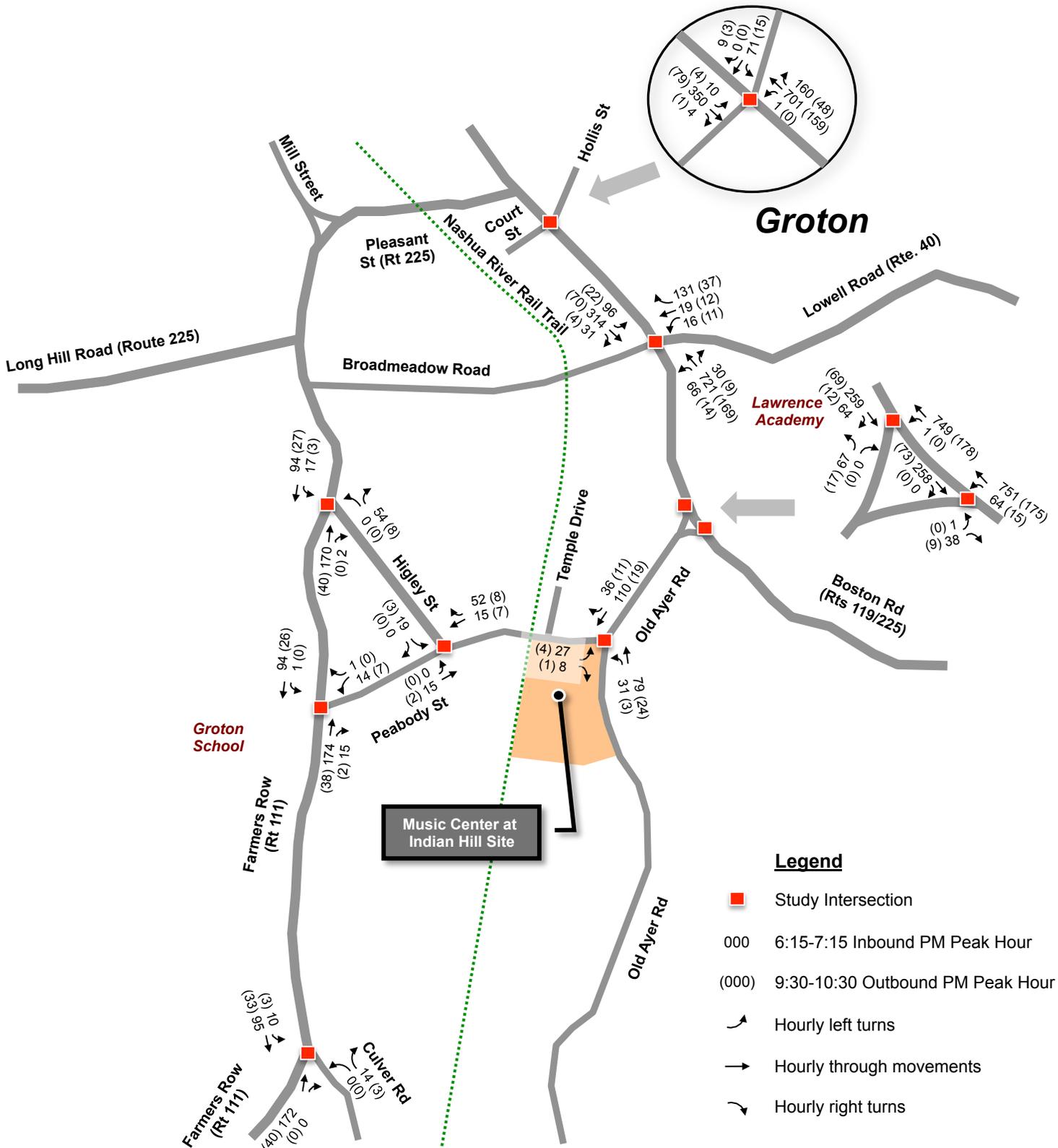
Schematic Diagram:
Not to Scale

Stantec Consulting Services Inc.



Music Center at Indian Hill
Groton, Massachusetts

Year 2024 No-Build Traffic Volumes
4:45 - 5:45 PM and (6:00 - 7:00 PM)
During "Typical" School Peak Day Peak Hours



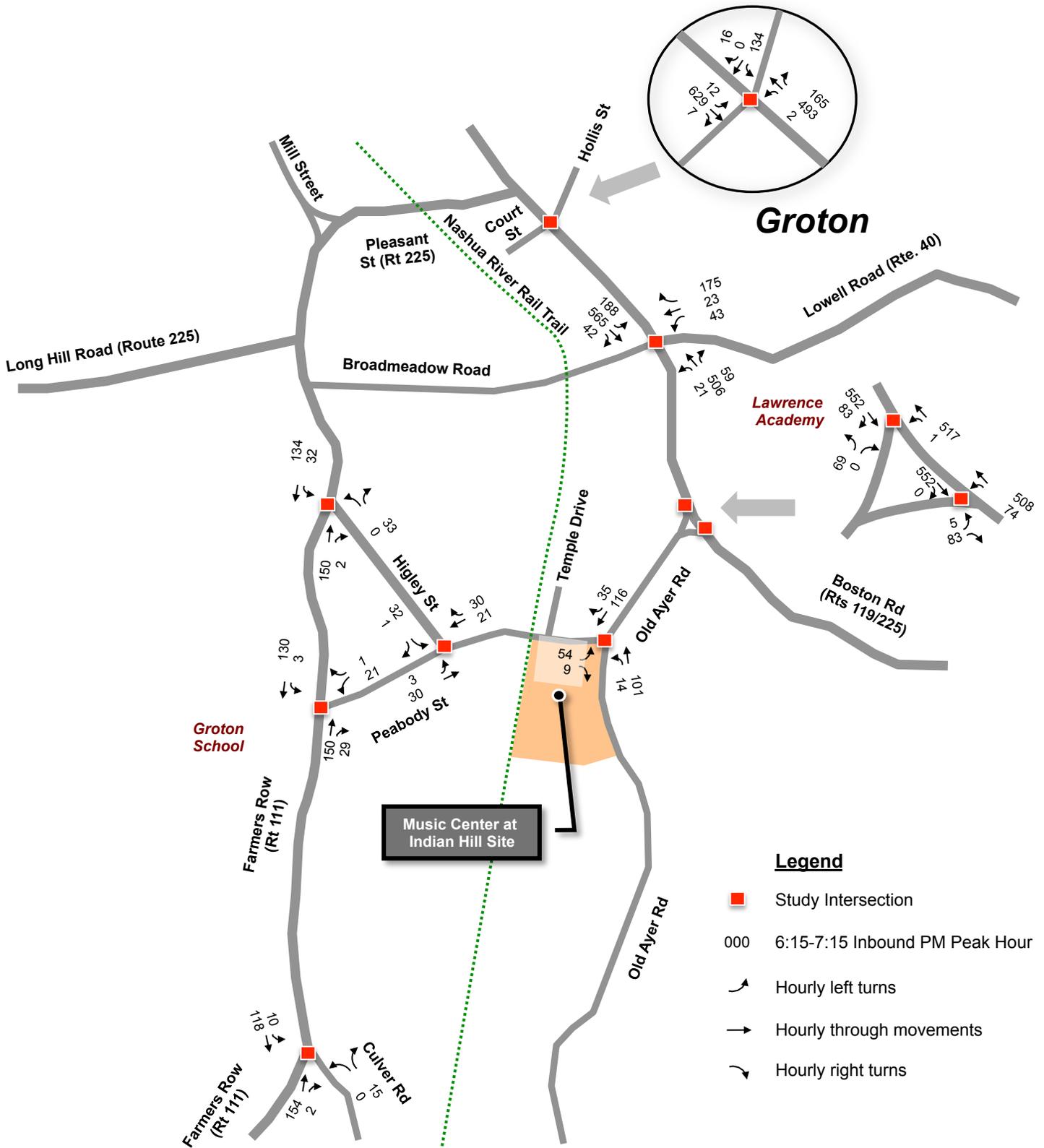
Schematic Diagram:
Not to Scale

Music Center at Indian Hill
Groton, Massachusetts

Year 2024 No-Build Traffic Volumes

6:15 - 7:15 PM and (9:30 - 10:30 PM)

During Year 2024 "Large" Friday Evening Concert Peak Hours



Schematic Diagram:
Not to Scale

Stantec Consulting Services Inc.



Music Center at Indian Hill
Groton, Massachusetts

Year 2024 No-Build Traffic Volumes

11:00 AM - 12:00 Noon

During "Festival" Mid-day Saturday Peak Hour

b. No-Build (2024) Peak Hour Levels of Service

Table 5 on the next page provides No- Build Year of 2024 analyses of the nine intersections for the various peak hours evaluated under the *Typical*, *Large*, and *Festival* MCIH Build scenarios. These include the *Typical* Peak School Day from 4:45-5:45 PM and 6:00-7:00 PM, *Large* from 6:15-7:15 PM and 9:30-10:30 PM on a Friday assuming 1,000 and 2,300 patron analysis scenarios, as well as a Saturday *Festival* mid-day peak hour from 11:00 AM – 12 Noon.

From Table 5, the analysis of year 2024 Future No-Build conditions concurrent with MCIH activities, the same three of the nine Groton off-site intersections evaluated, only three intersections with either Boston Road or Main Street (Routes 119/225) experience congested conditions (LOS E/F) during the six possible peak hours evaluated. They included:

- ❖ The Old Ayer Road (N) approach to Main Street during both School peak hours.
- ❖ The Lowell Road westbound approach to Main Street during both School peak hours and the early Festival peak hour.
- ❖ The Hollis Road approach to Main Street during both School peak hours, the early Concert peak hour, and the mid-day Saturday Festival peak hours. As noted previously, a typical *Festival* is most likely to culminate in an evening concert that will end at 10 PM. Consequently, the Friday *Large* day late Friday peak hours are expected to represent worse traffic conditions than comparable Saturday (or Sunday) late peak hours.

Only relatively small volume to capacity and queuing increases occur between Existing (2016) and the No-Build (2024) conditions.

Table 5 - No-Build Year 2024 Peak Hour Operations Analysis																					
Intersection	During "Typical" School Peak Day Peak Hours								During Friday "Large" Performance Peak Hours Assuming 1,000-Patron or 2,300-Patron Events								During Saturday Mid-day Peak Hour at a "Festival" Assuming 2,300 Patrons				
	2024 No-Build 4:45-5:45 PM				2024 No-Build 6:00-7:00 PM				2024 No-Build 6:15-7:15 PM				2024 No-Build 9:30-10:30 PM				2024 No-Build 11:00 AM-12:00 PM				
	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	
1) Old Ayer Road (S) at Boston Rd	Old Ayer Rd EB	B	0.16	14	13	B	0.11	9	13	B	0.07	6	11	A	0.01	1	9	C	0.26	26	16
	Boston Rd NB	A	0.08	7	3	A	0.06	5	2	A	0.05	4	1	A	0.01	1	1	A	0.08	7	2
2) Old Ayer Road (N) at Main St	Old Ayer Rd EB	F	0.95	155	135	E	0.46	54	43	D	0.36	40	29	B	0.05	4	11	D	0.43	49	34
	Main St NB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
3) Lowell Road at Main St/Broadmeadow	Lowell Rd WB	F	2.54	677	777	F	1.05	243	126	D	0.51	71	34	B	0.06	5	11	F	1.13	296	143
	Main St NB	A	0.04	3	2	A	0.07	5	2	A	0.06	5	2	A	0.01	1	1	A	0.02	2	1
	Main St SB	A	0.29	30	8	A	0.17	16	5	A	0.13	12	4	A	0.02	1	2	A	0.20	18	5
4) Main Street at Hollis St	Hollis Street WB	F	1.30	185	307	F	0.87	127	131	F	0.64	89	64	B	0.05	4	11	F	1.04	205	144
	Main St NB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
	Main St SB	A	0.05	4	1	A	0.02	1	1	A	0.02	1	1	A	0.00	0	0	A	0.01	1	0
5) Farmers Row at Higley St	Farmers Row SB	A	0.04	3	2	A	0.02	2	2	A	0.02	1	1	A	0.00	0	1	A	0.03	2	2
	Higley St NWB	B	0.22	21	12	A	0.13	11	10	A	0.07	6	10	A	0.01	1	9	A	0.05	4	9
6) Farmers Row at Peabody St	Farmers Row SB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
	Peabody St WB	B	0.11	9	13	B	0.02	2	10	B	0.13	2	11	A	0.02	1	9	B	0.04	3	11
7) Farmers Row at Culver Rd	Farmers Row SB	A	0.01	1	1	A	0.01	0	1	A	0.01	1	1	A	0.00	0	1	A	0.01	1	1
	Culver Rd NWB	B	0.11	9	13	B	0.02	2	10	A	0.03	2	9	A	0.00	0	9	A	0.02	2	9
8) Peabody St at Higley St	Higley St SB	A	0.07	6	10	A	0.03	2	9	A	0.03	2	9	A	0.00	0	9	A	0.05	4	9
	Peabody St EB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	1
9) Peabody St at Old Ayer Rd	Peabody St EB	B	0.17	15	13	B	0.07	5	11	B	0.06	4	10	A	0.01	1	9	B	0.11	9	11
	Old Ayer Rd NB	A	0.08	7	4	A	0.04	3	3	A	0.03	2	2	A	0.00	0	1	A	0.01	1	1

LOS - Level of Service from A-F; A is best, F is worst.

V/C - Proportion of volume to available capacity during analysis hour

Q - 95th percentile vehicle queue measured in feet from the intersection.

Del - Average motorist delay expressed in seconds during peak 15 minute period of the peak hour.

Over-capacity LOS F condition --V/C greater than 1.0.



IV. FUTURE 2024 BUILD ANALYSIS SCENARIOS

a. Trip Generation

Within 5 years of opening, the MCIH projects that its future school-related activities will be approximately 50% higher than existing Indian Hill Music activities. We therefore expect *Typical* MCIH school-related traffic and parking demands to increase approximately 50% over those measured at the Indian Hill Music site. From the Indian Hill Music count data collected on March 14-15, 2016, on-site parking demands peaked at 77 spaces on a Monday when the Youth Orchestra was rehearsing and at 47 spaces on a Tuesday, reflecting normal non-event, school-related parking conditions.

Therefore, by the year 2024, *Typical* MCIH School-related parking demands could range from 70-115 parking spaces simultaneously occupied, or a small fraction of the proposed paved site parking supply estimated at *just under 675 spaces*. At this time, the Design Team anticipates the potential site parking supply of no more than *775 spaces* including paved plus unmarked field spaces, could be occupied during the most intensive of the *Large* and *Festival* events only. The Design Team indicates the proposed 675 space paved parking supply is necessary to provide flexibility for accommodations during *Large* events that may be occurring during poor weather conditions (heavy rain/snow, etc.).

Estimating Future MCIH Trips – Build Scenarios

To address typical “worst-case” traffic conditions, Build traffic impacts were reviewed under the following three traffic analysis scenarios:

- ❖ **Typical** - Operating from 9 AM-10 PM, the MCIH music school component will function on a daily basis. While open at 9 AM, the school’s after-school program is most active, and tends to peak in the late afternoon. Classes will average from 45 minutes to 1 hour. We assume the distribution of arrivals and departures will be similar to those measured at the existing Indian Hill Music site. Consistent with the School’s vision for aggressive growth in student enrollments, a 50% increase was assumed by 2024.

On the advice of the Indian Hill Music, for future analysis purposes, Monday and Tuesday traffic conditions were measured. During the count program, Mondays currently represent the highest traffic days for the School, as that is when the Youth Orchestra is rehearsing. Because MCIH could opt to change this to another day, to be conservative, i.e., high side, we evaluated composite traffic conditions using Tuesday Groton volumes, as Tuesday volumes tend to be slightly higher for background traffic volumes than those with the School's higher Monday operations.

We evaluated *Typical* peak day school peak hours from 4:45-5:45 PM and from 6:00-7:00 PM, the two highest hours measured. Based on the measured Indian Hill Music volumes, during the early peak hour entering traffic represents approximately 58% of its total generated traffic, while during the later peak hour, exiting traffic represents approximately 61% of total generated traffic.

- ❖ **Large** – operations were evaluated for 1,000 and 2,300 patron scenarios under “worst case” Friday background traffic volumes. For evening performances, most concert start times will be from 7-7:30 PM on Fridays or, more commonly, on Saturdays. Sunday concerts will typically begin at 3 PM. Expected attendance will depend on the performance, but could range from 300 to 2,300 persons, inclusive of outdoor lawn seating that would be available under good weather conditions.

We chose to analyze two types of *Large* conditions –assuming either 1,000 patrons or the most intensive 2,300 patrons on a Friday. While rare, Friday concerts will represent “worst case” conditions from a traffic impact perspective. In both analysis cases, we assumed patrons, staff, and musician traffic will be arriving and departing performances in a manner similar to the arrival/departure patterns exhibited at the measured March 12, 2016 Indian Hill Music event entitled “The Classics”.

Traffic measured for “The Classics” included early and post-concert activities. Indian Hill Music indicated that 802 staff, orchestra, and patrons, were involved in “The Classics” concert.

Specifically, we evaluated *Large* Friday hours from 6:15-7:15 PM, assuming a 7:30 PM start time, and from 9:30-10:30 PM, assuming a 9:30 PM end time, similar to “The Classics” concert. Based on the Indian Hill Music count data, we estimate that 70% of

the concert related arrivals would take place during the start time peak hour, and 94% of departures during the end time peak hour. Essentially, compared to “The Classics” concert, we project that for Year 2024 concerts MCIH site-generated traffic will grow by nearly 40% in the condition where 1,000 attendees are assumed, and nearly 350% with the most intensive *Large* or *Festival* summer concert with 2,300 attendees.

- ❖ **Festivals** - were evaluated for Saturday Mid-day Peak Hour conditions. For a few times per year, all during warm weather months, up to 2,300 attendees will participate in an extra large day long event. We assume these all day extra large events will begin in the late morning, say 10 AM and last until approximately 10:30 PM. Day long *Festival* events represent the largest site-generated traffic impacts over a single day.

For analysis purposes we assumed that during the mid-day peak arrival period from 10-11 AM, 30% of the daily attendees would arrive, while during the late hour at the end of the day, approximately the same level of site generation will occur as during the extra large Friday late peak hour. We assumed the late Saturday exiting peak hour will be roughly equivalent, though slightly smaller a *Large* Friday late peak hour assuming 2,300 patrons. In reality, some people may not necessarily stay all day, but may gradually leave as their particular performance or performances of interest are completed.

Table 6 summarizes Build analysis peak hour traffic operations assuming projected year 2024 Build peak hour volumes.

**Table 6 - Summary of MCIH
Year 2024 Trip Generation Estimates ¹**

**YEAR 2024 TYPICAL SCHOOL OPERATIONS
PEAK SCHOOL DAY (NORMAL SCHOOL DAY)
Early/Late Peak Hours**

	IN	OUT	TOTAL
4:45-5:45 PM	100 (50)	75 (50)	175 (100)
6:00-7:00 PM	85 (45)	125 (55)	210 (100)

**YEAR 2024 LARGE OPERATIONS
OCCASIONAL 1,000 PATRON EVENT
Friday Early/Late Peak Hours**

	IN	OUT	TOTAL
6:15-7:15 PM	345	10	355
9:30-10:30 PM	5	460	465

**YEAR 2024 LARGE OPERATIONS
RARE 2,300 PATRON EVENT
Friday Early/Late Peak Hours**

	IN	OUT	TOTAL
6:15-7:15 PM	615	30	645
9:30-10:30 PM	20	825	845

**YEAR 2024 FESTIVAL OPERATIONS
Saturday Early/Late Peak Hours**

	IN	OUT	TOTAL
11:00 AM-12:00 PM	365	65	430
10:30-11:30 PM²	20	825	845

1 - Source: Stantec estimates based on Indian Hill Music information.

2 - Saturday Festival exiting peak hour volumes were not specifically analyzed as Friday background traffic volumes are higher, representing late peak hour "worst case" conditions.

In the absence of applicable ITE Trip Generation analysis rates, future MCIH volumes were scaled to existing volumes exhibited by vehicle activities measured at the Indian Hill Music. Additionally, traffic characteristics of large concerts were based on a sample sold out concert count at the Littleton High School Performing Arts Center. Indian Hill Music provided information on concert attendees¹², staffing, and performers on the day the vehicle counts were performed to provide vehicle occupancy estimates.

Existing Indian Hill Music daily traffic was measured at **593** total vehicle trips on a Monday, March 14th, with approximately 297 trips in and out. On Tuesday, March 15th, daily traffic was measured at **339** total vehicle trips, with approximately 170 trips in and out.

MCIH expects the school component of activities to grow approximately 50% by 2024.

According to Indian Hill Music, throughout much of the year, MCIH will be open 7 days a week for normal school operations. Days when the Youth Orchestra will rehearse, presently one day per week (this could change in the future), represent the typical highest traffic day of the week for normal school operations.

Layered on top of normal school operations, are performance events of varying magnitude, most of which will occur on Friday, Saturday and Sunday. Based on preliminary low side and high side estimates of MCIH activities, Table 7 provides a summary range of projected MCIH annual and daily trip generation by day of the week. Table 7 indicates that a lot of daily variation is expected in trip generation at the MCIH. Right now, Mondays are highest 'normal' school days, as those are when the Youth Orchestra rehearses. The School could conceivably change this in future, but Youth Orchestra rehearsals are expected to occur once each week.

What Table 7 also shows is that on an overall average annual daily basis, we project MCIH will average between approximately **765-945** total vehicle trips-- ins plus outs each day.

¹² Kate Weiss-Gordon, Manager of Artistic Operations, Indian Hill Music.

**Table 7 - Range of MCIH Trip Generation
Projected by Day of Week– Year 2024**

Day of Week¹	Annual Average Low Side Daily Trips¹	Annual Average High Side Daily Trips¹
Sunday	975	1370
Monday	765	780
Tuesday	525	540
Wednesday	525	540
Thursday	525	540
Friday	985	1350
Saturday	1,075	1500
Low Estimate Average Annual Daily Trips		765
High Estimate Average Annual Daily Trips		945

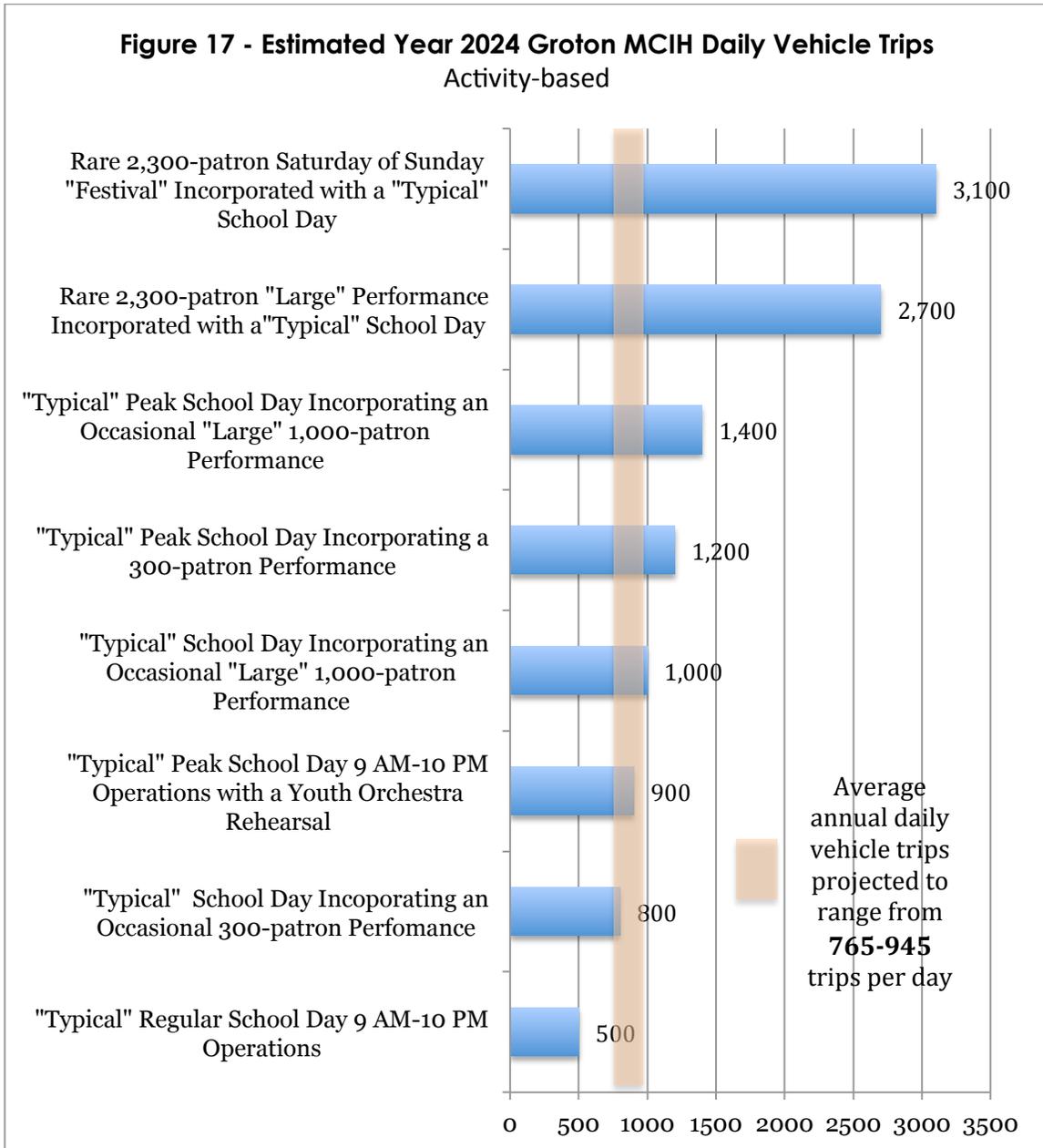
1 – Source: Stantec based on Indian Hill Music future daily activity projections.

On average, throughout the year, the MCIH will add approximately 3% to the traffic volumes being carried on Boston Road, but actual day-to-day traffic it adds will be highly variable.

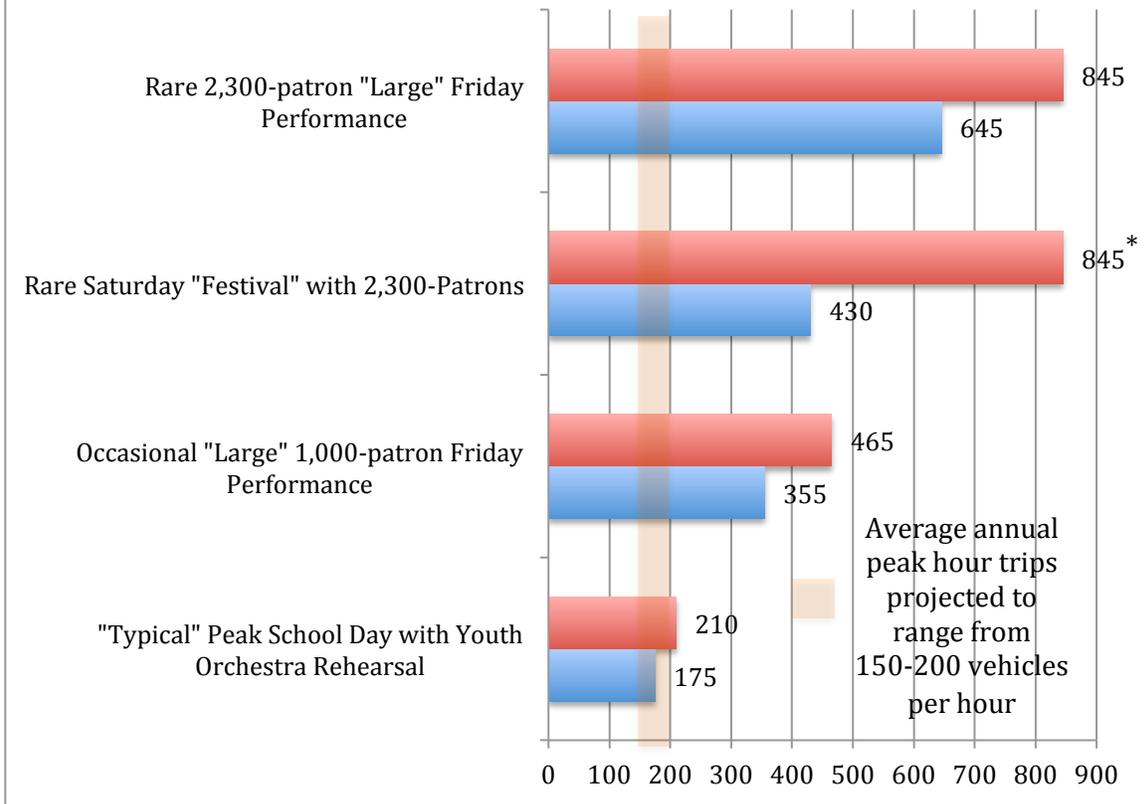
From a trip generation perspective, on an annual basis, Fridays and Saturdays are expected to be the busiest days, averaging from approximately 985-1,500 vehicle trips per day, while Tuesdays through Thursdays should average approximately 525-540 vehicle trips per day. Unlike other land use types related to offices or retail, based on existing Indian Hill Music count findings, carpooling will be the “norm” for accessing the MCIH.

On MCIH *Large* and *Festival* days, total site daily trips will be highly variable. Daily traffic volumes will depend on the day of the week and the size of the expected patron/staff/musicians participants. Daily traffic generation comparisons for the range of

site trip generation are illustrated on Figure 17 below. Figure 18 illustrated estimates of peak hour trip generation by evaluated site operations scenarios.



**Figure 18 - Groton IHMC Total Year 2024
Early and Late Peak Hour Trips
by Evaluated Scenario**



* Only the Friday late peak hour was evaluated, as its background traffic volumes are larger than will occur on Saturdays .

Sight Distance at the future Site Driveways

Site designers propose two driveways to serve the MCIH staff and patrons, a main driveway and a gated secondary driveway exit only. The main driveway on Old Ayer Road will be available at all times, while the secondary driveway exit onto Peabody Street will be available only after the most traffic intensive *Large* and *Festival* events.

Proposed driveway locations were evaluated to determine if adequate sight distance could be provided at each location. The two driveways analyzed include:

1. Main driveway - Old Ayer Road driveway, approximately 200 feet south of the intersection with Peabody Street
2. Secondary driveway - Peabody Street driveway, located directly across from Temple Drive

At this time the viability of retaining an existing third driveway being explored. The third driveway intersects Peabody Street on a skew approximately 200 feet south of the proposed main site driveway. Because it traverses a wetland, if retained, it would be gated undisturbed and serve as only as an emergency egress.

The speed limit along Old Ayer Road is 35 mph in the vicinity of the proposed main site driveway. Its measured 85th percentile speeds are 42 mph northbound and 45 mph southbound.

The speed limit along Peabody Street is 30 mph. Its measured 85th percentile speeds were 38 mph eastbound and 37 mph westbound.

Since the measured 85th percentile speeds are higher than the posted speed limits on Old Ayer Road and Peabody Street, both sets of speeds were analyzed for adequacy of motorist sight lines at both driveway locations. Two types of sight distance were analyzed: stopping sight distance and intersection sight distance. Stopping sight distance (SSD) is the length of roadway necessary to allow a vehicle traveling at or near the design speed to stop before reaching a stationary object in its path.

Intersection sight distance (ISD) is the length of roadway necessary to allow drivers turning out of a road or driveway to perceive the presence of potentially conflicting vehicles. The American Association of State and Highway Transportation Officials (AASHTO)¹³ provides guidance on recommended and minimum sight distances for various speeds. Table 8 provides a summary of the AASHTO recommended and minimum distances for the design speed.

¹³ A Policy on Geometric Design of Highways and Streets, American Association of State Highway and Transportation Officials.

Table 8 - MCIH New Driveway Sight Distances

Speed (mph)	Stopping Sight Distance (SSD) measured on major street		Intersection Sight Distance (ISD) measured on minor street	
	AASHTO Recommended	AASHTO Minimum	AASHTO Desirable for Left Turns from Stop	AASHTO Desirable for Right Turns from Stop
30	200 feet	200 feet	335 feet	335 feet
35	250 feet	250 feet	390 feet	385 feet
45	360 feet	360 feet	500 feet	480 feet

AASHTO states that the Intersection Sight Distance be “at least equal to the appropriate Stopping Sight Distance for the major road”, however this distance may not provide sufficient visibility for the driver exiting the minor street to turn onto the major street without requiring the vehicle on the major street to stop or slow down. AASHTO states “to enhance traffic operations, ISDs that exceed SSDs are desirable along the major road.” (i.e., not to cause the driver on the major road to slow down). Nonetheless, ISD’s are a matter of convenience for drivers on a roadway, while SSD is a matter of safety.

In evaluating sight distances at intersections, Stopping Sight Distance is typically measured on both major road approaches to confirm that sufficient sight lines are available for a driver to react and then stop should a vehicle or pedestrian enter the intersection from the minor street unexpectedly. Intersection Sight Distance is typically measured on the minor street and is based on the time it takes a driver to turn left from the minor street and enter the major street. As shown in Table 8, the recommended SSD and the minimum ISD for 30 mph is 200 feet. For 35 mph, the SSD and minimum ISD increase to 250 feet. The recommended ISD for 30 mph is 335 feet, while the recommended ISD for 35 mph is 390 feet for left turns and 385 feet for right turns. The recommended SSD and the minimum ISD for 45 mph is 360 feet. The recommended ISD for 45 mph is 500 feet for left turns and 480 feet for right turns.

Sight distances were measured in the field at the location of each of the driveways. In accordance with AASHTO standards, stopping sight distance was measured from the center of the travel lane in each direction, with the driver's eye height of 3.5 feet viewing an object two feet high. Intersection sight distance was measured at the approximate location of the exit approach at each of the three driveways, 14.5 feet back from the edge of the traveled way, with a driver's eye height of 3.5 feet and an object height of 3.5 feet. A summary of the sight distance analysis performed on the site driveways is shown below in Tables 9 and 10.

Table 9- Stopping Sight Distance Summary

Driveway To	Direction	SSD Available	SSD		
			SSD Adequate for 30 mph	Adequate for 35 mph	SSD Adequate for 45 mph
Old Ayer Road	NB	500'+	N/A	Yes	Yes
	SB	500'+		Yes	Yes
Peabody Street	EB	425'	Yes	Yes	N/A
	WB	500'+	Yes	Yes	

As shown in Table 10 on the next page the minimum intersection sight distance requirement is met for the posted speed limit as well as the 85th percentile speed at the Old Ayer Road main driveway location.

Table 10- Intersection Sight Distance Summary

Driveway To	DIR ¹	ISD Available	ISD Adequate for 30 mph		ISD Adequate for 35 mph		ISD Adequate for 45 mph	
			(minimum)	(desirable)	(minimum)	(desirable)	(minimum)	(desirable)
Old Ayer Rd	Left	500'+	N/A		Yes	Yes	Yes	Yes
	Right	500'+			Yes	Yes	Yes	Yes
Peabody St	Left	250'	Yes	No	Yes	No	N/A	
	Right	500'+	Yes	Yes	Yes	Yes		

1 – Direction motorist is looking to observe on-coming vehicles.

At the Peabody Street driveway, there is adequate intersection sight distance looking right for both the posted speed limit and the observed 85th percentile speed. Looking left, the intersection sight line is blocked by a large tree and some brush from 14.5 feet back. If the measurement is taken from closer to the edge of the traveled way (say 8 to 10 feet back), the intersection sight distance is adequate.

In reality, a driver's eye would likely be eight to ten feet back from the edge of the traveled way so this driveway location should be fine as currently planned. Trimming some of the brush that is there would be helpful as it may block some of line of sight when the vegetation is in full bloom.

Future Mode-Split Estimates

We project the vast majority of the site person trip demands will be accommodated by private automobile, most of them in carpools. For analysis purposes, we have assumed that both sidewalk enhancement projects discussed in the No-Build subsection will be completed prior to the year 2024 analysis time periods.

As measured at the Indian Hill Music "The Classics Concert", a substantial amount of carpooling is occurring for these events, so single occupant vehicles will comprise a relatively small proportion of site-generated traffic. During "The Classics Concert" on March 12th, an average auto occupancy of 2.32 persons per vehicle was calculated. This average auto occupancy is more than double the typical auto occupancy for commuting vehicles, so we project at least that much carpooling during future concerts and festivals. Additionally, given the relatively small traffic generation of the existing Indian Hill Music site, a large portion of normal school traffic is occurring in multi-occupant vehicles.

To be conservative in our future traffic estimates, we assumed the existing auto occupancy for concerts, and school related activities would remain as measured during the March 12th Indian Hill Music concert and Indian Hill Music operations on March 14 and 15, 2016.

MCIH is located within walking distance of three schools – the Groton School, Lawrence Academy, and the Country Day School of the Holy Union. Additionally, Groton Center businesses and municipal buildings are within a half-mile of the site. No nearby regular local public transportation services are available.

Groton School proposes to install a sidewalk on the north side of Peabody Street. When that happens, we recommend adding a crosswalk to the site to serve both directions of pedestrians who desire to access the site via Peabody Street near Temple Drive.

Because most of the MCIH concerts will be in the late afternoon and evenings, few site-related walking and bicycle demands are projected. We recommend that MCIH encourage bicycle and walking access options to help reduce site traffic demands during those periods when it may make sense to do so.

The site driveway has a drop-off/pick-up area being designed to accommodate senior citizen shuttles/vans by off-site providers who may desire to access the site. MCIH does not propose to run shuttle services to and from the site.

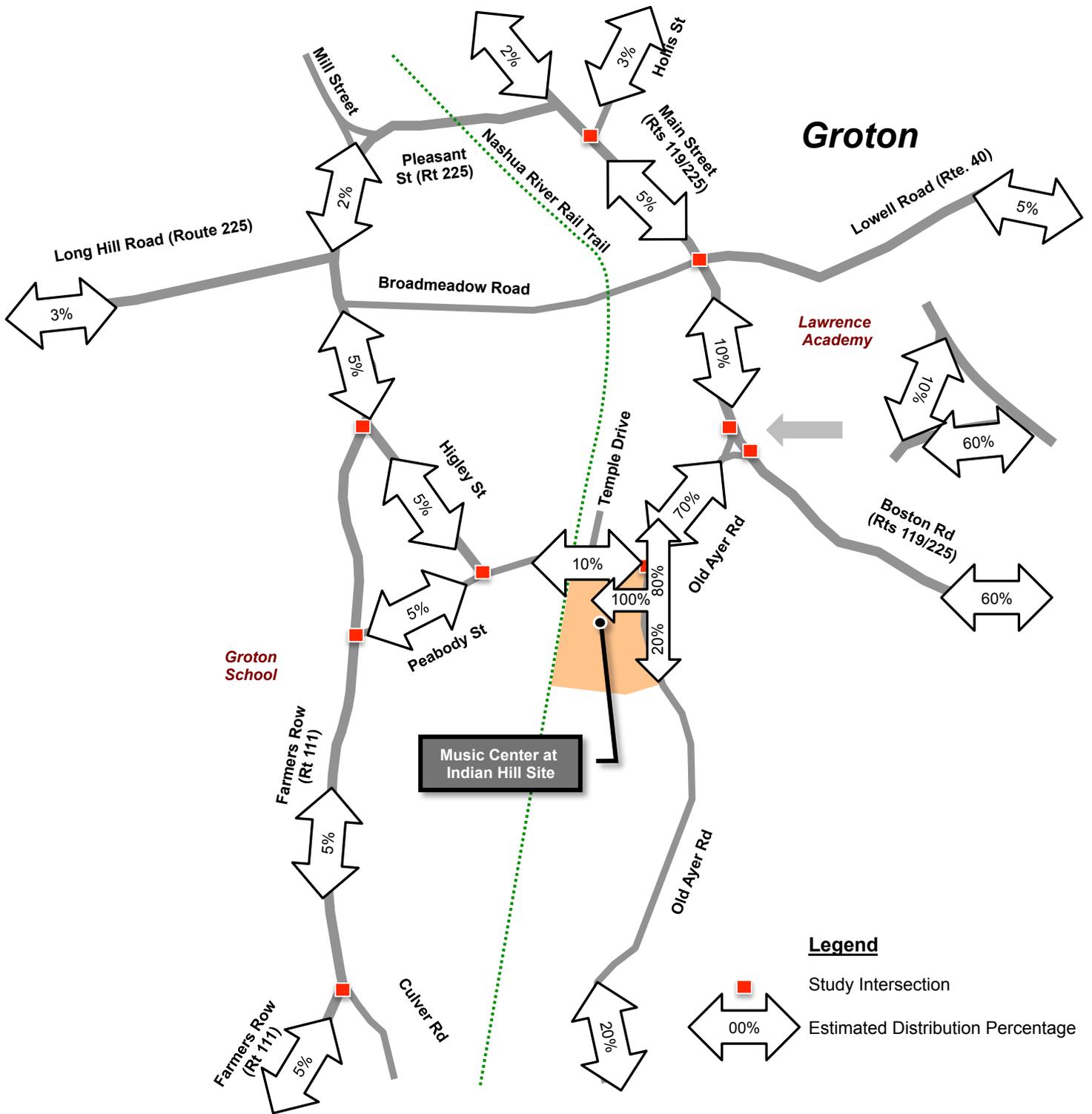
b. Site-Related Trip Distribution Patterns

Distributing Future MCIH Vehicle Trips

Indian Hill Music provided detailed information on communities of origin for its students and staff, as well as concert attendees for year 2015 school and concert operations. Using available mapping, likely travel routes were identified by community. Groton trips, which can come anywhere from Groton's residential neighborhoods were normalized to the overall trip distribution pattern. Ultimately, we estimated two existing traffic distribution patterns – one for arrival/departures related to normal school operations, and a second for concert and Festival arrival/departures as if they were traveling to and from the proposed Groton site, rather than the Littleton site. Figures 19 and 20 illustrate these distribution patterns.

For *Typical* school trips and medium concert events, the proposed Peabody Street exit will be gated in a closed position, and will only be available for the most intensive *Large* and *Festival* days. For both projected trip distribution patterns, a very strong orientation of travel is expected on Boston Road, as it will be absorbing from 75-80% of all site related trips, with 60-65% coming to and from the south and 10% to and from the north. Approximately 10% to and from Peabody Street.

Table 11 summarizes the additional peak hour traffic associated with the seven evaluated Build peak hour typical and analysis scenarios for all intersections within the study area by traffic movement. Overall, the differences between the two trip distribution patterns are relatively minor, but the School trips are oriented slightly less toward Boston Road/Main Street (Routes 119/225) than the Concert and Festival trips. Because the future MCIH site is located 7.4 miles northwest from the existing Indian Hill Music site, the two projected future trip distribution projections were modified to reflect a slightly more northwesterly orientation than existing. Future year 2024 site generated trips were estimated by peak hour and the four Build scenarios evaluated were added to No-Build volumes according to the estimated trip distribution patterns. Figures 21-23 are Year 2024 Build traffic volume displays comparable to those illustrated with the existing year 2016 and No-Build Year 2024 displays—i.e., Figures 5-7 and 14-16 presented previously. Refer to the Technical Appendix for the detailed trip distribution calculations.



Schematic Diagram:
Not to Scale

Music Center at Indian Hill
Groton, Massachusetts

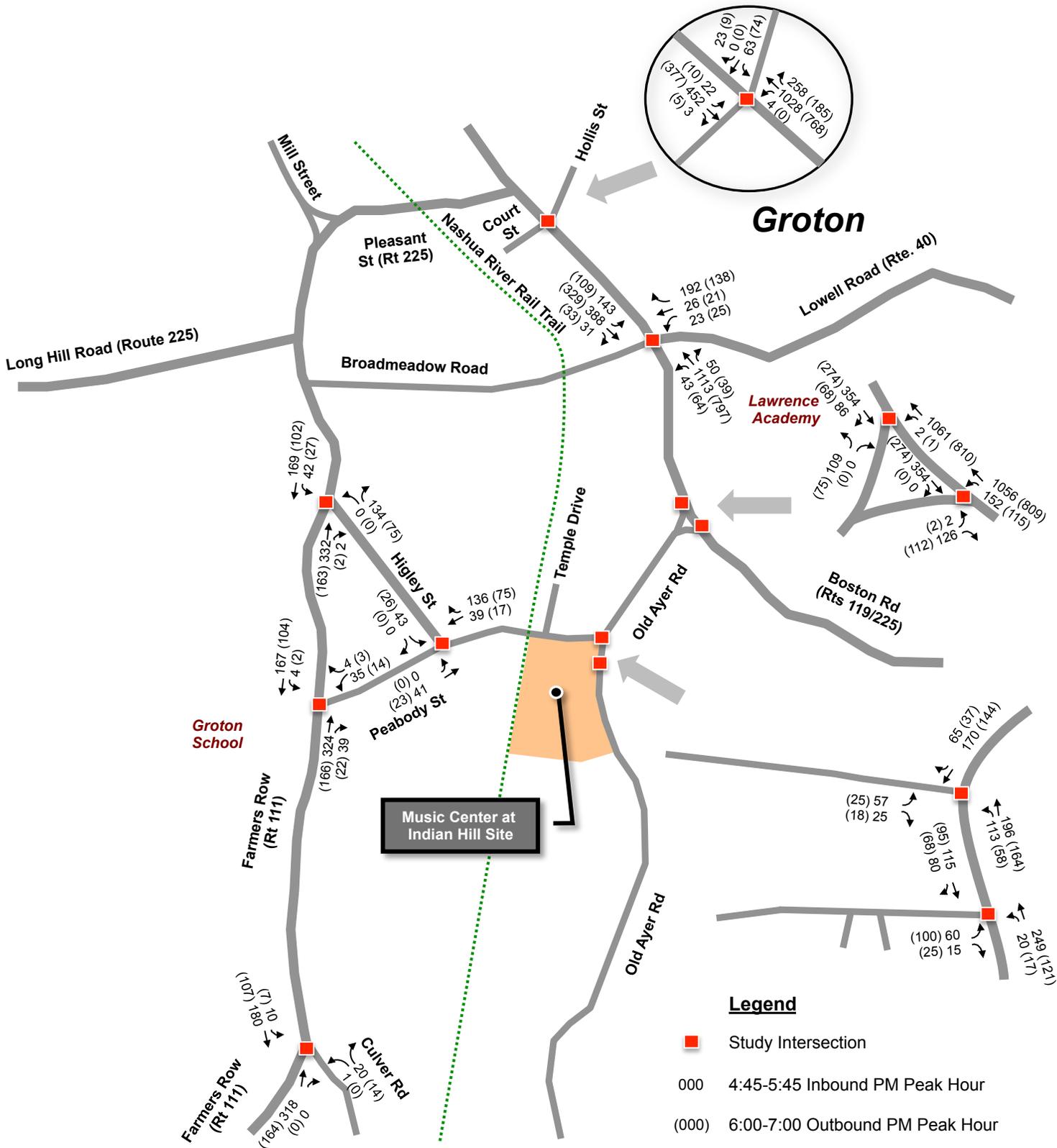
Estimated MCIH Trip Distribution Percentages
Indian Hill Music School-Related Vehicle Trips Only

Stantec Consulting Services Inc.



Table 11 - MCIH Distributed Vehicle Trips Summary By Analysis Scenario-- Intersection Add-ons by Traffic Movement

Location	"Typical" Peak School Day 4:45-5:45 PM	"Typical" Peak School Day 6:00-7:00 PM	Occasional "Large" Friday 1,000-Patron Concert 6:15-7:15 PM	Occasional "Large" Friday 1,000-Patron Concert 9:30-10:30 PM	Rare Friday "Large" 2,300 Patron Concert 6:15-7:15 PM	Rare Friday "Large" 2,300 Patron Concert 9:30-10:30 PM	Rare "Festival" Saturday Mid-day 11:00 AM-12:00 PM
1) Old Ayer Road (S) at Boston Rd							
Old Ayer Rd EB Right turn	45	75	7	299	20	536	42
Boston Rd NB left turn	60	51	224	3	400	13	237
2) Old Ayer Road (N) at Main St							
Old Ayer Rd EB left turn	8	13	1	46	3	83	7
Main St SB right turn	10	9	35	1	62	2	37
3) Lowell Road at Main St/Broadmeadow							
Lowell Rd WB left turn	5	4	17	0	31	1	27
Main St NB Right	4	6	1	23	2	41	2
Main St NB Through	4	6	1	23	2	41	2
Main St SB Through	5	4	17	0	31	1	27
4) Main Street at Hollis St							
Hollis Street WB left	3	3	7	0	12	1	7
Main St NB right	2	4	0	9	1	17	1
Main St NB Through	2	3	0	14	1	25	2
Main St SB Through	2	2	10	0	18	1	11
5) Farmers Row at Higley St							
Farmers Row SB Left	5	4	17	0	31	1	18
Higley St NB right	4	6	1	23	2	41	3
6) Farmers Row at Peabody St							
Farmers Row NB Right	5	4	17	0	31	1	18
Peabody St WB left	4	6	1	23	2	41	3
7) Farmers Row at Culver Rd							
Farmers Row NB through	5	4	17	0	31	1	18
Farmers Row SB through	4	6	1	23	2	41	3
8) Peabody St at Higley St							
Higley St SB Left	5	4	17	0	31	1	18
Peabody St WB right	4	6	1	23	2	41	3
Peabody St EB Through	5	4	17	0	31	1	18
Peabody St WB Through	4	6	1	23	2	41	3
9) Peabody St at Old Ayer Rd							
Peabody St EB right	10	9	35	1	62	2	0
Old Ayer Rd NB left	8	13	0	0	0	0	0
Old Ayer Rd NB Through	70	88	8	345	23	619	49
Old Ayer Rd SB Through	53	60	259	4	461	15	274
10) Old Ayer Rd at Primary Access							
Old Ayer Rd SB Right	80	68	294	4	523	17	274
Old Ayer Rd NB Left	20	17	52	1	92	3	55
Site Driveway EB Left	60	100	8	345	23	619	49
Site Driveway EB Right	15	25	2	69	5	124	10
11) Peabody St at Secondary Access							
Peabody St EB Right	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Site Driveway NB Left	N/A	N/A	1	46	3	83	7



Schematic Diagram:
Not to Scale

Stantec Consulting Services Inc.



Music Center at Indian Hill
Groton, Massachusetts
Year 2024 Build Volumes
4:45 - 5:45 PM and (6:00 - 7:00 PM)
"Typical" School Peak Day Peak Hours

Figure 21



Schematic Diagram:
Not to Scale

Stantec Consulting Services Inc.



Music Center at Indian Hill
Groton, Massachusetts

Year 2024 Build Volumes

6:15 - 7:15 PM and (9:30 - 10:30 PM)

Occasional 1,000-Patron "Large" Friday Concert Peak Hours



Schematic Diagram:
Not to Scale

Stantec Consulting Services Inc.

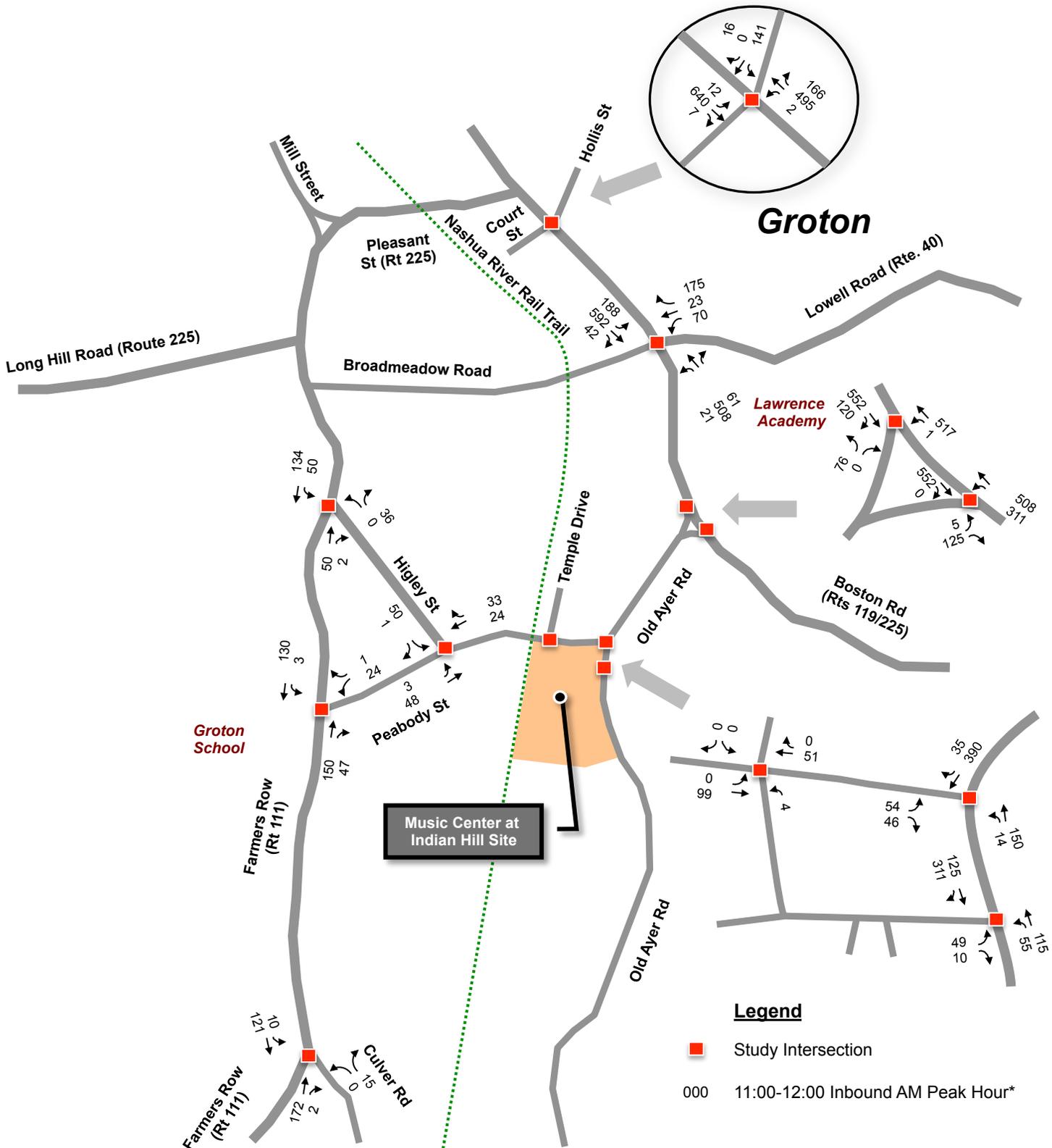


Music Center at Indian Hill
Groton, Massachusetts

Year 2024 Build Volumes

6:15 - 7:15 PM and (9:30 - 10:30 PM)

Rare 2,300-Patron "Large" Friday Concert Peak Hours



Schematic Diagram:
Not to Scale

Stantec Consulting Services Inc.



Music Center at Indian Hill
Groton, Massachusetts

Year 2024 Build Volumes

11:00 - 12:00 Noon

Rare 2,300-Patron "Festival" Saturday Mid-day Peak Hour

C. Levels of Service Comparing Existing to No-Build, and Build Scenarios

Traffic operations projected for the four Build scenarios evaluated were compared with No-Build and Existing peak hour traffic operations under the four scenarios in Tables 12-15. While not showing up as a problem in the LOS analysis on Tables 12-15, the increased volume of northbound left turns from Boston Road to Old Ayer Road south will create turbulence in the single northbound Boston Road lane as motorists are delayed waiting for any southbound Boston Road traffic to clear the intersection. This is discussed further on in the Mitigation Measures section.

From Table 12, on a typical peak School day when the Youth Orchestra is playing, MCIH school operations result in peak hour levels of service similar to those found with the Existing (2016) or Future No-Build (2024). Lowell Road and Hollis Street approaches to Main Street will experience increased delays under this scenario compared to existing and No-Build conditions, though levels of service E/F remain the same under all conditions. When the V/C exceeds 1.0, it is of particular concern since it means, motorists must accept gaps in traffic lower than considered safely desirable. This happens during both peak hours at Lowell Road on its approach to Main Street and on the Hollis Street approach during the early peak hour.

This analysis is representative of approximately 14% of year 2024 annual days. For three of the remaining six days per week, school operations without scheduled events represent approximately 31-34% of year 2024 annual days. These are days that typically will be lower than the Monday operations presented on Table 12, even closer to those expected with the year 2024 No-Build.

From Table 13, representing a Friday situation at a sold-out 1,000 seat Concert event during 2024, traffic operational problems at Lowell Road and Main Street will worsen compared to the No-Build condition. The Table 13 analysis represents approximately 5-9% of annual days, as similar concerts occurring on a Saturday evening or Sunday afternoon should represent in aggregate as 10-18% of Year 2024 annual days. Saturday late hour analysis is not provided since Friday provides a worse case for background traffic than Saturday, or Sunday for that matter.

Table 12 -Build MCIH Year 2024 - "Typical" Peak School Day Peak Hour Traffic Operations

Intersection	Early Peak Hour												Late Peak Hour											
	2016 Existing 4:45-5:45 PM				2024 No-Build 4:45-5:45 PM				2024 Build 4:45-5:45 PM				2016 Existing 6:00-7:00 PM				2024 No-Build 6:00-7:00 PM				2024 Build 6:00-7:00 PM			
	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del
1) Old Ayer Road (S) at Boston Rd																								
Old Ayer Rd EB	B	0.14	13	12	B	0.16	14	13	B	0.24	23	13	B	0.10	8	13	B	0.10	8	12	B	0.25	25	13
Boston Rd NB	A	0.08	6	2	A	0.08	7	3	A	0.14	12	4	A	0.06	5	2	A	0.06	5	2	A	0.11	9	3
2) Old Ayer Road (N) at Main St																								
Old Ayer Rd EB	F	0.78	120	87	F	0.95	155	135	F	1.03	177	158	E	0.42	47	38	E	0.46	54	43	E	0.53	67	47
Main St NB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
3) Lowell Road at Main St/Broadmeadow																								
Lowell Rd WB	F	1.90	553	477	F	2.54	677	777	F	2.86	725	923	F	0.84	168	67	F	1.05	243	126	F	1.18	286	174
Main St NB	A	0.04	3	1	A	0.04	3	2	A	0.04	3	2	A	0.06	5	2	A	0.07	5	2	A	0.07	5	2
Main St SB	A	0.26	26	7	A	0.29	30	8	A	0.29	30	8	A	0.16	14	4	A	0.17	16	5	A	0.17	16	5
4) Main Street at Hollis St																								
Hollis Street WB	F	1.15	164	242	F	1.30	185	307	F	1.40	200	349	F	0.76	106	100	F	0.87	127	131	F	0.92	136	143
Main St NB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
Main St SB	A	0.05	4	2	A	0.05	4	1	A	0.05	4	2	A	0.02	1	1	A	0.02	1	1	A	0.02	1	1
5) Farmers Row at Higley St																								
Farmers Row SB	A	0.04	3	2	A	0.04	3	2	A	0.04	3	2	A	0.02	2	2	A	0.02	2	2	A	0.02	2	2
Higley St NWB	B	0.21	19	12	B	0.22	21	12	B	0.22	21	12	A	0.12	10	10	A	0.13	11	10	B	0.14	12	10
6) Farmers Row at Peabody St																								
Farmers Row SB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
Peabody St WB	B	0.10	9	13	B	0.11	9	13	B	0.12	11	14	B	0.02	2	10	B	0.02	2	10	B	0.04	3	11
7) Farmers Row at Culver Rd																								
Farmers Row SB	A	0.01	1	1	A	0.01	1	1	A	0.01	1	1	A	0.01	0	1	A	0.01	0	1	A	0.01	0	1
Culver Rd NWB	B	0.04	3	10	B	0.11	9	13	B	0.12	11	14	B	0.02	2	10	B	0.02	2	10	B	0.04	3	11
8) Peabody St at Higley St																								
Higley St SB	A	0.05	5	10	A	0.07	6	10	A	0.08	6	10	A	0.03	2	9	A	0.03	2	9	A	0.04	3	9
Peabody St EB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
9) Peabody St at Old Ayer Rd																								
Peabody St EB	B	0.15	13	13	B	0.17	15	13	C	0.22	21	16	B	0.06	5	10	B	0.07	5	11	B	0.09	8	12
Old Ayer Rd NB	A	0.08	6	4	A	0.08	7	4	A	0.09	8	4	A	0.04	3	3	A	0.04	3	3	A	0.06	4	2
10) Old Ayer Rd at Primary Access																								
Old Ayer Rd NB	N/A				N/A				A 0.02 1 1				N/A				N/A				A 0.01 1 1			
Site Driveway EB	N/A				N/A				B 0.15 13 12				N/A				N/A				B 0.20 18 11			
11) Peabody St at Secondary Access																								
Peabody St WB	N/A				N/A				N/A				N/A				N/A				N/A			
Site Driveway NB	N/A				N/A				N/A				N/A				N/A				N/A			

LOS - Level of Service from A-F; A is best, F is worst.

V/C - Proportion of volume to available capacity during analysis hour

Q - 95th percentile vehicle queue measured in feet from the intersection.

Del - Average motorist delay expressed in seconds during peak 15 minute period of the peak hour.

Over-capacity LOS F condition --V/C greater than 1.0.



Table 13 - Build MCIH Year 2024- Occasional 1,000 Patron "Large" Concert Friday Early and Late Peak Hour Traffic Operations

Intersection	Early Peak Hour												Late Peak Hour											
	2016 Existing 6:15-7:15 PM				2024 No-Build 6:15-7:15 PM				2024 Build 6:15-7:15 PM				2016 Existing 9:30-10:30 PM				2024 No-Build 9:30-10:30 PM				2024 Build 9:30-10:30 PM			
	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del
1) Old Ayer Road (S) at Boston Rd																								
Old Ayer Rd EB	B	0.08	6	11	B	0.07	6	11	B	0.09	8	11	A	0.01	1	9	A	0.01	1	9	B	0.36	41	11
Boston Rd NB	A	0.05	4	1	A	0.05	4	1	A	0.24	23	5	A	0.01	1	1	A	0.01	1	1	A	0.02	1	1
2) Old Ayer Road (N) at Main St																								
Old Ayer Rd EB	D	0.33	34	27	D	0.36	40	29	D	0.38	42	31	B	0.05	4	11	B	0.05	4	11	B	0.18	17	12
Main St NB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
3) Lowell Road at Main St/Broadmeadow																								
Lowell Rd WB	D	0.45	58	30	D	0.51	71	34	F	0.98	233	96	B	0.06	4	11	B	0.06	5	11	B	0.06	5	11
Main St NB	A	0.06	4	1	A	0.06	5	2	A	0.06	5	2	A	0.01	1	1	A	0.01	1	1	A	0.01	1	1
Main St SB	A	0.13	11	3	A	0.13	12	4	A	0.13	12	4	A	0.02	1	2	A	0.02	1	2	A	0.02	1	2
4) Main Street at Hollis St																								
Hollis Street WB	F	0.57	73	53	F	0.64	89	64	F	0.71	104	75	B	0.05	4	11	B	0.05	4	11	B	0.06	4	11
Main St NB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
Main St SB	A	0.01	1	0	A	0.02	1	1	A	0.02	1	1	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
5) Farmers Row at Higley St																								
Farmers Row SB	A	0.02	1	1	A	0.02	1	1	A	0.03	3	2	A	0.00	0	1	A	0.00	0	1	A	0.00	0	1
Higley St NWB	A	0.07	6	10	A	0.07	6	10	A	0.08	6	10	A	0.01	1	9	A	0.01	1	9	A	0.05	4	9
6) Farmers Row at Peabody St																								
Farmers Row SB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
Peabody St WB	B	0.03	2	11	B	0.13	2	11	B	0.03	3	11	A	0.01	1	9	A	0.02	1	9	A	0.07	5	9
7) Farmers Row at Culver Rd																								
Farmers Row SB	A	0.01	1	1	A	0.01	1	1	A	0.01	1	1	A	0.00	0	0	A	0.00	0	1	A	0.00	0	0
Culver Rd NWB	A	0.03	2	9	A	0.03	2	9	A	0.03	2	10	A	0.00	0	9	A	0.00	0	9	A	0.00	0	9
8) Peabody St at Higley St																								
Higley St SB	A	0.03	2	9	A	0.03	2	9	A	0.06	4	9	A	0.00	0	9	A	0.00	0	9	A	0.00	0	9
Peabody St EB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
9) Peabody St at Old Ayer Rd																								
Peabody St EB	B	0.05	4	10	B	0.06	4	10	B	0.15	13	13	A	0.01	1	9	A	0.01	1	9	B	0.02	1	13
Old Ayer Rd NB	A	0.02	2	2	A	0.03	2	2	A	0.03	2	2	A	0.00	0	1	A	0.00	0	1	A	0.00	0	0
10) Old Ayer Rd at Primary Access																								
Old Ayer Rd NB	N/A				N/A				A	0.13	11	4	N/A				N/A				A	0.00	0	0
Site Driveway EB	N/A				N/A				C	0.07	6	19	N/A				N/A				D	0.90	324	33
11) Peabody St at Secondary Access																								
Peabody St WB	N/A				N/A				A	0.00	0	0	N/A				N/A				A	0.00	0	0
Site Driveway NB	N/A				N/A				B	0.00	0	10	N/A				N/A				A	0.09	8	9

LOS - Level of Service from A-F; A is best, F is worst.

V/C - Proportion of volume to available capacity during analysis hour

Q - 95th percentile vehicle queue measured in feet from the intersection.

Del - Average motorist delay expressed in seconds during peak 15 minute period of the peak hour.

Over-capacity LOS F condition --V/C greater than 1.0.



Tables 14 and 15 represent “worst-case” traffic operating conditions for a small number of the most intensive *Large* and *Festival* events that would take place during the summer months only.

Table 14 - Build MCIH Year 2024 - Rare 2,300-Patron "Large" Concert Friday Early and Late Peak Hour Traffic Operations																									
Intersection	Early Peak Hour												Late Peak Hour												
	2016 Existing 6:15-7:15 PM				2024 No-Build 6:15-7:15 PM				2024 Build 6:15-7:15 PM				2016 Existing 9:30-10:30 PM				2024 No-Build 9:30-10:30 PM			2024 Build 9:30-10:30 PM					
	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del					
1) Old Ayer Road (S) at Boston Rd	Old Ayer Rd EB	B	0.08	6	11	B	0.07	6	11	B	0.14	12	13	A	0.01	1	9	A	0.01	1	9	B	0.64	118	15
	Boston Rd NB	A	0.05	4	1	A	0.05	4	1	A	0.39	46	8	A	0.01	1	1	A	0.01	1	1	A	0.02	2	1
2) Old Ayer Road (N) at Main St	Old Ayer Rd EB	D	0.33	34	27	D	0.36	40	29	D	0.40	45	32	B	0.05	4	11	B	0.05	4	11	B	0.29	30	13
	Main St NB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
3) Lowell Road at Main St/Broadmeadow	Lowell Rd WB	D	0.45	58	30	D	0.51	71	34	F	1.34	372	228	B	0.06	4	11	B	0.06	5	11	B	0.06	5	11
	Main St NB	A	0.06	4	1	A	0.06	5	2	A	0.06	5	2	A	0.01	1	1	A	0.01	1	1	A	0.01	1	1
	Main St SB	A	0.13	11	3	A	0.13	12	4	A	0.13	12	4	A	0.02	1	2	A	0.02	1	2	A	0.02	2	2
4) Main Street at Hollis St	Hollis Street WB	F	0.57	73	53	F	0.64	89	64	F	0.77	117	84	B	0.05	4	11	B	0.05	4	11	B	0.06	5	12
	Main St NB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
	Main St SB	A	0.01	1	0	A	0.02	1	1	A	0.02	1	1	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
5) Farmers Row at Higley St	Farmers Row SB	A	0.02	1	1	A	0.02	1	1	A	0.05	4	3	A	0.00	0	1	A	0.00	0	1	A	0.00	0	1
	Higley St NWB	A	0.07	6	10	A	0.07	6	10	A	0.08	6	10	A	0.01	1	9	A	0.01	1	9	A	0.08	7	9
6) Farmers Row at Peabody St	Farmers Row SB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
	Peabody St WB	B	0.03	2	11	B	0.13	2	11	B	0.04	3	11	A	0.01	1	9	A	0.02	1	9	A	0.10	9	9
7) Farmers Row at Culver Rd	Farmers Row SB	A	0.01	1	1	A	0.01	1	1	A	0.01	1	1	A	0.00	0	0	A	0.00	0	1	A	0.00	0	0
	Culver Rd NWB	A	0.03	2	9	A	0.03	2	9	A	0.03	2	10	A	0.00	0	9	A	0.00	0	9	A	0.00	0	9
8) Peabody St at Higley St	Higley St SB	A	0.03	2	9	A	0.03	2	9	A	0.08	6	9	A	0.00	0	9	A	0.00	0	9	A	0.01	0	9
	Peabody St EB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
9) Peabody St at Old Ayer Rd	Peabody St EB	B	0.05	4	10	B	0.06	4	10	C	0.27	27	17	A	0.01	1	9	A	0.01	1	9	C	0.04	3	18
	Old Ayer Rd NB	A	0.02	2	2	A	0.03	2	2	A	0.04	3	2	A	0.00	0	1	A	0.00	0	1	A	0.00	0	0
10) Old Ayer Rd at Primary Access	Old Ayer Rd NB	N/A				N/A				B	0.34	37	10	N/A				N/A				A	0.00	0	1
	Site Driveway EB	N/A				N/A				F	0.44	49	54	N/A				N/A				F	1.61	1933	292
11) Peabody St at Secondary Access	Peabody St WB	N/A				N/A				A	0.00	0	0	N/A				N/A				A	0.00	0	0
	Site Driveway NB	N/A				N/A				B	0.01	0	11	N/A				N/A				A	0.17	15	9

LOS - Level of Service from A-F; A is best, F is worst.

V/C - Proportion of volume to available capacity during analysis hour

Q - 95th percentile vehicle queue measured in feet from the intersection.

Del - Average motorist delay expressed in seconds during peak 15 minute period of the peak hour.

Over-capacity LOS F conditions --V/C greater than 1.0.



Table 15 - Build MCIH Year 2024												
Saturday Day-Long 2.300-Patron "Festival" Mid-day Peak Hour Traffic Operations												
Intersection	Saturday Mid-day Peak Hour											
	2016 Existing				2023 No-Build				2023 Build			
	11:00 AM-12:00 PM				11:00 AM-12:00 PM				11:00 AM-12:00 PM			
	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del
1) Old Ayer Road (S) at Boston Rd												
Old Ayer Rd EB	C	0.25	24	15	C	0.26	26	16	C	0.47	60	23
Boston Rd NB	A	0.08	7	2	A	0.08	7	2	A	0.36	41	8
2) Old Ayer Road (N) at Main St												
Old Ayer Rd EB	D	0.38	42	31	D	0.43	49	34	E	0.48	59	38
Main St NB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
3) Lowell Road at Main St/Broadmeadow												
Lowell Rd WB	F	0.95	221	85	F	1.13	296	143	F	1.69	503	384
Main St NB	A	0.02	2	1	A	0.02	2	1	A	0.02	2	1
Main St SB	A	0.18	17	4	A	0.20	18	5	A	0.20	18	5
4) Main Street at Hollis St												
Hollis Street WB	F	0.94	175	109	F	1.04	205	144	F	1.13	231	171
Main St NB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
Main St SB	A	0.01	1	0	A	0.01	1	0	A	0.01	1	0
5) Farmers Row at Higley St												
Farmers Row SB	A	0.03	2	2	A	0.03	2	2	A	0.04	3	2
Higley St NWB	A	0.05	4	9	A	0.05	4	9	A	0.06	4	9
6) Farmers Row at Peabody St												
Farmers Row SB	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
Peabody St WB	B	0.04	3	11	B	0.04	3	11	B	0.05	4	11
7) Farmers Row at Culver Rd												
Farmers Row SB	A	0.01	1	1	A	0.01	1	1	A	0.01	1	1
Culver Rd NWB	A	0.02	2	9	A	0.02	2	9	A	0.02	2	9
8) Peabody St at Higley St												
Higley St SB	A	0.05	4	9	A	0.05	4	9	A	0.08	6	10
Peabody St EB	A	0.00	0	1	A	0.00	0	1	A	0.00	0	1
9) Peabody St at Old Ayer Rd												
Peabody St EB	B	0.10	9	11	B	0.11	9	11	C	0.26	26	16
Old Ayer Rd NB	A	0.01	1	1	A	0.01	1	1	A	0.02	1	1
10) Old Ayer Rd at Primary Access												
Old Ayer Rd NB		N/A				N/A			A	0.06	4	3
Site Driveway EB		N/A				N/A			B	0.24	23	15
11) Peabody St at Secondary Access												
Peabody St WB		N/A				N/A			A	0.00	0	0
Site Driveway NB		N/A				N/A			A	0.01	1	10

LOS - Level of Service from A-F; A is best, F is worst.

V/C - Proportion of volume to available capacity during analysis hour

Q - 95th percentile vehicle queue measured in feet from the intersection.

Del - Average motorist delay expressed in seconds during peak 15 minute period of the peak hour.

Over-capacity LOS F condition --V/C greater than 1.0.



D. Traffic Mitigation Measures

This study reviewed the level of appropriate traffic mitigation associated with various MCIH activities, particularly the most intensive *Large* and *Festival* events.

Mitigation measures are typically only proposed for locations where Build levels of service are worse than the No-Build traffic operations, and/or where the Build case will present new safety concerns.

The same three intersections on Boston Road/Main Street (Routes 119/225) that are problematic in the existing (2016) analyses and future No-Build analyses, will be adversely affected with the Build traffic added. Because most site related impacts are expected to occur at the intersection of Old Ayer Road at Boston Road/Main Street (Routes 119/225), modest structural mitigation measures are recommended at that intersection.

However, in keeping with Groton's desire to minimize new pavement, projected mitigation measures primarily relate to *operations management* including:

- ❖ We recommend providing off-site police control only at *the intersection of Old Ayer Road with Boston Road* when necessary for the most intensive *Large* and *Festival* days.
- ❖ We also recommend that MCIH coordinate with the Groton Police Department in setting criteria for the time periods for police control might be required at the off-site intersection of Old Ayer Road with Boston and Main Streets.

Police traffic control should only be provided when undue congestion or travel hazards will otherwise occur.

We recommend an ADA-compliant crosswalk be installed on Peabody Street to connect the future Peabody Street sidewalk to MCIH.

Old Ayer Road at Boston Road/Main Street

Boston Road at Old Ayer Road will likely be absorbing 70-75% of the site's generated

traffic. Accommodating MCIH-generated left turns, both going into and leaving Old Ayer Road is the primary future issue. Overall, on an annual basis, it add 2-3% new traffic to this intersection. During its regular PM peak hours, MCIH traffic will represent up to 16% of Old Ayer Road at Boston Road/Main Street peak hour traffic, on its peak day of the week. Proportions of MCIH peak hour traffic passing through this intersection increase from during *Large* and *Festival* MCIH events.

This intersection is complicated by Prescott Park located adjacent to it on the west side of Main Street. This happens to be parkland covered under the State's Article 97 statute. As we understand it, several years ago, the Town of Groton considered converting this intersection into a conventional T intersection, but the idea was not implemented.

Existing traffic conditions already meet warrants to provide an exclusive left turn lane northbound on Boston Road approaching Old Ayer Road. South of Old Ayer Road, Boston Road has recently been resurfaced with a large shoulder on the west side adjacent to a nearby gas station. Negotiating left turns out of Old Ayer Road North onto Main Street is already difficult and hazardous based on our site review and the historical crash data. Adding future MCIH left turning traffic to both of these left turning movements would serve to exacerbate existing conditions.

Refer to the Technical Appendix to this report for a left lane warrant analysis with MCIH traffic added to northbound Boston Road traffic.¹⁴

While the intersection of Old Ayer Road with Boston Road and Main Streets has no simple and easy fix, based on our review of the pros and cons of various strategies, we recommend the Town consider implementation of the following elements to improve the safety of MCIH site access to and from Old Ayer Road, as well as general intersection safety for all of its users:

¹⁴ MassDOT Project Development and Design Guide, 2006 Edition, as amended.

- ❖ Retain two T intersections with Boston Road and Main Street.
- ❖ Create a short northbound bypass/left turn lane on Boston Road as it approaches Old Ayer Road South. Restripe the northbound approach to accommodate the new left lane. A small grass area on the southeast corner of the park would be needed to re-orient southbound Boston Road and eastbound Old Ayer Road properly.
- ❖ Modify the skewed “Y” unsignalized intersection of Old Ayer Road North at Main Street to slow southbound traffic flow turning into Old Ayer Road and allow traffic turning left out of Old Ayer Road North to form a more perpendicular position, thereby reducing the hazard of motorists trying to turn left out. Achieving this may require some minor pavement re-grading on Old Ayer Road to adjust for pavement grade changes. The intersection realignment should be designed to allow motorists to turn right onto Old Ayer Road North without encroaching on Old Ayer Road traffic approaching Main Street.
- ❖ Increase the total amount of green space by adding two non-contiguous green spaces that to improve the safety of traffic flowing into and out of Old Ayer Road to and from the site as well as pedestrians crossing Old Ayer Road North near Main Street onto Prescott Park.
- ❖ Relocate the stop sign from westbound Old Ayer Road South to southbound Old Ayer Road North, so that the primary flow of westbound Old Ayer Road traffic will not have to stop when accessing the MCIH site. While the current configuration works for existing conditions, the added MCIH volumes, especially during the most intensive of *Large* and *Festival* events will be better served by making the stop sign reversal.

With implementation of conceptual changes similar those illustrated on Figure 25, the Old Ayer Road at Main Street/Boston Road intersection would retain approximately the same amount, if not more, of green space as exists today. MCIH site access and pedestrian safety will be enhanced over existing conditions. Results of an operational analysis with proposed mitigation in place is presented on Table 16.



Base Map Source: App Geo & Executive Office of Environmental Affairs MassGIS 2014 Orthophotos



Schematic Diagram:
Not to Scale

*Music Center at Indian Hill
Groton, Massachusetts*

Mitigation Concept Illustration
Old Ayer Road at Boston Road (119/225)
Safety & Operations Measures

Stantec Consulting Services Inc.



**Table 16 - Build MCIH Year 2024 Traffic Operations With Mitigation
Old Ayer Road at Boston Road and Main Street (Route 119/225) by Scenario**

Intersection	"Typical" School Peak Day- Early Peak Hour												"Typical" School Peak Day - Late Peak Hour											
	2024 No-Build 4:45-5:45 PM				2024 Build 4:45-5:45 PM				2024 Mitigated Build 4:45-5:45 PM				2024 No-Build 6:00-7:00 PM				2024 Build 6:00-7:00 PM				2024 Mitigated Build 6:00-7:00 PM			
	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del
1) Old Ayer Road (S) at Boston Rd Old Ayer Rd EB Boston Rd NB	B	0.16	14	13	B	0.24	23	13	B	0.21	20	12	B	0.10	8	12	B	0.25	25	13	B	0.22	21	11
	A	0.08	7	3	A	0.14	12	4	A	0.14	12	9	A	0.06	5	2	A	0.11	9	3	A	0.11	9	8
2) Old Ayer Road (N) at Main Street Old Ayer Rd EB Main St NB	F	0.95	155	135	F	1.03	177	158	F	1.05	183	165	E	0.46	54	43	E	0.53	67	47	E	0.53	67	47
	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
Intersection	Occasional Friday 1,000 Patron "Large" Concert - Early Peak Hour												Occasional Friday 1,000-Patron "Large" Concert - Late Peak Hour											
	2024 No-Build 6:15-7:15 PM				2024 Build 6:15-7:15 PM				2024 Mitigated Build 6:15-7:15 PM				2024 No-Build 9:30-10:30 PM				2024 Build 9:30-10:30 PM				2024 Mitigated Build 9:30-10:30 PM			
	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del
1) Old Ayer Road (S) at Boston Rd Old Ayer Rd EB Boston Rd NB	B	0.07	6	11	B	0.09	8	11	B	0.07	6	10	A	0.01	1	9	B	0.36	41	11	B	0.36	41	11
	A	0.05	4	1	A	0.24	23	5	A	0.24	23	9	A	0.01	1	1	A	0.02	1	7	A	0.02	1	7
2) Old Ayer Road (N) at Main Street Old Ayer Rd EB Main St NB	D	0.36	40	29	D	0.38	42	31	D	0.38	42	31	B	0.05	4	11	B	0.18	17	12	B	0.18	17	12
	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
Intersection	Rare Friday 2,300-Patron "Large" Concert - Early Peak Hour												Rare Friday 2,300-Patron "Large" Concert - Late Peak Hour											
	2024 No-Build 6:15-7:15 PM				2024 Build 6:15-7:15 PM				2024 Mitigated Build 6:15-7:15 PM				2024 No-Build 9:30-10:30 PM				2024 Build 9:30-10:30 PM				2024 Mitigated Build 9:30-10:30 PM			
	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del
1) Old Ayer Road (S) at Boston Rd Old Ayer Rd EB Boston Rd NB	B	0.07	6	11	B	0.14	12	13	B	0.10	8	10	A	0.01	1	9	B	0.64	118	15	B	0.64	118	15
	A	0.05	4	1	A	0.39	46	8	A	0.39	46	10	A	0.01	1	1	A	0.02	2	1	A	0.02	2	1
2) Old Ayer Road (N) at Main Street Old Ayer Rd EB Main St NB	D	0.36	40	29	D	0.40	45	32	D	0.40	45	32	B	0.05	4	11	B	0.29	30	13	B	0.29	30	13
	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0
Intersection	Rare 2,300-Patron Day-Long "Festival" - Saturday Mid-day Peak Hour																							
	2024 No-Build 11:00 AM-12:00 PM				2024 Build 11:00 AM-12:00 PM				2024 Mitigated Build 11:00 AM-12:00 PM															
	LOS	V/C	Q	Del	LOS	V/C	Q	Del	LOS	V/C	Q	Del												
1) Old Ayer Road (S) at Boston Rd Old Ayer Rd EB Boston Rd NB	C	0.26	26	16	C	0.47	60	23	B	0.08	7	11												
	A	0.08	7	2	A	0.36	41	8	A	0.04	3	1												
2) Old Ayer Road (N) at Main Street Old Ayer Rd EB Main St NB	D	0.43	49	34	D	0.40	45	32	D	0.41	46	32												
	A	0.00	0	0	A	0.00	0	0	A	0.00	0	0												

LOS - Level of Service from A-F; A is best, F is worst.

V/C - Proportion of volume to available capacity during analysis hour

Q - 95th percentile vehicle queue measured in feet from the intersection.

Del - Average motorist delay expressed in seconds during peak 15 minute period of the peak hour.

Over-capacity LOS F condition --V/C greater than 1.0.

Old Ayer Road at Boston Road/Main Street (Continued)

From Table 16, the mitigated Build levels of service and delays are similar to those associated with the No-Build Alternative. While the “Do-Nothing” option provides peak hour operations similar to the mitigation plan, we expect potential mitigation measures to accrue future safety benefits to motorists, bicyclists, and pedestrians who pass through this intersection.

Way-finding Signs

MCIH should have a sign on site on its property at the main site driveway off Old Ayer Road conforming to Groton’s sign ordinance, Chapter 196 of its Zoning Code. Since nearly everyone has access to electronic Global Positioning Systems (GPS) devices, way finding traffic signs to the MCIH in public layouts are not as mandatory as they have been in the past. Any way-finding signage being considered should be minimized to avoid sign pollution in Groton and elsewhere.

From a traffic perspective, as the MCIH has a regional catchment area, no more than two to three optional way-finding signs might be considered –either on I-495 or Route 119 regional highways. The two optional signs northbound and southbound on I-495 will assist travelers in finding the best exit to Route 119, Exit 31.

Additionally, one much smaller optional sign, on the northbound Route 119/225 approaching Old Ayer Road, might help slow travelers in advance of making a left turn. A southbound sign on the approach to Old Ayer Road North at Main Street is not as critical. If installed, it ideally should be located on a taller version of the post serving the existing Nashoba Valley Medical Center way finding sign.

Any sign to be located in a MassDOT right of way will require a sign permit. Abutters should be notified prior to the placement of a sign in front of their property to adjust placement if necessary to accommodate driveway sight lines or other adjacent owner preferences. Figure 26 summarizes off-site traffic mitigation measures recommended for the MCIH.



Schematic Diagram:
Not to Scale

Music Center at Indian Hill
Groton, Massachusetts

Summary of Recommended Off-Site Build Traffic Mitigation Measures

V. CONCLUSIONS AND RECOMMENDATIONS

General

On average overall for the year 2024, the MCIH site will generate relatively low amounts of new traffic, averaging approximately 685-870 vehicle trips per day with approximately 3,100 trips on a few Saturdays or Sundays per year.

Groton School proposes to construct sidewalk enhancements on Peabody Street. A crosswalk connection should be made between the MCIH and the future sidewalk that will be constructed on the north side of Peabody Street. Proposed MassDOT sidewalk enhancements on the west side of Boston Road between Old Ayer Road and the CVS shopping area should be beneficial to the connectivity of pedestrian movements in the area.

Lawrence Academy is proposing to relocate its existing Main Street (Routes 119/225) Powder House Road to a new location further south on Main Street, away from an existing crosswalk. While beneficial to Lawrence Academy and Boston Road traffic circulation, the Lawrence Academy changes have little impact on future MCIH traffic operations, but should enhance the safety of those who choose to access MCIH from the north.

MCIH *daily and peak hour* traffic generation will vary significantly, depending on scheduled events. On non-event school days, MCIH will generate approximately 100 vehicle trips, 45 to 55 trips in and out during its daily peak hour. On the highest days during the most intensive of *Large* and *Festival* events, it could generate up to 845 vehicle trips -- 825 out and 20 in -- during the late peak exiting hour from 9:30-10:30 PM on a Friday or 10:00-11:00 PM on a Saturday. The site will be generating its highest exiting volumes during periods when background traffic is low.

Boston Road/Main Street (Route 119/225) at Old Ayer Road

We believe that while the safety record for the Old Ayer Road at Boston Road intersection is acceptable with existing Old Ayer Road volumes, the Town should address it if MCIH is to realize its full potential as a regional music facility. Even though MCIH traffic will

comprise approximately 2-3% of the total annual traffic passing through this intersection, its peak hour impacts will be highly variable.

We understand the Town of Groton unsuccessfully attempted to modify this intersection in the past and that Prescott Park, essentially the west edge of the intersection, is very important to the Town.

Consequently, after careful consideration of many options for this intersection, only two options emerged as being feasible, and one of them being the “Do Nothing” option, as MassDOT recently resurfaced Boston Road. The mitigation measures we recommend will not only improve future safety of site access and egress to and from MCIH via the Old Ayer Road/Main Street/Boston Road intersection, but pedestrian safety for those who are traveling to and from Boston Road on the future MassDOT sidewalk.

If mitigation measures are to be undertaken, we recommend the Town propose them in cooperation with MassDOT. As noted above, the vast majority of future traffic through this intersection by 2024 year will be unrelated to MCIH. The Town is in the best position to weigh tradeoffs between Prescott Park impacts and traffic/pedestrian safety benefits. Because the intersection is not a high crash location, the Town could conceivably adopt a “wait and see” approach to addressing it. Based on the MassDOT sidewalk plan design, the improvements shown on Figure 25 show it may be possible to re-orient the center line on the already widened segment of Boston Road to create room for motorists to bypass left turning vehicles on the right while minimizing park related impacts on the southeast corner of Prescott Park.

Even with implementation of recommended mitigation measures, police control will likely be needed at Old Ayer Road at Boston Road during the most intensive MCIH *Large* and *Festival* site events.

Site Parking Demands

MCIH will have highly variable parking demands. Based on the school’s future vision for planned events by the year 2024, it is likely that 500 of the site’s available paved parking supply of just under 675 spaces will suffice during much of the year, with the remaining undesignated ±100 overflow unmarked parking spaces within the site’s perimeter road being used infrequently.

During typical non-event school days, site peak parking demands should range from 70-150 vehicles. The total available site parking supply -- inclusive of paved and unmarked spaces -- of no more than 775 spaces will constrain traffic impacts during rare *Large* and *Festival* events. MCIH site-related parking demands will be accommodated on site to the maximum extent possible.

Peabody Street Pedestrian Access/Site Bicycle Access

While most site access will be via carpools in automobiles, we recommend MCIH provide an ADA-compliant crosswalk to connect the site to the future Peabody Street sidewalk proposed by the Groton School. We understand that MCIH will be providing bike racks to accommodate the limited amount of bike trips that may be generated to and from the site.