

## MEMORANDUM

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**FROM:** Mr. Shaun P. Kelly [SPK](#)  
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**DATE:** February 4, 2022

**RE:** 9038

**SUBJECT:** Transportation Impact Assessment  
Proposed Research & Development Facility – One Corporate Drive  
Andover, Massachusetts

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Vanasse & Associates, Inc. (VAI) has conducted a Transportation Impact Assessment (TIA) in order to determine the potential impacts on the transportation infrastructure associated with the proposed repurposing and expansion to an existing office building, located at One Corporate Drive in Andover, Massachusetts, in order to accommodate a research & development facility and associated manufacturing space (hereafter referred to as the “Project”).

This study evaluates the following specific areas as they relate to the Project: i) access requirements; ii) potential off-site improvements; and iii) safety considerations; and identifies and analyzes existing traffic conditions and future traffic conditions, both with and without the Project, along River Road and Shattuck Road, and at the intersection of River Road at Minuteman Road and Shattuck Road. Based on this assessment, we have concluded the following with respect to the Project:

1. Using trip-generation statistics published by the Institute of Transportation Engineers (ITE)<sup>1</sup>, the Project is expected to generate 344 additional weekday daily vehicle trips (172 entering and 172 exiting), including 10 new vehicle trips (3 fewer entering and 13 additional exiting) during the weekday morning peak hour, and 12 new vehicle trips (10 entering and 2 exiting) during the weekday evening peak hour;
2. The Project is not expected to result in a significant impact (increase) on motorist delays or vehicle queuing over future conditions without the Project (No-Build conditions) with overall delays expected to increase by less than 1 second per vehicle due to Project-related traffic increases;
3. Independent of the Project, one or more movements at the River Road/Minuteman Road/Shattuck Road intersection were identified as operating at their design capacity (defined as a level-of-service (LOS) “E”) during the weekday evening peak-hour;

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<sup>1</sup>*Trip Generation*, 11<sup>th</sup> Edition; Institute of Transportation Engineers; Washington, DC; 2017.



4. No apparent safety deficiencies were identified at the study intersection based on a review of motor vehicle crash data available from the Massachusetts Department of Transportation(MassDOT).

The following details our assessment of the Project.

## **PROJECT DESCRIPTION**

The proposed Project consists of the renovation of an existing two story office building located at One Corporate Drive, to repurpose the building from business office use to research and development laboratory use. The current 67,990 square foot (sf) building will be slightly reduced to 67,885 sf as a result of the proposed renovation. The project also includes a new two story addition to the existing One Corporate Drive building. The proposed uses in this addition are an Atrium and cGMP manufacturing space. The total area of the new Atrium and cGMP space (with all of the second floor space filled in for mechanical equipment by future tenants) is 95,640 sf.

## **STUDY METHODOLOGY**

This study was prepared in consultation with the Massachusetts Department of Transportation (MassDOT) and the Town of Andover; was performed in accordance with MassDOT's *Transportation Impact Assessment (TIA) Guidelines* and the standards of the Traffic Engineering and Transportation Planning professions for the preparation of such reports; and was conducted in three distinct stages.

The first stage involved an assessment of existing conditions in the study area and included an inventory of roadway geometrics; pedestrian and bicycle facilities; on-street parking; public transportation services; observations of traffic flow; and collection of pedestrian, bicycle and vehicle counts.

In the second stage of the study, future traffic conditions were projected and analyzed. Specific travel demand forecasts for the Project were assessed along with future traffic demands due to expected traffic growth independent of the Project. A seven-year time horizon was selected for analyses consistent with MassDOT's *Transportation Impact Assessment (TIA) Guidelines*. The analysis conducted in stage two identifies existing or projected future capacity, safety, and access issues, as these areas relate to the transportation infrastructure.

The third stage of the study presents and evaluates measures to address deficiencies in the transportation infrastructure, if any, identified in stage two of the study.

## **EXISTING CONDITIONS**

In order to establish the existing conditions context of the Project with respect to the transportation infrastructure, a comprehensive field inventory of existing geometric conditions within the study area was undertaken in December 2021. The field investigation consisted of an inventory of existing roadway geometrics; public transportation services; and pedestrian and bicycle facilities; as well as posted speed limits and land use information within the study area. The study area includes the intersection of River Road at Minuteman Road and Shattuck Road. The following summarizes existing conditions within the study area.



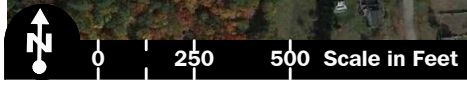
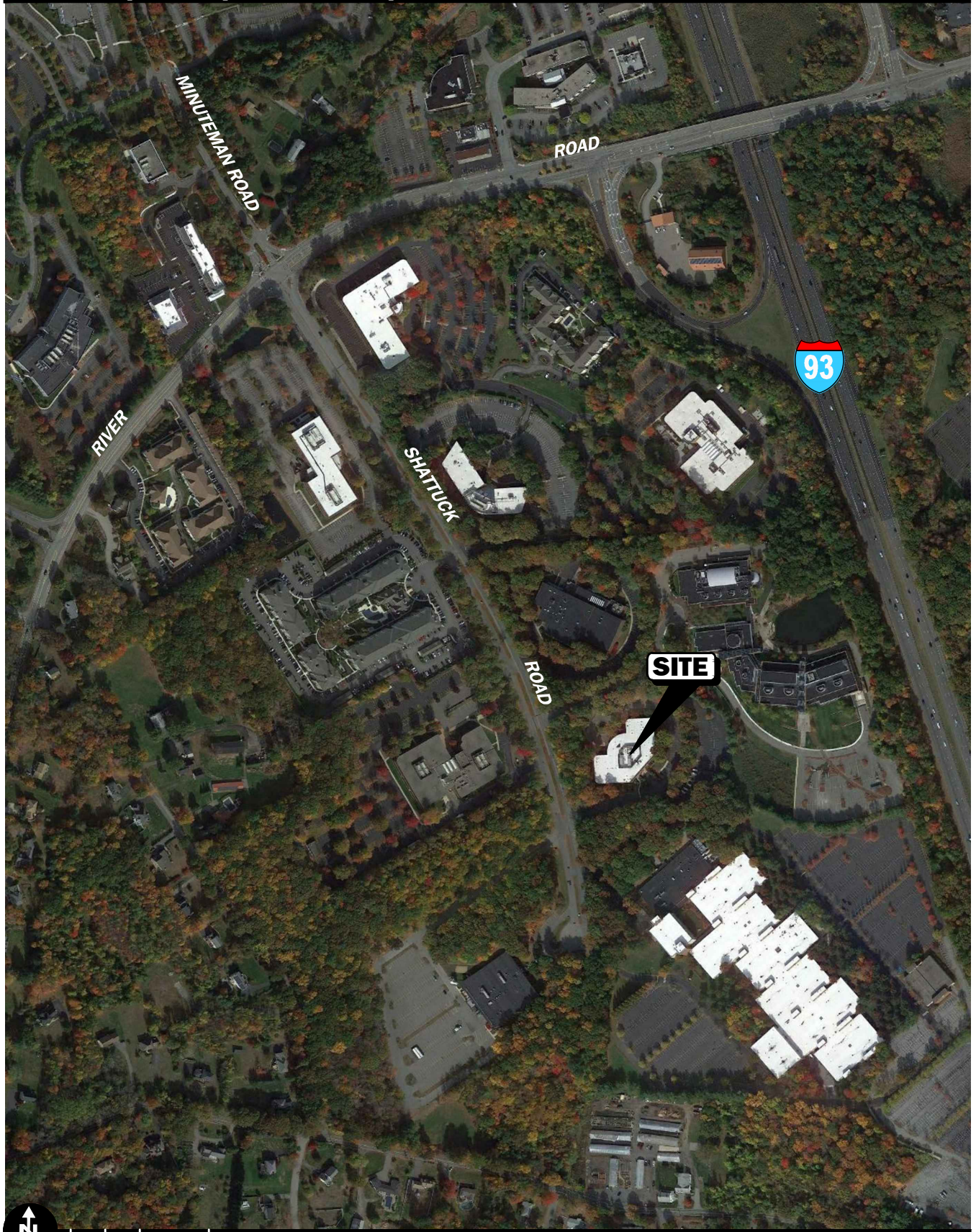


Figure 1  
Site Location Map



## **Roadways**

### **River Road**

- Two to four-lane urban minor arterial roadway under Town jurisdiction, with the exception of the segment of roadway between the I-93 north and southbound ramps which is under MassDOT jurisdiction
- Traverses the study area in a general east-west direction
- Provides four 11 to 12-foot-wide travel lanes separated by a raised median with variable width marked shoulders provided between Shattuck Road and North Street; west of Shattuck Road, River Road provides two 11 to 12-foot wide travel lanes separated by a double-yellow center with variable width marked shoulders provided
- Sidewalks are generally provided along one or both sides of the roadway in the Project study area
- Illumination is provided by way of street lights mounted on wood poles
- Posted speed limit along River Road within the study area is 35 miles per hour (mph) west of the I-93 northbound ramps and 30 mph to the east
- Bicycle lanes are provided along both sides of the roadway between 1776 Drive and Minuteman Road
- Land use within the study area consists of commercial properties and areas of open and wooded space

### **Shattuck Road**

- Four-lane private road
- Traverses a general north-south direction between River Road and the Project site (approximately 700 lf)
- Provides two 12-foot wide travel lanes per direction separated by a raised median with 1 to 2-foot wide marked shoulders provided
- Posted speed limit is 25 mph
- Land use within the study area consists of the Project site and commercial properties

## **Intersections**

Table 1 summarizes lane use, traffic control, and pedestrian and bicycle accommodations at the study area intersection as observed in November 2021.



**Table 1**  
**STUDY AREA INTERSECTION DESCRIPTION**

| <b>Intersection</b>                   | <b>Traffic Control Type<sup>a</sup></b> | <b>No. of Travel Lanes Provided</b>  | <b>Shoulder Provided? (Yes/No/Width)</b> | <b>Pedestrian Accommodations? (Yes/No/Description)</b>   | <b>Bicycle Accommodations? (Yes/No/Description)</b>  |
|---------------------------------------|---|--|--|--|--|
| River Rd./ Minuteman Rd./ Shattuck Rd | TS                                      | 1 left-turn lane and 2 general-purpose lanes on River Rd. eastbound; 2 left-turn lanes, 1 through lane and 1 right-turn lane on River Rd. westbound; 1 left-turn/through lane and 2 right-turn lanes on Shattuck Rd.; and 1 left-turn lane, 1 left/through lane and right-turn lane on Minuteman Rd. | Yes – 1 to 4 feet on all legs            | Yes – Sidewalks provided along the north side of River Rd. east of the intersection and along both sides of River Rd. west of the intersection, along the east side of Minuteman Rd. and along the west side of Shattuck Rd.; crosswalks provided for crossing the north and west legs of intersection; pedestrian traffic signal equipment and phasing provided | Yes – Bike lane on River Rd. west of intersection and shared traveled-way <sup>b</sup> on River Rd. east of intersection, on Minuteman Rd. and on Shattuck Rd. |

<sup>a</sup>TS = traffic signal control; S = STOP-sign control; NC = no control present.

<sup>b</sup>Combined shoulder and travel lane width equal to or exceed 14 feet.

**Existing Traffic Volumes**

In order to determine existing traffic-volume demands and flow patterns within the study area, automatic traffic recorder (ATR) counts, manual turning movement counts (TMCs) and vehicle classification counts were obtained from traffic counts that were completed in October and November 2017 as a part of a prior study due to the impact on traffic volumes resulting from the COVID-19 pandemic.<sup>2</sup> The ATR counts were conducted on October 26<sup>th</sup> through October 27<sup>th</sup> and on November 2<sup>nd</sup> through November 3<sup>rd</sup> (both Thursday through Friday, inclusive) on River Road in the vicinity of the Project site in order to record weekday daily traffic conditions over an extended period, with weekday evening (4:00 to 6:00 PM) peak period manual TMCs performed at the study intersection on October 26<sup>th</sup> (Thursday). The weekday morning peak-hour traffic volumes were developed by reversing the traffic volumes that were observed during the weekday evening peak-hour as it is assumed that traffic volumes during the weekday morning peak-hour will be similar in magnitude to those observed the weekday evening peak-hour, and then adjusting the traffic volumes on Minuteman Road and Shattuck Road using the weekday morning peak-hour traffic volume data obtained from the ATR counts.

**Traffic-Volume Adjustments**

In order to evaluate the potential for seasonal fluctuation of traffic volumes within the study area, traffic volume data from MassDOT Continuous Count Station No. 5124 located on I-93 south of the Methuen city line in Andover were reviewed.<sup>3</sup> Based on a review of this data, it was determined that traffic volumes for the month of October approximate average-month conditions and traffic volumes for the month of November are approximately 2.9 percent below average-month conditions. As such and in accordance with MassDOT standards, the November traffic volumes were adjusted upward accordingly to reflect average-month conditions. The 2017 traffic volumes were adjusted to 2022 conditions by applying a general

<sup>2</sup>Transportation Impact Assessment, Proposed Mixed-Use Commercial Development, 1 Minuteman Road and 161 River Road Andover, Massachusetts; VAI; February 2019.

<sup>3</sup>MassDOT Traffic Volumes for the Commonwealth of Massachusetts; 2021.



background traffic growth rate of 1.0 percent per year (discussed in further detail in the *General Background Traffic Growth* section of this assessment).

The 2022 Existing traffic volumes are summarized in Table 1, with the weekday morning and evening peak-hour traffic volumes graphically depicted on Figure 2.

**Table 2**  
**2022 EXISTING TRAFFIC VOLUMES**

| Location/Peak Hour                       | AWT <sup>a</sup> | VPH <sup>b</sup> | K Factor <sup>c</sup> | Directional Distribution <sup>d</sup> |
|--|------------------|------------------|-----------------------|---------------------------------------|
| <i>River Road, west of Shattuck Road</i> | 9,650            | --               | --                    | --                                    |
| Weekday Morning (7:30 – 8:30 AM)         | --               | 1,034            | 10.7                  | 56.3% WB                              |
| Weekday Evening (4:30 – 5:30 PM)         | --               | 1,043            | 10.8                  | 60.7% EB                              |

<sup>a</sup>Average weekday traffic in vehicles per day.

<sup>b</sup>Vehicles per hour.

<sup>c</sup>Percent of daily traffic occurring during the peak hour.

<sup>d</sup>Percent traveling in peak direction.

NB = northbound; SB = southbound; EB = eastbound; WB = westbound.

As summarized in Table 2, River Road west of Shattuck Road was found to accommodate approximately 9,650 vehicles on an average weekday (two-way, 24-hour volume), with approximately 1,034 vehicles per hour (vph) during the weekday morning peak-hour and 1,043 vph during the weekday evening peak-hour.

### **Pedestrian and Bicycle Facilities**

A comprehensive field inventory of pedestrian and bicycle facilities within the study area was undertaken in November 2021. The field inventory consisted of a review of the location of sidewalks and pedestrian crossing locations along the study roadways and at the study intersection, as well as the location of existing and planned future bicycle facilities. Sidewalks are provided along the east side of Minuteman Road, along both sides of River Road west of Minuteman Road and Shattuck Road; along the north side of River Road between the I-93 southbound ramps and Minuteman Road; and along the west side of Shattuck Road. Marked crosswalks are provided for crossing Minuteman Road the River Road west leg of the River Road/Minuteman Road/Shattuck Road intersection, with pedestrian traffic signal equipment and phasing provided for crossing River Road. Bicycle lanes are provided along both sides of River Road between Brundrett Avenue and Minuteman Road, with the remaining portions of River Road and both Minuteman Road and Shattuck Road providing sufficient width (combined travel lane and shoulder)<sup>4</sup> to support bicycle travel in a shared travelled-way configuration.

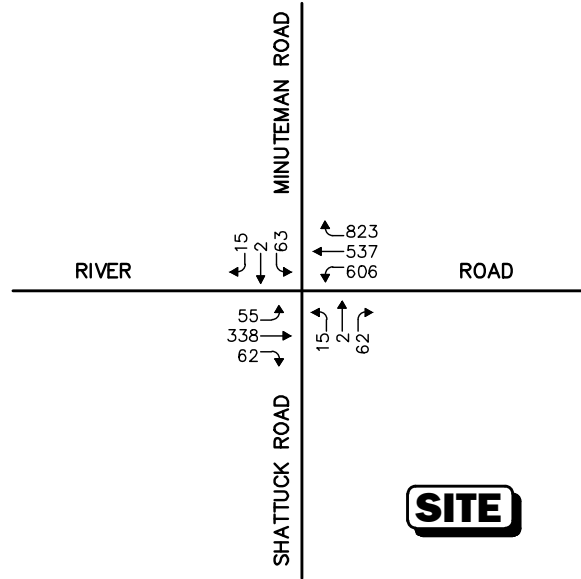
### **Public Transportation**

The Project site is served by public transportation services that are provided by the Merrimack Valley Regional Transit Authority (MVRTA). The MVRTA operates bus Route 37, *Beacon Street*, which travels along River Road to Minuteman Road, with a stop located at Springhill Suites by Marriot (north of the Project site), and thereafter to the Buckley Transportation Center in Lawrence where connections can be made to other bus lines. From the Buckley Transportation Center, bus service is provided to

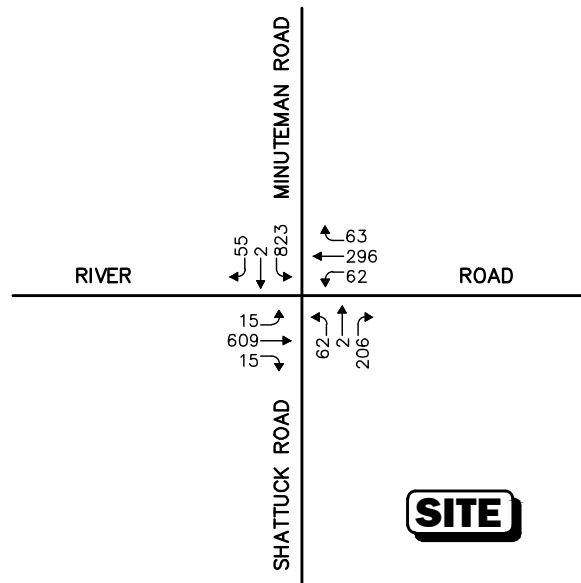
<sup>4</sup>A minimum combined travel lane and paved shoulder width of 14-feet is required to support bicycle travel in a shared traveled-way condition.



WEEKDAY MORNING PEAK HOUR



WEEKDAY EVENING PEAK HOUR



Not To Scale



Figure 2

2022 Existing Peak-Hour Traffic Volumes

Lawrence Station on the Haverhill Line of the Massachusetts Bay Transportation Authority (MBTA) Commuter Rail system with service to North Station in Boston. MVRTA buses operate in a passenger demand service mode and will stop anywhere along the service route where it is safe to pick-up or discharge a passenger. The public transportation schedules and fare information are provided in the Appendix.

### **Motor Vehicle Crash Data**

Motor vehicle crash information for the River Road/Minuteman Road/Shattuck Road intersection was provided by the MassDOT Highway Division Safety Management/Traffic Operations Unit for the most recent five-year period available (2014 through 2018, inclusive) in order to examine motor vehicle crash trends occurring within the study area. The data is summarized by intersection, type, severity, roadway and weather conditions, and day of occurrence, and presented in Table 3.

As summarized in Table 2, three (3) motor vehicle crashes were reported to have occurred at the River Road/Minuteman Road/Shattuck Road intersection over the five-year review period, or an average of less than one (1) crash per year, the majority of which occurred on a weekday, during daylight, under clear weather conditions and involved rear-end type collisions that resulted in property damage only. The calculated motor vehicle crash rate was found to be below both the MassDOT statewide and District averages for a signalized intersection for the MassDOT Highway Division District in which the intersections is located (District 4).

A review of the MassDOT statewide High Crash Location List indicated that there are no locations within the study area that are included on MassDOT's Highway Safety Improvement Program (HSIP) listing as high crash locations. In addition, no motor vehicle crashes that resulted in a fatality were identified to have occurred at the study area intersection over the five-year review period.

***Based on a review of the MassDOT motor vehicle crash data, no discernible safety deficiencies were apparent within the study area.*** The detailed MassDOT Crash Rate Worksheet and HSIP mapping are provided in the Appendix.



**Table 3**  
**MOTOR VEHICLE CRASH DATA SUMMARY<sup>a</sup>**

|                                   | River Road/<br>Minuteman Road/<br>Shattuck Road |
|-----------------------------------|---|
| Traffic Control Type <sup>b</sup> | TS  |
| <i>Year:</i>                      |   |
| 2014                              | 1   |
| 2015                              | 0   |
| 2016                              | 0   |
| 2017                              | 1   |
| <u>2018</u>                       | <u>1</u>  |
| Total                             | 3   |
| Average Rate <sup>c</sup>         | 0.60  |
| MassDOT Crash Rate <sup>d</sup>   | 0.78/0.73                                       |
| Significant <sup>e</sup>          | No  |
| <i>Type:</i>                      |   |
| Angle                             | 0   |
| Rear-End                          | 2   |
| Head-On                           | 0   |
| Sideswipe                         | 0   |
| Fixed Object                      | 1   |
| <u>Other</u>                      | <u>0</u>  |
| Total                             | 3   |
| <i>Conditions:</i>                |   |
| Clear                             | 3   |
| Cloudy                            | 0   |
| Snow/Ice                          | 0   |
| rain                              | 0   |
| <u>Unknown</u>                    | <u>0</u>  |
| Total                             | 3   |
| <i>Lighting:</i>                  |   |
| Daylight                          | 3   |
| Dawn/Dusk                         | 0   |
| Dark (lit)                        | 0   |
| Dark (unlit)                      | 0   |
| <u>Unknown</u>                    | <u>0</u>  |
| Total                             | 0   |
| <i>Day of Week:</i>               |   |
| Monday through Friday             | 3   |
| Saturday                          | 0   |
| <u>Sunday</u>                     | <u>0</u>  |
| Total                             | 3   |
| <i>Severity:</i>                  |   |
| Property Damage Only              | 2   |
| Personal Injury                   | 1   |
| Fatality                          | 0   |
| <u>Unknown</u>                    | <u>0</u>  |
| Total                             | 3   |

<sup>a</sup>Source: MassDOT Safety Management/Traffic Operations Unit records, 2014 through 2018.

<sup>b</sup>Traffic Control Type: U = unsignalized; TS = traffic signal.

<sup>c</sup>Crash rate per million vehicles entering the intersection.

<sup>d</sup>Statewide/District crash rate.

<sup>e</sup>The intersection crash rate is significant if it is found to exceed the MassDOT statewide and/or District crash rate for the MassDOT Highway Division District in which the Project is located (District 4).



## **FUTURE CONDITIONS**

Traffic volumes in the study area were projected to the year 2029, which reflects a seven-year planning horizon consistent with MassDOT's *Transportation Impact Assessment (TIA) Guidelines*. Independent of the Project, traffic volumes on the roadway network in the year 2029 under No-Build conditions include all existing traffic and new traffic resulting from background traffic growth. Anticipated Project-generated traffic volumes superimposed upon the 2028 No-Build traffic volumes reflect 2029 Build traffic volume conditions with the Project.

### **Future Traffic Growth**

Future traffic growth is a function of the expected land development in the immediate area and the surrounding region. Several methods can be used to estimate this growth. A procedure frequently employed estimates an annual percentage increase in traffic growth and applies that percentage to all traffic volumes under study. The drawback to such a procedure is that some turning volumes may actually grow at either a higher or a lower rate at particular intersections.

An alternative procedure identifies the location and type of planned development, estimates the traffic to be generated, and assigns it to the area roadway network. This procedure produces a more realistic estimate of growth for local traffic; however, potential population growth and development external to the study area would not be accounted for in the resulting traffic projections.

To provide a conservative analysis framework, both procedures were used, the salient components of which are described below.

### **Specific Development by Others**

The Planning Division of the Department of Planning & Economic Development of the Town of Andover was contacted in order to determine if there were any projects planned within the study area that would have an impact on future traffic volumes at the study intersections. Based on this discussion, the following projects were identified for inclusion in the future condition traffic volumes that were not complete at the time that that traffic counts that form the basis of this assessment were performed (2017):

- ***The Lodge at Andover, 30 Shattuck Road, Andover, Massachusetts.*** This project entails the construction of a 288-unit apartment community.
- ***Riverside Woods at Andover, 459 River Road, Andover, Massachusetts.*** This project will entail the construction of an age-qualified residential community consisting of 186 condominium units and 14 single-family homes.
- ***Commercial Development, 1 Minuteman Road and 161 River Road, Andover, Massachusetts.*** This project will entail the construction of a 24,000± sf mixed-use commercial development.
- ***Vicor Corporation Expansion, 400 Federal Street, Andover, Massachusetts.*** This project will entail the construction of an approximately 90,616± sf of manufacturing space.
- ***300 Minuteman Drive, Andover, Massachusetts.*** This project will entail the construction of a 224,500± sf medical/pharmaceutical manufacturing facility.



Traffic volumes associated with the aforementioned specific development project by others were obtained from their respective traffic studies or using trip-generation information available from the ITE<sup>5</sup> for the appropriate land use, and were assigned onto the study area roadway network based on existing traffic patterns.

No other developments were identified at this time that are expected to result in an increase in traffic within the study area beyond the general background traffic growth rate.

### **General Background Traffic Growth**

Traffic volume data compiled by MassDOT from Continuous Count Station No. 5124 were reviewed in order to determine general background traffic growth trends. Based on a review of this data, it was determined that traffic volumes within the study area have, on average, generally increase approximately 1.0 percent per year. In order to provide a prudent planning condition for the Project, a 1.0 percent per year compounded annual background traffic growth rate was used in order to account for future traffic growth and presently unforeseen development within the study area.

### **Roadway Improvement Projects**

MassDOT and the Town of Andover were contacted in order to determine if there were any planned future roadway improvement projects expected to be complete by 2029 within the study area. Based on these discussions, the only identified improvement project entails the upgrade to the existing traffic signal at the intersection of River Road with Shattuck Road and Minuteman Drive. Specifically, as mitigation for the 300 Minuteman Drive, the existing traffic signal timing will be optimized, as well as the following signal upgrades:

- Replace the existing inductive loop vehicle detection system with video detection (four (4) video cameras required)
- Replace the existing pedestrian signal indications (two (2)) with countdown-type indications
- Replace the existing pedestrian pushbuttons with ADA compliant audible devices

Future year traffic analyses reflect proposed improvements by others at this location.

### **No-Build Traffic Volumes**

The 2029 No-Build condition peak-hour traffic-volumes were developed by applying the 1.0 percent per year compounded annual background traffic growth rate to the 2022 Existing peak-hour traffic volumes and then adding the additional traffic associated with the identified specific development projects by others. The resulting 2029 No-Build weekday morning and evening peak-hour traffic volumes are shown on Figure 3.

## **PROJECT-GENERATED TRAFFIC**

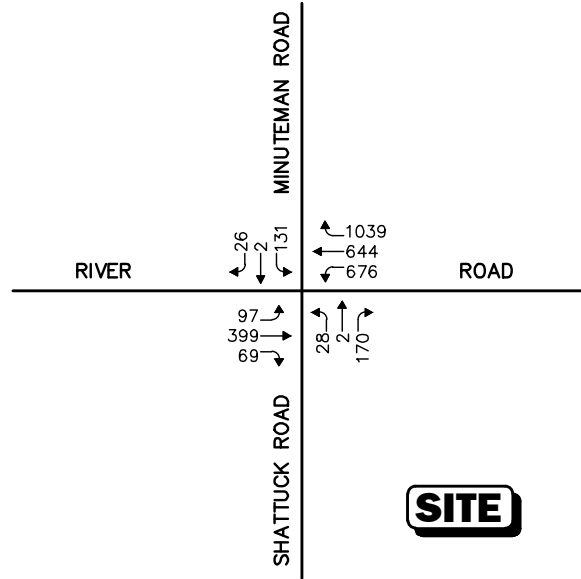
As proposed, the Project entails the renovation of an existing 67,990± sf office building that will be slightly reduced to 67,885± sf as a result of the proposed renovation, in order to accommodate research and development laboratory space. The project also includes a new two story addition that totals 95,640 sf that will provide manufacturing space supportive of the lab use. In order to identify the anticipated increase in

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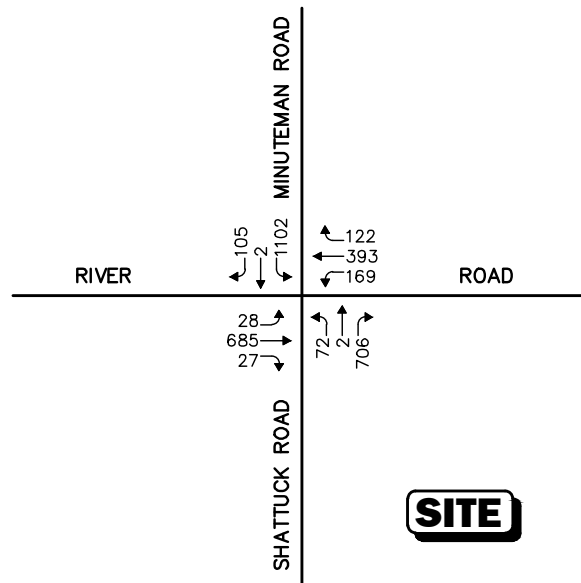
<sup>5</sup>Ibid 1.



WEEKDAY MORNING PEAK HOUR



WEEKDAY EVENING PEAK HOUR



Not To Scale



Figure 3  
2029 No-Build  
Peak-Hour Traffic Volumes

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both daily and peak hour traffic due to the renovation and expansion, trip-generation statistics published by the ITE<sup>6</sup> for similar land uses to the existing and proposed use of the site were utilized. Specifically, data for ITE Land Use Code (LUC) 710, *General Office Building*, LUC 140, *Manufacturing*, and LUC 760, *Research and Development Center*, was used to develop the traffic characteristics of the Project. It is noted that the existing office use was operational during the time that the data collection for this assessment were collected. Additionally, it is also noted that approximately 7,000± sf of the proposed manufacturing building would accommodate open atrium space that is not expected to result in any traffic generation, and as such was excluded from the trip generation calculations. Table 4 summarizes the anticipated trip generation increases associated with the Project.

**Table 4  
TRIP GENERATION SUMMARY**

| Time Period/Direction            | Vehicle Trips   |   |                       |
|----------------------------------|---|---|-----------------------|
|                                  | (A)<br>Existing Office Building<br>(67,990 sf) <sup>a</sup> | (B)<br>Proposed<br>Research &<br>Development<br>Facility<br>(163,525 sf) <sup>b</sup> | (A - B)<br>Difference |
| <i>Average Weekday Daily:</i>    | 830   | 1,174   | 344                   |
| <i>Weekday Morning Peak Hour</i> |   |   |                       |
| <i>Entering</i>                  | 106   | 103   | -3                    |
| <i>Exiting</i>                   | 14  | 27  | 13                    |
| <i>Total</i>                     | 120   | 130   | 10                    |
| <i>Weekday Evening Peak Hour</i> |   |   |                       |
| <i>Entering</i>                  | 21  | 31  | 10                    |
| <i>Exiting</i>                   | 100   | 102   | 2                     |
| <i>Total</i>                     | 121   | 133   | 12                    |

<sup>a</sup>Based on ITE LUC 710, *General Office Building*, 67,990 sf.

<sup>b</sup>Based on ITE LUC 760, *Research and Development Center*, 67,885 sf and LUC 140, *Manufacturing*, 88,640 sf.

As summarized in Table 4, in comparison to the existing office use, the proposed Project is expected to generate 344 additional weekday daily vehicle trips (172 entering and 172 exiting), including 10 new vehicle trips (3 fewer entering and 13 additional exiting) during the weekday morning peak hour, and 12 new vehicle trips (10 entering and 2 exiting) during the weekday evening peak hour.

<sup>6</sup>Ibid 1.



## **Trip Distribution and Assignment**

The directional distribution of generated trips to and from the Project site was determined based on a review of existing traffic patterns within the study area during the peak periods. This methodology is consistent with the commercial nature of the Project and the proximate abutting land use, and reflects traffic patterns during the peak hours. In general it is expected that 80 percent of Project-related traffic will arrive and depart from River Road to the east, towards the Interstate 93 (I-93) interchange, with the remaining 20 percent arriving and departing to and from the west on River Road. The additional traffic expected to be generated by the Project was assigned on the study area roadway network as shown on Figure 4.

## **Build Traffic Volumes**

The 2029 Build condition traffic volumes were developed by adding the traffic expected to be generated by the Project to the 2029 No-Build condition traffic volumes. The 2029 Build weekday morning and evening peak-hour traffic-volumes are graphically depicted on Figure 5.

## **TRAFFIC OPERATIONS ANALYSIS**

In order to assess the potential impact of the Project on the roadway network, a detailed traffic operations and vehicle queue analysis (“LOS analysis”) was performed at the study area intersections. Capacity analyses provide an indication of how well transportation facilities serve the traffic demands placed upon them, with vehicle queue analyses providing a secondary measure of the operational characteristics of an intersection or section of roadway under study.

In brief, six levels of service are defined for each type of facility. They are given letter designations ranging from A to F, with level-of-service (LOS) “A” representing the best operating conditions and LOS “F” representing congested or constrained operations. An LOS of “E” is representative of a transportation facility that is operating at its design capacity with an LOS of “D” generally defined as the limit of “acceptable” traffic operations. Since the level-of-service of a traffic facility is a function of the flows placed upon it, such a facility may operate at a wide range of levels of service depending on the time of day, day of week, or period of the year. The Synchro® intersection capacity analysis software, which is based on the analysis methodologies and procedures presented in the 2010 *Highway Capacity Manual* (HCM)<sup>7</sup> for signalized intersection, was used to complete the level-of-service and vehicle queue analyses.

## **Analysis Results**

Level-of-service and vehicle queue analyses were conducted for 2022 Existing, 2029 No-Build and 2029 Build conditions for the intersections within the study area. The results of the intersection capacity and vehicle queue analyses are summarized on Table 5, with the detailed analysis results presented in the Appendix. Project-related impacts at the study area intersections were identified as follows:

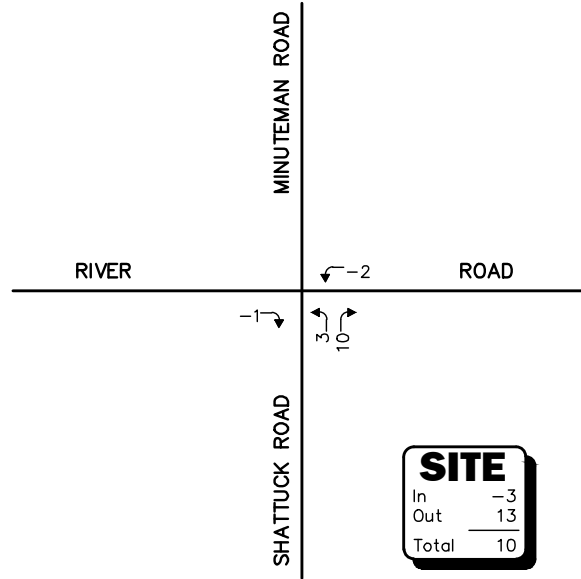
***River Road/Minuteman Road Road/Shattuck Road*** – As summarized in Table 5, the intersection of River Road with Minuteman Road and Shattuck Road currently operates at an overall LOS B and D during the weekday morning and weekday evening peak hours. Under future No-Build conditions, this location is projected to operate at an overall LOS B and E during the weekday morning and weekday evening peak hours. Under future Build conditions this location is projected to operate at LOS B and E, with Project-related traffic increases resulting in minimal increases to overall delays, of less than one second per vehicle.

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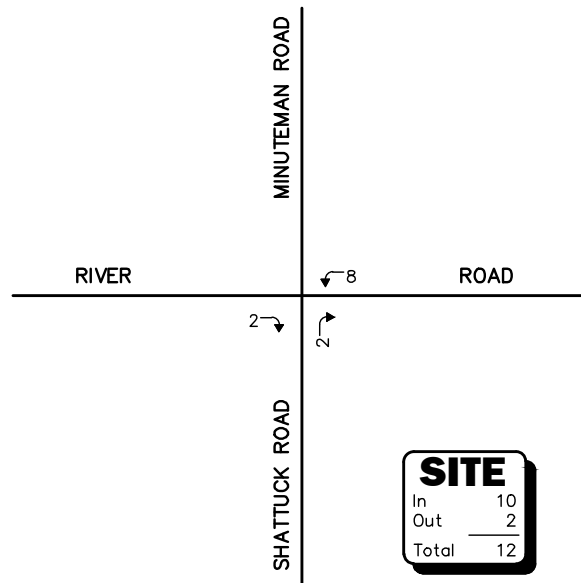
<sup>7</sup>*Highway Capacity Manual*, Transportation Research Board; Washington, DC; 2010.



WEEKDAY MORNING PEAK HOUR



WEEKDAY EVENING PEAK HOUR



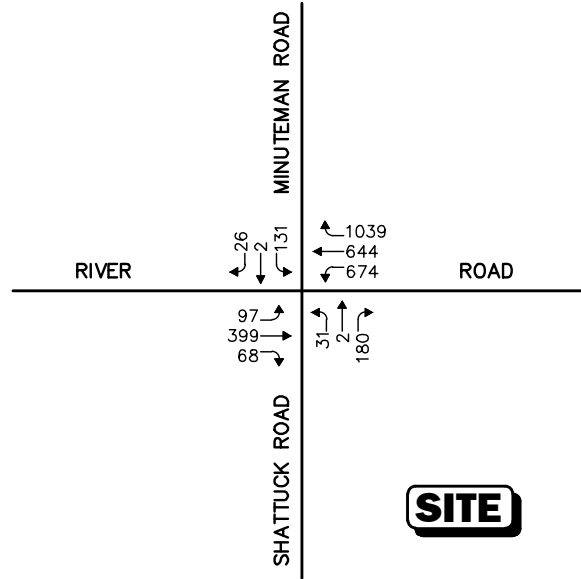
Not To Scale

Figure 4

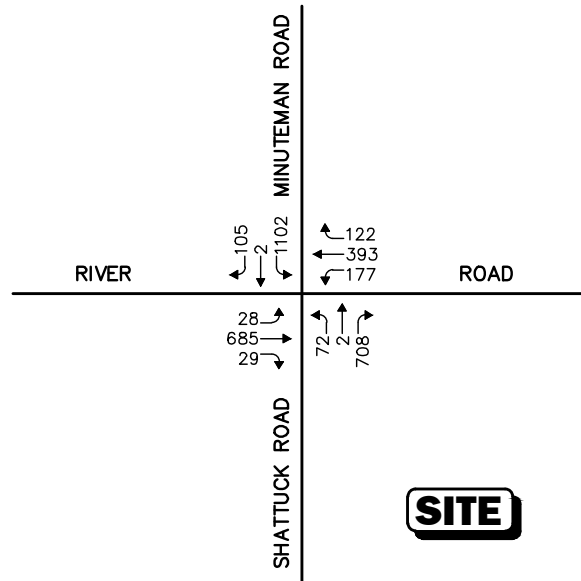


Project-Generated Peak-Hour Traffic Volumes

WEEKDAY MORNING PEAK HOUR



WEEKDAY EVENING PEAK HOUR



Not To Scale



Figure 5

2029 Build Peak-Hour Traffic Volumes

**Table 5**  
**SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY**

| Signalized Intersection/Peak Hour/Movement            | 2022 Existing    |                    |                  |   | 2029 No-Build |             |          |                                | 2029 Build |             |          |                                |
|---|------------------|--------------------|------------------|---|---------------|-------------|----------|--------------------------------|------------|-------------|----------|--------------------------------|
|   | V/C <sup>a</sup> | Delay <sup>b</sup> | LOS <sup>c</sup> | Queue <sup>d</sup><br>Avg./95 <sup>th</sup> | V/C           | Delay       | LOS      | Queue<br>Avg./95 <sup>th</sup> | V/C        | Delay       | LOS      | Queue<br>Avg./95 <sup>th</sup> |
| <b>River Road at Minuteman Road and Shattuck Road</b> |                  |                    |                  |   |               |             |          |                                |            |             |          |                                |
| <i>Weekday Morning:</i>                               |                  |                    |                  |   |               |             |          |                                |            |             |          |                                |
| Shattuck Road NB LT/TH                                | 0.22             | 34.9               | C                | 1/1   | 0.29          | 33.6        | C        | 1/2                            | 0.29       | 33.6        | C        | 1/2                            |
| Shattuck Road NB RT                                   | 0.03             | 34.0               | C                | 0/0   | 0.07          | 32.4        | C        | 0/1                            | 0.07       | 32.4        | C        | 0/1                            |
| Minuteman Road SB LT                                  | 0.33             | 34.8               | C                | 1/2   | 0.44          | 34.8        | C        | 2/3                            | 0.44       | 34.8        | C        | 2/3                            |
| Minuteman Road SB LT/TH                               | 0.34             | 34.8               | C                | 1/2   | 0.45          | 34.9        | C        | 2/3                            | 0.45       | 34.9        | C        | 2/3                            |
| Minuteman Road SB RT                                  | 0.02             | 0.0                | A                | 0/0   | 0.02          | 0.0         | A        | 0/0                            | 0.02       | 0.0         | A        | 0/0                            |
| River Road EB LT                                      | 0.43             | 36.2               | D                | 1/3   | 0.52          | 34.5        | C        | 2/4                            | 0.52       | 34.5        | C        | 2/4                            |
| River Road EB TH/RT                                   | 0.30             | 17.9               | B                | 3/5   | 0.44          | 22.5        | C        | 4/7                            | 0.44       | 22.5        | C        | 4/7                            |
| River Road WB LT                                      | 0.75             | 28.8               | C                | 5/6   | 0.80          | 27.2        | C        | 7/7                            | 0.80       | 27.2        | C        | 7/7                            |
| River Road WB TH                                      | 0.55             | 10.0               | B                | 7/9   | 0.79          | 15.5        | B        | 10/16                          | 0.79       | 15.5        | B        | 10/16                          |
| River Road WB RT                                      | 0.55             | 0.1                | A                | 0/0   | 0.73          | 0.3         | A        | 1/1                            | 0.73       | 0.3         | A        | 1/1                            |
| <b>Overall</b>  | --               | <b>14.6</b>        | <b>B</b>         | --  | --            | <b>16.3</b> | <b>B</b> | --                             | --         | <b>16.3</b> | <b>B</b> | --                             |
| <i>Weekday Evening:</i>                               |                  |                    |                  |   |               |             |          |                                |            |             |          |                                |
| Shattuck Road NB LT/TH                                | 0.56             | 35.8               | D                | 2/3   | 0.57          | 36.1        | D        | 2/3                            | 0.57       | 36.1        | D        | 2/3                            |
| Shattuck Road NB RT                                   | 0.80             | 30.6               | C                | 8/8   | 0.76          | 29.2        | C        | 7/10                           | 0.76       | 29.2        | C        | 7/10                           |
| Minuteman Road SB LT                                  | 0.94             | 53.2               | D                | 10/17                                       | 1.18          | >80.0       | F        | 16/24                          | 1.18       | >80.0       | F        | 16/24                          |
| Minuteman Road SB LT/TH                               | 0.94             | 53.5               | D                | 10/17                                       | 1.18          | >80.0       | F        | 16/24                          | 1.18       | >80.0       | F        | 16/24                          |
| Minuteman Road SB RT                                  | 0.04             | 0.0                | A                | 0/0   | 0.07          | 0.1         | A        | 0/0                            | 0.07       | 0.1         | A        | 0/0                            |
| River Road EB LT                                      | 0.33             | 39.3               | D                | 1/1   | 0.36          | 38.0        | D        | 1/2                            | 0.36       | 38.0        | D        | 1/2                            |
| River Road EB TH/RT                                   | 0.98             | 58.6               | E                | 8/12  | 1.01          | 65.2        | E        | 9/14                           | 1.01       | 65.2        | E        | 9/14                           |
| River Road WB LT                                      | 0.13             | 17.4               | B                | 1/1   | 0.34          | 20.9        | C        | 2/3                            | 0.34       | 20.9        | C        | 2/3                            |
| River Road WB TH                                      | 0.54             | 20.3               | C                | 5/13  | 0.71          | 27.9        | C        | 8/18                           | 0.71       | 27.9        | C        | 8/18                           |
| River Road WB RT                                      | 0.05             | 0.1                | A                | 0/0   | 0.09          | 0.1         | A        | 0/0                            | 0.09       | 0.1         | A        | 0/0                            |
| <b>Overall</b>  | --               | <b>41.4</b>        | <b>D</b>         | --  | --            | <b>66.0</b> | <b>E</b> | --                             | --         | <b>66.0</b> | <b>E</b> | --                             |

<sup>a</sup>Volume-to-capacity ratio.

<sup>b</sup>Control (signal) delay per vehicle in seconds.

<sup>c</sup>Level-of-Service.

<sup>d</sup>Queue length in vehicles.

EB = eastbound; WB = westbound; NB = northbound; SB = southbound; LT = left-turning movements; TH = through movements; RT = right-turning movements.



## **SUMMARY**

VAI has prepared a detailed assessment of the potential impacts on the transportation infrastructure associated with the renovation and expansion of an existing office building to accommodate a research and development laboratory at 1 Corporate Drive in Andover, Massachusetts. The following specific areas have been evaluated as they relate to the Project: i) access requirements; ii) potential off-site improvements; and iii) safety considerations; under existing and future conditions, both with and without the Project.

Based on this assessment, we have concluded the following with respect to the Project:

1. Using trip-generation statistics published by the Institute of Transportation Engineers (ITE)<sup>8</sup>, the Project is expected to generate 344 additional weekday daily vehicle trips (172 entering and 172 exiting), including 10 new vehicle trips (3 fewer entering and 13 additional exiting) during the weekday morning peak hour, and 12 new vehicle trips (10 entering and 2 exiting) during the weekday evening peak hour, as compared to the existing office use;
2. The Project is not expected to result in a significant impact (increase) on motorist delays or vehicle queuing over future conditions without the Project (No-Build conditions);
3. Independent of the Project, one or more movements at the River Road/Minuteman Road/Shattuck Road intersection were identified as operating at their design capacity (defined as a level-of-service (LOS) “E”) during the weekday evening peak-hour;
4. No apparent safety deficiencies were identified at the study intersection based on a review of motor vehicle crash data available from the Massachusetts Department of Transportation(MassDOT).

In consideration of the above, we have concluded that the Project can be accommodated within the confines of the existing transportation infrastructure with minimal impacts to area traffic operations, and recommend the following measures.

## **Recommendations**

### **Project Access**

Primary access to the Project site will continue to be provided by way of two unsignalized driveways that intersect the eastern side of Shattuck Road. The following recommendations are offered with respect to the design and operation of the Project site access and internal circulation:

- The Project site driveways should be a minimum of 24-feet in width or as required to accommodate the turning and maneuvering requirements of delivery trucks and the largest anticipated responding emergency vehicle as defined by the Andover Fire Department.
- Within the Project site, drive aisles should be a minimum of 23-feet where perpendicular parking is proposed in order to facilitate parking maneuvers, and should accommodate the turning and maneuvering requirements of delivery vehicles where appropriate.

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<sup>8</sup>*Trip Generation*, 11<sup>th</sup> Edition; Institute of Transportation Engineers; Washington, DC; 2017.



- All signs and pavement markings to be installed within the Project site shall conform to the applicable standards of the *Manual on Uniform Traffic Control Devices (MUTCD)*.<sup>9</sup>
- American with Disabilities Act (ADA) compliant wheelchair ramps should be provided at all pedestrian crossings where a sidewalk is provided.
- Signs and landscaping to be installed as a part of the Project within the intersection sight triangle areas of the Project site driveways should be designed and maintained so as not to restrict lines of sight.
- Snow windrows within the sight triangle areas of the Project site driveways should be promptly removed where such accumulations would impede sight lines.
- Consideration should be given to providing electric vehicle (EV) charging stations within the Project site.

### **Transportation Demand Management**

The Project site is ideally situated to take advantage of available public transportation opportunities in the area (MVRTA bus Route 37). In an effort to encourage the use of alternative modes of transportation to single-occupant vehicles and to promote healthy transportation options to employees of the Project, the following Transportation Demand Management (TDM) measures will be implemented or will be encouraged to be implemented as a part of the Project:

- A transportation coordinator will be assigned for the Project to coordinate the TDM program;
- Information regarding public transportation services, maps, schedules and fare information will be posted in a central location and/or otherwise made available to employees;
- The transportation coordinator will facilitate a rideshare matching program for employees to encourage carpooling;
- A “welcome packet” will be provided to employees detailing available commuter options and will include the contact information for the transportation coordinator and information to enroll in the employee rideshare program;
- Specific amenities should be considered to discourage off-site trips, including providing a break-room equipped with a microwave and refrigerator; offering direct deposit of paychecks; coordinating with a dry-cleaning service for on-site pick-up and delivery; allowing telecommuting or flexible work schedules; and other such measures to reduce overall traffic volumes and travel during peak traffic volume periods; and
- Secure bicycle parking should be provided within the Project site and should include an exterior bicycle rack and weather protected bicycle parking within the building.

With implementation of the above recommendations, safe and efficient access can be provided to the Project site and the Project can be accommodated within the confines of the existing transportation infrastructure.

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<sup>9</sup>*Manual on Uniform Traffic Control Devices (MUTCD)*; Federal Highway Administration; Washington, D.C.; 2009.



## APPENDIX

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AUTOMATIC TRAFFIC RECORDER COUNT DATA  
MANUAL TURNING MOVEMENT COUNT DATA  
SEASONAL ADJUSTMENT DATA  
PUBLIC TRANSPORTATION INFORMATION  
MASSDOT CRASH RATE WORKSHEETS AND HIGH CRASH LOCATION MAPPING  
BACKGROUND DEVELOPMENT TRAFFIC-VOLUME NETWORKS  
GENERAL BACKGROUND TRAFFIC GROWTH  
TRIP-GENERATION CALCULATIONS  
CAPACITY ANALYSIS WORKSHEETS



AUTOMATIC TRAFFIC RECORDER COUNT DATA

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# Accurate Counts

978-664-2565

Location : River Road  
 Location : West of Site Driveway  
 City/State: Andover, MA

7613VOL1

| Start Time | 11/2/2017 Thu | EB      |           | Hour Totals |           | WB      |           | Hour Totals |           | Combined Totals |           |
|------------|---------------|---------|-----------|-------------|-----------|---------|-----------|-------------|-----------|-----------------|-----------|
|            |               | Morning | Afternoon | Morning     | Afternoon | Morning | Afternoon | Morning     | Afternoon | Morning         | Afternoon |
| 12:00      |               | 5       | 47        |             |           | 13      | 52        |             |           |                 |           |
| 12:15      |               | 4       | 73        |             |           | 7       | 61        |             |           |                 |           |
| 12:30      |               | 3       | 77        |             |           | 5       | 58        |             |           |                 |           |
| 12:45      |               | 2       | 72        | 14          | 269       | 1       | 57        | 26          | 228       | 40              | 497       |
| 01:00      |               | 1       | 62        |             |           | 3       | 55        |             |           |                 |           |
| 01:15      |               | 3       | 56        |             |           | 1       | 59        |             |           |                 |           |
| 01:30      |               | 2       | 63        |             |           | 0       | 49        |             |           |                 |           |
| 01:45      |               | 2       | 58        | 8           | 239       | 9       | 57        | 13          | 220       | 21              | 459       |
| 02:00      |               | 3       | 55        |             |           | 4       | 53        |             |           |                 |           |
| 02:15      |               | 2       | 81        |             |           | 2       | 61        |             |           |                 |           |
| 02:30      |               | 1       | 85        |             |           | 1       | 59        |             |           |                 |           |
| 02:45      |               | 0       | 102       | 6           | 323       | 0       | 62        | 7           | 235       | 13              | 558       |
| 03:00      |               | 0       | 95        |             |           | 2       | 65        |             |           |                 |           |
| 03:15      |               | 2       | 107       |             |           | 0       | 68        |             |           |                 |           |
| 03:30      |               | 3       | 121       |             |           | 4       | 96        |             |           |                 |           |
| 03:45      |               | 1       | 103       | 6           | 426       | 2       | 73        | 8           | 302       | 14              | 728       |
| 04:00      |               | 3       | 104       |             |           | 0       | 84        |             |           |                 |           |
| 04:15      |               | 4       | 104       |             |           | 4       | 82        |             |           |                 |           |
| 04:30      |               | 12      | 169       |             |           | 6       | 95        |             |           |                 |           |
| 04:45      |               | 12      | 111       | 31          | 488       | 4       | 81        | 14          | 342       | 45              | 830       |
| 05:00      |               | 5       | 161       |             |           | 3       | 108       |             |           |                 |           |
| 05:15      |               | 13      | 120       |             |           | 17      | 111       |             |           |                 |           |
| 05:30      |               | 33      | 102       |             |           | 11      | 99        |             |           |                 |           |
| 05:45      |               | 21      | 105       | 72          | 488       | 31      | 89        | 62          | 407       | 134             | 895       |
| 06:00      |               | 30      | 91        |             |           | 26      | 110       |             |           |                 |           |
| 06:15      |               | 31      | 69        |             |           | 22      | 89        |             |           |                 |           |
| 06:30      |               | 58      | 48        |             |           | 55      | 94        |             |           |                 |           |
| 06:45      |               | 82      | 57        | 201         | 265       | 83      | 45        | 186         | 338       | 387             | 603       |
| 07:00      |               | 62      | 46        |             |           | 102     | 62        |             |           |                 |           |
| 07:15      |               | 83      | 30        |             |           | 124     | 38        |             |           |                 |           |
| 07:30      |               | 95      | 34        |             |           | 142     | 38        |             |           |                 |           |
| 07:45      |               | 97      | 25        | 337         | 135       | 161     | 41        | 529         | 179       | 866             | 314       |
| 08:00      |               | 108     | 40        |             |           | 134     | 39        |             |           |                 |           |
| 08:15      |               | 123     | 17        |             |           | 105     | 32        |             |           |                 |           |
| 08:30      |               | 112     | 15        |             |           | 103     | 43        |             |           |                 |           |
| 08:45      |               | 95      | 28        | 438         | 100       | 102     | 33        | 444         | 147       | 882             | 247       |
| 09:00      |               | 70      | 37        |             |           | 60      | 40        |             |           |                 |           |
| 09:15      |               | 58      | 20        |             |           | 60      | 16        |             |           |                 |           |
| 09:30      |               | 55      | 12        |             |           | 45      | 19        |             |           |                 |           |
| 09:45      |               | 60      | 17        | 243         | 86        | 51      | 19        | 216         | 94        | 459             | 180       |
| 10:00      |               | 46      | 16        |             |           | 31      | 12        |             |           |                 |           |
| 10:15      |               | 42      | 8         |             |           | 40      | 18        |             |           |                 |           |
| 10:30      |               | 54      | 10        |             |           | 38      | 12        |             |           |                 |           |
| 10:45      |               | 58      | 10        | 200         | 44        | 45      | 9         | 154         | 51        | 354             | 95        |
| 11:00      |               | 47      | 15        |             |           | 48      | 26        |             |           |                 |           |
| 11:15      |               | 74      | 8         |             |           | 51      | 25        |             |           |                 |           |
| 11:30      |               | 64      | 5         |             |           | 46      | 10        |             |           |                 |           |
| 11:45      |               | 61      | 16        | 246         | 44        | 36      | 7         | 181         | 68        | 427             | 112       |
| Total      |               | 1802    | 2907      |             |           | 1840    | 2611      |             |           | 3642            | 5518      |
| Percent    |               | 38.3%   | 61.7%     |             |           | 41.3%   | 58.7%     |             |           | 39.8%           | 60.2%     |

# Accurate Counts

978-664-2565

Location : River Road  
 Location : West of Site Driveway  
 City/State: Andover, MA

7613VOL1

| Start Time | 11/3/2017<br>Fri | EB      |           | Hour Totals |           | WB      |           | Hour Totals |           | Combined Totals |           |
|------------|------------------|---------|-----------|-------------|-----------|---------|-----------|-------------|-----------|-----------------|-----------|
|            |                  | Morning | Afternoon | Morning     | Afternoon | Morning | Afternoon | Morning     | Afternoon | Morning         | Afternoon |
| 12:00      |                  | 6       | 54        |             |           | 10      | 52        |             |           |                 |           |
| 12:15      |                  | 5       | 74        |             |           | 5       | 62        |             |           |                 |           |
| 12:30      |                  | 2       | 65        |             |           | 6       | 48        |             |           |                 |           |
| 12:45      |                  | 0       | 73        | 13          | 266       | 9       | 64        | 30          | 226       | 43              | 492       |
| 01:00      |                  | 1       | 68        |             |           | 7       | 36        |             |           |                 |           |
| 01:15      |                  | 5       | 59        |             |           | 4       | 52        |             |           |                 |           |
| 01:30      |                  | 3       | 67        |             |           | 4       | 53        |             |           |                 |           |
| 01:45      |                  | 0       | 65        | 9           | 259       | 10      | 52        | 25          | 193       | 34              | 452       |
| 02:00      |                  | 3       | 73        |             |           | 4       | 62        |             |           |                 |           |
| 02:15      |                  | 5       | 95        |             |           | 2       | 71        |             |           |                 |           |
| 02:30      |                  | 1       | 81        |             |           | 3       | 67        |             |           |                 |           |
| 02:45      |                  | 0       | 102       | 9           | 351       | 1       | 66        | 10          | 266       | 19              | 617       |
| 03:00      |                  | 0       | 91        |             |           | 8       | 88        |             |           |                 |           |
| 03:15      |                  | 1       | 112       |             |           | 7       | 79        |             |           |                 |           |
| 03:30      |                  | 3       | 138       |             |           | 2       | 110       |             |           |                 |           |
| 03:45      |                  | 2       | 104       | 6           | 445       | 1       | 90        | 18          | 367       | 24              | 812       |
| 04:00      |                  | 1       | 125       |             |           | 2       | 104       |             |           |                 |           |
| 04:15      |                  | 6       | 107       |             |           | 2       | 91        |             |           |                 |           |
| 04:30      |                  | 7       | 137       |             |           | 5       | 115       |             |           |                 |           |
| 04:45      |                  | 14      | 112       | 28          | 481       | 4       | 122       | 13          | 432       | 41              | 913       |
| 05:00      |                  | 11      | 131       |             |           | 3       | 103       |             |           |                 |           |
| 05:15      |                  | 18      | 119       |             |           | 11      | 116       |             |           |                 |           |
| 05:30      |                  | 21      | 112       |             |           | 15      | 93        |             |           |                 |           |
| 05:45      |                  | 24      | 93        | 74          | 455       | 19      | 61        | 48          | 373       | 122             | 828       |
| 06:00      |                  | 24      | 108       |             |           | 28      | 65        |             |           |                 |           |
| 06:15      |                  | 36      | 69        |             |           | 23      | 49        |             |           |                 |           |
| 06:30      |                  | 55      | 53        |             |           | 56      | 40        |             |           |                 |           |
| 06:45      |                  | 62      | 43        | 177         | 273       | 89      | 43        | 196         | 197       | 373             | 470       |
| 07:00      |                  | 62      | 56        |             |           | 75      | 28        |             |           |                 |           |
| 07:15      |                  | 86      | 29        |             |           | 93      | 29        |             |           |                 |           |
| 07:30      |                  | 86      | 33        |             |           | 107     | 50        |             |           |                 |           |
| 07:45      |                  | 98      | 27        | 332         | 145       | 106     | 29        | 381         | 136       | 713             | 281       |
| 08:00      |                  | 87      | 33        |             |           | 113     | 30        |             |           |                 |           |
| 08:15      |                  | 113     | 31        |             |           | 86      | 36        |             |           |                 |           |
| 08:30      |                  | 101     | 18        |             |           | 69      | 37        |             |           |                 |           |
| 08:45      |                  | 96      | 14        | 397         | 96        | 69      | 29        | 337         | 132       | 734             | 228       |
| 09:00      |                  | 73      | 22        |             |           | 51      | 35        |             |           |                 |           |
| 09:15      |                  | 71      | 23        |             |           | 54      | 39        |             |           |                 |           |
| 09:30      |                  | 62      | 23        |             |           | 40      | 21        |             |           |                 |           |
| 09:45      |                  | 48      | 19        | 254         | 87        | 45      | 22        | 190         | 117       | 444             | 204       |
| 10:00      |                  | 46      | 29        |             |           | 33      | 23        |             |           |                 |           |
| 10:15      |                  | 52      | 17        |             |           | 39      | 20        |             |           |                 |           |
| 10:30      |                  | 44      | 17        |             |           | 43      | 21        |             |           |                 |           |
| 10:45      |                  | 45      | 19        | 187         | 82        | 26      | 17        | 141         | 81        | 328             | 163       |
| 11:00      |                  | 50      | 13        |             |           | 31      | 33        |             |           |                 |           |
| 11:15      |                  | 61      | 6         |             |           | 39      | 23        |             |           |                 |           |
| 11:30      |                  | 64      | 7         |             |           | 41      | 20        |             |           |                 |           |
| 11:45      |                  | 59      | 10        | 234         | 36        | 51      | 10        | 162         | 86        | 396             | 122       |
| Total      |                  | 1720    | 2976      |             |           | 1551    | 2606      |             |           | 3271            | 5582      |
| Percent    |                  | 36.6%   | 63.4%     |             |           | 37.3%   | 62.7%     |             |           | 36.9%           | 63.1%     |

# Accurate Counts

978-664-2565

Location : River Road  
 Location : West of Site Driveway  
 City/State: Andover, MA

7613VOL1

| Start Time  | 11/4/2017 |  | EB      |           | Hour Totals |           | WB      |           | Hour Totals |           | Combined Totals |           |
|-------------|-----------|--|---------|-----------|-------------|-----------|---------|-----------|-------------|-----------|-----------------|-----------|
|             | Sat       |  | Morning | Afternoon | Morning     | Afternoon | Morning | Afternoon | Morning     | Afternoon | Morning         | Afternoon |
| 12:00       |           |  | 6       | 60        |             |           | 12      | 42        |             |           |                 |           |
| 12:15       |           |  | 7       | 58        |             |           | 11      | 38        |             |           |                 |           |
| 12:30       |           |  | 6       | 46        |             |           | 12      | 54        |             |           |                 |           |
| 12:45       |           |  | 3       | 68        | 22          | 232       | 5       | 45        | 40          | 179       | 62              | 411       |
| 01:00       |           |  | 2       | 47        |             |           | 10      | 46        |             |           |                 |           |
| 01:15       |           |  | 1       | 55        |             |           | 4       | 44        |             |           |                 |           |
| 01:30       |           |  | 3       | 44        |             |           | 4       | 36        |             |           |                 |           |
| 01:45       |           |  | 2       | 70        | 8           | 216       | 7       | 61        | 25          | 187       | 33              | 403       |
| 02:00       |           |  | 6       | 58        |             |           | 10      | 51        |             |           |                 |           |
| 02:15       |           |  | 3       | 54        |             |           | 1       | 51        |             |           |                 |           |
| 02:30       |           |  | 3       | 50        |             |           | 4       | 50        |             |           |                 |           |
| 02:45       |           |  | 5       | 53        | 17          | 215       | 3       | 55        | 18          | 207       | 35              | 422       |
| 03:00       |           |  | 0       | 54        |             |           | 6       | 46        |             |           |                 |           |
| 03:15       |           |  | 2       | 39        |             |           | 3       | 51        |             |           |                 |           |
| 03:30       |           |  | 2       | 42        |             |           | 1       | 57        |             |           |                 |           |
| 03:45       |           |  | 5       | 51        | 9           | 186       | 5       | 57        | 15          | 211       | 24              | 397       |
| 04:00       |           |  | 1       | 42        |             |           | 0       | 41        |             |           |                 |           |
| 04:15       |           |  | 0       | 35        |             |           | 1       | 50        |             |           |                 |           |
| 04:30       |           |  | 7       | 41        |             |           | 0       | 42        |             |           |                 |           |
| 04:45       |           |  | 10      | 47        | 18          | 165       | 2       | 29        | 3           | 162       | 21              | 327       |
| 05:00       |           |  | 3       | 52        |             |           | 5       | 42        |             |           |                 |           |
| 05:15       |           |  | 7       | 51        |             |           | 3       | 39        |             |           |                 |           |
| 05:30       |           |  | 14      | 39        |             |           | 5       | 45        |             |           |                 |           |
| 05:45       |           |  | 24      | 57        | 48          | 199       | 4       | 52        | 17          | 178       | 65              | 377       |
| 06:00       |           |  | 11      | 52        |             |           | 16      | 38        |             |           |                 |           |
| 06:15       |           |  | 13      | 44        |             |           | 14      | 37        |             |           |                 |           |
| 06:30       |           |  | 18      | 40        |             |           | 10      | 45        |             |           |                 |           |
| 06:45       |           |  | 24      | 36        | 66          | 172       | 9       | 35        | 49          | 155       | 115             | 327       |
| 07:00       |           |  | 16      | 31        |             |           | 10      | 34        |             |           |                 |           |
| 07:15       |           |  | 15      | 24        |             |           | 14      | 22        |             |           |                 |           |
| 07:30       |           |  | 24      | 23        |             |           | 18      | 38        |             |           |                 |           |
| 07:45       |           |  | 43      | 24        | 98          | 102       | 26      | 75        | 68          | 169       | 166             | 271       |
| 08:00       |           |  | 25      | 20        |             |           | 27      | 81        |             |           |                 |           |
| 08:15       |           |  | 38      | 20        |             |           | 28      | 94        |             |           |                 |           |
| 08:30       |           |  | 49      | 20        |             |           | 32      | 30        |             |           |                 |           |
| 08:45       |           |  | 50      | 19        | 162         | 79        | 44      | 35        | 131         | 240       | 293             | 319       |
| 09:00       |           |  | 42      | 22        |             |           | 28      | 26        |             |           |                 |           |
| 09:15       |           |  | 43      | 17        |             |           | 29      | 25        |             |           |                 |           |
| 09:30       |           |  | 51      | 12        |             |           | 25      | 22        |             |           |                 |           |
| 09:45       |           |  | 51      | 19        | 187         | 70        | 29      | 17        | 111         | 90        | 298             | 160       |
| 10:00       |           |  | 44      | 14        |             |           | 43      | 26        |             |           |                 |           |
| 10:15       |           |  | 67      | 11        |             |           | 27      | 20        |             |           |                 |           |
| 10:30       |           |  | 59      | 11        |             |           | 40      | 18        |             |           |                 |           |
| 10:45       |           |  | 55      | 11        | 225         | 47        | 34      | 16        | 144         | 80        | 369             | 127       |
| 11:00       |           |  | 55      | 10        |             |           | 40      | 23        |             |           |                 |           |
| 11:15       |           |  | 48      | 9         |             |           | 62      | 17        |             |           |                 |           |
| 11:30       |           |  | 61      | 9         |             |           | 34      | 12        |             |           |                 |           |
| 11:45       |           |  | 62      | 12        | 226         | 40        | 42      | 6         | 178         | 58        | 404             | 98        |
| Total       |           |  | 1086    | 1723      |             |           | 799     | 1916      |             |           | 1885            | 3639      |
| Percent     |           |  | 38.7%   | 61.3%     |             |           | 29.4%   | 70.6%     |             |           | 34.1%           | 65.9%     |
| Grand Total |           |  | 4608    | 7606      |             |           | 4190    | 7133      |             |           | 8798            | 14739     |
| Percent     |           |  | 37.7%   | 62.3%     |             |           | 37.0%   | 63.0%     |             |           | 37.4%           | 62.6%     |

ADT                      ADT 7,846                      AADT 7,846

# Accurate Counts

978-664-2565

Location : River Road  
 Location : West of Site Driveway  
 City/State: Andover, MA

7613VOL1

| Start Time | 10/30/2017 |    | Tue |    | Wed |    | Thu   |       | Fri   |       | Sat   |       | Sun |    | Week Average |       |
|------------|------------|----|-----|----|-----|----|-------|-------|-------|-------|-------|-------|-----|----|--------------|-------|
|            | EB         | WB | EB  | WB | EB  | WB | EB    | WB    | EB    | WB    | EB    | WB    | EB  | WB | EB           | WB    |
| 12:00 AM   | *          | *  | *   | *  | *   | *  | 14    | 26    | 13    | 30    | 22    | 40    | *   | *  | 16           | 32    |
| 01:00      | *          | *  | *   | *  | *   | *  | 8     | 13    | 9     | 25    | 8     | 25    | *   | *  | 8            | 21    |
| 02:00      | *          | *  | *   | *  | *   | *  | 6     | 7     | 9     | 10    | 17    | 18    | *   | *  | 11           | 12    |
| 03:00      | *          | *  | *   | *  | *   | *  | 6     | 8     | 6     | 18    | 9     | 15    | *   | *  | 7            | 14    |
| 04:00      | *          | *  | *   | *  | *   | *  | 31    | 14    | 28    | 13    | 18    | 3     | *   | *  | 26           | 10    |
| 05:00      | *          | *  | *   | *  | *   | *  | 72    | 62    | 74    | 48    | 48    | 17    | *   | *  | 65           | 42    |
| 06:00      | *          | *  | *   | *  | *   | *  | 201   | 186   | 177   | 196   | 66    | 49    | *   | *  | 148          | 144   |
| 07:00      | *          | *  | *   | *  | *   | *  | 337   | 529   | 332   | 381   | 98    | 68    | *   | *  | 256          | 326   |
| 08:00      | *          | *  | *   | *  | *   | *  | 438   | 444   | 397   | 337   | 162   | 131   | *   | *  | 332          | 304   |
| 09:00      | *          | *  | *   | *  | *   | *  | 243   | 216   | 254   | 190   | 187   | 111   | *   | *  | 228          | 172   |
| 10:00      | *          | *  | *   | *  | *   | *  | 200   | 154   | 187   | 141   | 225   | 144   | *   | *  | 204          | 146   |
| 11:00      | *          | *  | *   | *  | *   | *  | 246   | 181   | 234   | 162   | 226   | 178   | *   | *  | 235          | 174   |
| 12:00 PM   | *          | *  | *   | *  | *   | *  | 269   | 228   | 266   | 226   | 232   | 179   | *   | *  | 256          | 211   |
| 01:00      | *          | *  | *   | *  | *   | *  | 239   | 220   | 259   | 193   | 216   | 187   | *   | *  | 238          | 200   |
| 02:00      | *          | *  | *   | *  | *   | *  | 323   | 235   | 351   | 266   | 215   | 207   | *   | *  | 296          | 236   |
| 03:00      | *          | *  | *   | *  | *   | *  | 426   | 302   | 445   | 367   | 186   | 211   | *   | *  | 352          | 293   |
| 04:00      | *          | *  | *   | *  | *   | *  | 488   | 342   | 481   | 432   | 165   | 162   | *   | *  | 378          | 312   |
| 05:00      | *          | *  | *   | *  | *   | *  | 488   | 407   | 455   | 373   | 199   | 178   | *   | *  | 381          | 319   |
| 06:00      | *          | *  | *   | *  | *   | *  | 265   | 338   | 273   | 197   | 172   | 155   | *   | *  | 237          | 230   |
| 07:00      | *          | *  | *   | *  | *   | *  | 135   | 179   | 145   | 136   | 102   | 169   | *   | *  | 127          | 161   |
| 08:00      | *          | *  | *   | *  | *   | *  | 100   | 147   | 96    | 132   | 79    | 240   | *   | *  | 92           | 173   |
| 09:00      | *          | *  | *   | *  | *   | *  | 86    | 94    | 87    | 117   | 70    | 90    | *   | *  | 81           | 100   |
| 10:00      | *          | *  | *   | *  | *   | *  | 44    | 51    | 82    | 81    | 47    | 80    | *   | *  | 58           | 71    |
| 11:00      | *          | *  | *   | *  | *   | *  | 44    | 68    | 36    | 86    | 40    | 58    | *   | *  | 40           | 71    |
| Lane       | 0          | 0  | 0   | 0  | 0   | 0  | 4709  | 4451  | 4696  | 4157  | 2809  | 2715  | 0   | 0  | 4072         | 3774  |
| Day        | 0          | 0  | 0   | 0  | 0   | 0  | 9160  | 8853  | 8853  | 8853  | 5524  | 5524  | 0   | 0  | 7846         | 7846  |
| AM Peak    | -          | -  | -   | -  | -   | -  | 08:00 | 07:00 | 08:00 | 07:00 | 11:00 | 11:00 | -   | -  | 08:00        | 07:00 |
| Vol.       | -          | -  | -   | -  | -   | -  | 438   | 529   | 397   | 381   | 226   | 178   | -   | -  | 332          | 326   |
| PM Peak    | -          | -  | -   | -  | -   | -  | 16:00 | 17:00 | 16:00 | 16:00 | 12:00 | 20:00 | -   | -  | 17:00        | 17:00 |
| Vol.       | -          | -  | -   | -  | -   | -  | 488   | 407   | 481   | 432   | 232   | 240   | -   | -  | 381          | 319   |

|             |           |            |   |      |      |      |   |      |
|-------------|-----------|------------|---|------|------|------|---|------|
| Comb. Total | 0         | 0          | 0 | 9160 | 8853 | 5524 | 0 | 7846 |
| ADT         | ADT 7,846 | AADT 7,846 |   |      |      |      |   |      |

# Accurate Counts

Location : Minuteman Drive NB  
 Location : North of River Road  
 City/State: Andover, MA

978-664-2565

7613VOLNB2

| Start Time            | 10/26/201   |            | 10/27/201   |            | 10/28/201  |            | Daily Average |            |   |       |       |
|-----------------------|-------------|------------|-------------|------------|------------|------------|---------------|------------|---|-------|-------|
|                       | Thu A.M.    | P.M.       | Fri A.M.    | P.M.       | Sat A.M.   | P.M.       | A.M.          | P.M.       |   |       |       |
| 12:00                 | 4           | 40         | 2           | 22         | 4          | 4          | 3             | 22         |   |       |       |
| 12:15                 | 1           | 33         | 0           | 43         | 2          | 8          | 1             | 28         |   |       |       |
| 12:30                 | 1           | 47         | 1           | 44         | 4          | 13         | 2             | 35         |   |       |       |
| 12:45                 | 1           | 54         | 0           | 57         | 2          | 11         | 1             | 41         |   |       |       |
| 01:00                 | 2           | 38         | 1           | 62         | 1          | 8          | 1             | 36         |   |       |       |
| 01:15                 | 4           | 42         | 0           | 50         | 8          | 10         | 4             | 34         |   |       |       |
| 01:30                 | 1           | 34         | 0           | 43         | 5          | 10         | 2             | 29         |   |       |       |
| 01:45                 | 1           | 37         | 3           | 47         | 0          | 10         | 1             | 31         |   |       |       |
| 02:00                 | 1           | 26         | 0           | 28         | 2          | 10         | 1             | 21         |   |       |       |
| 02:15                 | 1           | 22         | 0           | 28         | 4          | 13         | 2             | 21         |   |       |       |
| 02:30                 | 2           | 28         | 1           | 24         | 3          | 11         | 2             | 21         |   |       |       |
| 02:45                 | 0           | 27         | 0           | 27         | 0          | 11         | 0             | 22         |   |       |       |
| 03:00                 | 0           | 19         | 0           | 19         | 0          | 10         | 0             | 16         |   |       |       |
| 03:15                 | 1           | 31         | 3           | 33         | 3          | 7          | 2             | 24         |   |       |       |
| 03:30                 | 6           | 27         | 2           | 9          | 3          | 8          | 4             | 15         |   |       |       |
| 03:45                 | 9           | 38         | 8           | 13         | 5          | 9          | 7             | 20         |   |       |       |
| 04:00                 | 4           | 35         | 1           | 22         | 4          | 6          | 3             | 21         |   |       |       |
| 04:15                 | 4           | 39         | 4           | 11         | 2          | 10         | 3             | 20         |   |       |       |
| 04:30                 | 11          | 19         | 13          | 17         | 2          | 4          | 9             | 13         |   |       |       |
| 04:45                 | 29          | 28         | 28          | 23         | 7          | 5          | 21            | 19         |   |       |       |
| 05:00                 | 23          | 17         | 17          | 20         | 3          | 5          | 14            | 14         |   |       |       |
| 05:15                 | 28          | 13         | 28          | 15         | 7          | 6          | 21            | 11         |   |       |       |
| 05:30                 | 37          | 10         | 38          | 14         | 7          | 2          | 27            | 9          |   |       |       |
| 05:45                 | 95          | 19         | 81          | 13         | 7          | 4          | 61            | 12         |   |       |       |
| 06:00                 | 49          | 18         | 43          | 13         | 10         | 7          | 34            | 13         |   |       |       |
| 06:15                 | 36          | 10         | 46          | 14         | 1          | 4          | 28            | 9          |   |       |       |
| 06:30                 | 51          | 10         | 42          | 10         | 7          | 5          | 33            | 8          |   |       |       |
| 06:45                 | 101         | 10         | 82          | 15         | 11         | 8          | 65            | 11         |   |       |       |
| 07:00                 | 102         | 10         | 95          | 15         | 5          | 7          | 67            | 11         |   |       |       |
| 07:15                 | 133         | 25         | 127         | 11         | 6          | 6          | 89            | 14         |   |       |       |
| 07:30                 | 164         | 13         | 174         | 5          | 8          | 8          | 115           | 9          |   |       |       |
| 07:45                 | 222         | 7          | 204         | 9          | 7          | 13         | 144           | 10         |   |       |       |
| 08:00                 | 196         | 10         | 184         | 12         | 6          | 3          | 129           | 8          |   |       |       |
| 08:15                 | 228         | 11         | 187         | 15         | 6          | 7          | 140           | 11         |   |       |       |
| 08:30                 | 247         | 19         | 180         | 16         | 5          | 7          | 144           | 14         |   |       |       |
| 08:45                 | 240         | 13         | 171         | 10         | 12         | 11         | 141           | 11         |   |       |       |
| 09:00                 | 221         | 8          | 147         | 9          | 4          | 6          | 124           | 8          |   |       |       |
| 09:15                 | 125         | 9          | 118         | 7          | 6          | 8          | 83            | 8          |   |       |       |
| 09:30                 | 104         | 9          | 61          | 8          | 7          | 5          | 57            | 7          |   |       |       |
| 09:45                 | 87          | 9          | 52          | 7          | 13         | 5          | 51            | 7          |   |       |       |
| 10:00                 | 54          | 3          | 45          | 5          | 7          | 2          | 35            | 3          |   |       |       |
| 10:15                 | 53          | 7          | 44          | 9          | 9          | 7          | 35            | 8          |   |       |       |
| 10:30                 | 32          | 6          | 22          | 9          | 5          | 10         | 20            | 8          |   |       |       |
| 10:45                 | 44          | 7          | 20          | 7          | 6          | 11         | 23            | 8          |   |       |       |
| 11:00                 | 27          | 1          | 31          | 6          | 6          | 9          | 21            | 5          |   |       |       |
| 11:15                 | 35          | 1          | 19          | 6          | 8          | 2          | 21            | 3          |   |       |       |
| 11:30                 | 38          | 4          | 28          | 6          | 7          | 3          | 24            | 4          |   |       |       |
| 11:45                 | 30          | 3          | 32          | 8          | 7          | 7          | 23            | 6          |   |       |       |
| <b>Total</b>          | <b>2885</b> | <b>946</b> | <b>2385</b> | <b>916</b> | <b>254</b> | <b>356</b> | <b>1838</b>   | <b>739</b> |   |       |       |
| <b>Combined Total</b> | <b>3831</b> |            | <b>3301</b> |            | <b>610</b> |            | <b>2577</b>   |            |   |       |       |
| Peak                  | 08:15       | 00:30      | -           | 07:45      | 00:30      | -          | 09:30         | 02:00      | - | 07:45 | 00:30 |
| Vol.                  | 936         | 181        | -           | 755        | 213        | -          | 36            | 45         | - | 557   | 146   |
| P.H.F.                | 0.947       | 0.838      |             | 0.925      | 0.859      |            | 0.692         | 0.865      |   | 0.967 | 0.890 |
| ADT                   | ADT 2,581   |            | AADT 2,581  |            |            |            |               |            |   |       |       |



# Accurate Counts

Location : Minuteman Drive SB  
 Location : North of River Road  
 City/State: Andover, MA

978-664-2565

7613VOLS B2

| Start Time            | 10/26/201   |             | 10/27/201   |             | 10/28/201  |            | Daily Average |             |   |       |       |
|-----------------------|-------------|-------------|-------------|-------------|------------|------------|---------------|-------------|---|-------|-------|
|                       | Thu A.M.    | P.M.        | Fri A.M.    | P.M.        | Sat A.M.   | P.M.       | A.M.          | P.M.        |   |       |       |
| 12:00                 | 14          | 68          | 8           | 80          | 11         | 9          | 11            | 52          |   |       |       |
| 12:15                 | 19          | 50          | 12          | 54          | 3          | 10         | 11            | 38          |   |       |       |
| 12:30                 | 0           | 41          | 2           | 59          | 0          | 8          | 1             | 36          |   |       |       |
| 12:45                 | 3           | 46          | 3           | 42          | 0          | 10         | 2             | 33          |   |       |       |
| 01:00                 | 7           | 29          | 3           | 42          | 5          | 7          | 5             | 26          |   |       |       |
| 01:15                 | 1           | 29          | 0           | 43          | 2          | 6          | 1             | 26          |   |       |       |
| 01:30                 | 1           | 32          | 1           | 42          | 1          | 6          | 1             | 27          |   |       |       |
| 01:45                 | 0           | 39          | 0           | 38          | 0          | 10         | 0             | 29          |   |       |       |
| 02:00                 | 0           | 70          | 1           | 79          | 2          | 7          | 1             | 52          |   |       |       |
| 02:15                 | 1           | 80          | 1           | 85          | 3          | 12         | 2             | 59          |   |       |       |
| 02:30                 | 7           | 67          | 8           | 70          | 5          | 7          | 7             | 48          |   |       |       |
| 02:45                 | 1           | 68          | 2           | 65          | 1          | 4          | 1             | 46          |   |       |       |
| 03:00                 | 1           | 91          | 0           | 94          | 2          | 14         | 1             | 66          |   |       |       |
| 03:15                 | 0           | 82          | 0           | 87          | 0          | 10         | 0             | 60          |   |       |       |
| 03:30                 | 0           | 88          | 0           | 97          | 1          | 18         | 0             | 68          |   |       |       |
| 03:45                 | 1           | 98          | 3           | 96          | 5          | 6          | 3             | 67          |   |       |       |
| 04:00                 | 2           | 180         | 3           | 154         | 4          | 11         | 3             | 115         |   |       |       |
| 04:15                 | 1           | 154         | 3           | 129         | 2          | 9          | 2             | 97          |   |       |       |
| 04:30                 | 2           | 196         | 3           | 148         | 2          | 8          | 2             | 117         |   |       |       |
| 04:45                 | 2           | 171         | 3           | 132         | 1          | 8          | 2             | 104         |   |       |       |
| 05:00                 | 6           | 231         | 7           | 167         | 2          | 13         | 5             | 137         |   |       |       |
| 05:15                 | 2           | 210         | 3           | 132         | 1          | 11         | 2             | 118         |   |       |       |
| 05:30                 | 3           | 207         | 1           | 119         | 2          | 11         | 2             | 112         |   |       |       |
| 05:45                 | 15          | 141         | 7           | 88          | 1          | 1          | 8             | 77          |   |       |       |
| 06:00                 | 6           | 166         | 10          | 99          | 5          | 4          | 7             | 90          |   |       |       |
| 06:15                 | 10          | 105         | 10          | 58          | 1          | 8          | 7             | 57          |   |       |       |
| 06:30                 | 12          | 85          | 11          | 46          | 7          | 4          | 10            | 45          |   |       |       |
| 06:45                 | 4           | 49          | 12          | 37          | 5          | 4          | 7             | 30          |   |       |       |
| 07:00                 | 15          | 51          | 20          | 32          | 9          | 7          | 15            | 30          |   |       |       |
| 07:15                 | 25          | 33          | 21          | 24          | 8          | 3          | 18            | 20          |   |       |       |
| 07:30                 | 20          | 28          | 14          | 20          | 5          | 7          | 13            | 18          |   |       |       |
| 07:45                 | 17          | 12          | 21          | 13          | 3          | 5          | 14            | 10          |   |       |       |
| 08:00                 | 16          | 21          | 16          | 12          | 11         | 4          | 14            | 12          |   |       |       |
| 08:15                 | 26          | 13          | 22          | 10          | 8          | 3          | 19            | 9           |   |       |       |
| 08:30                 | 19          | 8           | 14          | 15          | 7          | 3          | 13            | 9           |   |       |       |
| 08:45                 | 12          | 8           | 17          | 3           | 17         | 2          | 15            | 4           |   |       |       |
| 09:00                 | 18          | 13          | 13          | 6           | 7          | 1          | 13            | 7           |   |       |       |
| 09:15                 | 12          | 19          | 14          | 14          | 5          | 2          | 10            | 12          |   |       |       |
| 09:30                 | 20          | 6           | 22          | 9           | 15         | 1          | 19            | 5           |   |       |       |
| 09:45                 | 16          | 2           | 12          | 6           | 10         | 1          | 13            | 3           |   |       |       |
| 10:00                 | 16          | 5           | 15          | 6           | 15         | 1          | 15            | 4           |   |       |       |
| 10:15                 | 15          | 4           | 14          | 8           | 15         | 0          | 15            | 4           |   |       |       |
| 10:30                 | 11          | 1           | 24          | 8           | 12         | 5          | 16            | 5           |   |       |       |
| 10:45                 | 14          | 7           | 12          | 3           | 19         | 2          | 15            | 4           |   |       |       |
| 11:00                 | 30          | 5           | 29          | 3           | 11         | 8          | 23            | 5           |   |       |       |
| 11:15                 | 31          | 8           | 38          | 5           | 18         | 5          | 29            | 6           |   |       |       |
| 11:30                 | 53          | 5           | 55          | 2           | 18         | 4          | 42            | 4           |   |       |       |
| 11:45                 | 59          | 4           | 77          | 6           | 12         | 6          | 49            | 5           |   |       |       |
| <b>Total</b>          | <b>566</b>  | <b>3126</b> | <b>587</b>  | <b>2587</b> | <b>299</b> | <b>306</b> | <b>484</b>    | <b>2008</b> |   |       |       |
| <b>Combined Total</b> | <b>3692</b> |             | <b>3174</b> |             | <b>605</b> |            | <b>2492</b>   |             |   |       |       |
| Peak                  | 11:00       | 04:45       | -           | 11:00       | 04:30      | -          | 10:45         | 03:00       | - | 11:00 | 04:30 |
| Vol.                  | 173         | 819         | -           | 199         | 579        | -          | 66            | 48          | - | 143   | 476   |
| P.H.F.                | 0.733       | 0.886       |             | 0.646       | 0.867      |            | 0.868         | 0.667       |   | 0.730 | 0.869 |
| ADT                   | ADT 2,490   |             | AADT 2,490  |             |            |            |               |             |   |       |       |

# Accurate Counts

978-664-2565

Location : Minuteman Drive SB  
 Location : North of River Road  
 City/State: Andover, MA

7613VOLSB2

| Start Time   | Mon<br>10/23/2017 | Tue<br>10/24/2017 | Wed<br>10/25/2017 | Thu<br>10/26/2017 | Fri<br>10/27/2017 | Average<br>Day | Sat<br>10/28/2017 | Sun<br>10/29/2017 | Week<br>Average |   |   |
|--------------|-------------------|-------------------|-------------------|-------------------|-------------------|----------------|-------------------|-------------------|-----------------|---|---|
| 12:00 AM     | *                 | *                 | *                 | 36                | 25                | 30             | 14                | *                 | 25              |   |   |
| 01:00        | *                 | *                 | *                 | 9                 | 4                 | 6              | 8                 | *                 | 7               |   |   |
| 02:00        | *                 | *                 | *                 | 9                 | 12                | 10             | 11                | *                 | 11              |   |   |
| 03:00        | *                 | *                 | *                 | 2                 | 3                 | 2              | 8                 | *                 | 4               |   |   |
| 04:00        | *                 | *                 | *                 | 7                 | 12                | 10             | 9                 | *                 | 9               |   |   |
| 05:00        | *                 | *                 | *                 | 26                | 18                | 22             | 6                 | *                 | 17              |   |   |
| 06:00        | *                 | *                 | *                 | 32                | 43                | 38             | 18                | *                 | 31              |   |   |
| 07:00        | *                 | *                 | *                 | 77                | 76                | 76             | 25                | *                 | 59              |   |   |
| 08:00        | *                 | *                 | *                 | 73                | 69                | 71             | 43                | *                 | 62              |   |   |
| 09:00        | *                 | *                 | *                 | 66                | 61                | 64             | 37                | *                 | 55              |   |   |
| 10:00        | *                 | *                 | *                 | 56                | 65                | 60             | <b>61</b>         | *                 | 61              |   |   |
| 11:00        | *                 | *                 | *                 | <b>173</b>        | <b>199</b>        | <b>186</b>     | 59                | *                 | <b>144</b>      |   |   |
| 12:00 PM     | *                 | *                 | *                 | 205               | 235               | 220            | 37                | *                 | 159             |   |   |
| 01:00        | *                 | *                 | *                 | 129               | 165               | 147            | 29                | *                 | 108             |   |   |
| 02:00        | *                 | *                 | *                 | 285               | 299               | 292            | 30                | *                 | 205             |   |   |
| 03:00        | *                 | *                 | *                 | 359               | 374               | 366            | <b>48</b>         | *                 | 260             |   |   |
| 04:00        | *                 | *                 | *                 | 701               | <b>563</b>        | 632            | 36                | *                 | 433             |   |   |
| 05:00        | *                 | *                 | *                 | <b>789</b>        | 506               | <b>648</b>     | 36                | *                 | <b>444</b>      |   |   |
| 06:00        | *                 | *                 | *                 | 405               | 240               | 322            | 20                | *                 | 222             |   |   |
| 07:00        | *                 | *                 | *                 | 124               | 89                | 106            | 22                | *                 | 78              |   |   |
| 08:00        | *                 | *                 | *                 | 50                | 40                | 45             | 12                | *                 | 34              |   |   |
| 09:00        | *                 | *                 | *                 | 40                | 35                | 38             | 5                 | *                 | 27              |   |   |
| 10:00        | *                 | *                 | *                 | 17                | 25                | 21             | 8                 | *                 | 17              |   |   |
| 11:00        | *                 | *                 | *                 | 22                | 16                | 19             | 23                | *                 | 20              |   |   |
| Day Total    | 0                 | 0                 | 0                 | 3692              | 3174              | 3431           | 605               | 0                 | 2492            |   |   |
| % Avg. WkDay | 0.0%              | 0.0%              | 0.0%              | 107.6%            | 92.5%             |                |                   |                   |                 |   |   |
| % Avg. Week  | 0.0%              | 0.0%              | 0.0%              | 148.2%            | 127.4%            | 137.7%         | 24.3%             | 0.0%              |                 |   |   |
| AM Peak      | -                 | -                 | -                 | 11:00             | 11:00             | -              | 11:00             | -                 | 11:00           | - | - |
| Vol.         | -                 | -                 | -                 | 173               | 199               | -              | 186               | -                 | 144             | - | - |
| PM Peak      | -                 | -                 | -                 | 17:00             | 16:00             | -              | 17:00             | -                 | 17:00           | - | - |
| Vol.         | -                 | -                 | -                 | 789               | 563               | -              | 648               | -                 | 444             | - | - |
| Grand Total  | 0                 | 0                 | 0                 | 3692              | 3174              | 3431           | 605               | 0                 | 2492            |   |   |

ADT

ADT 2,490

AA DT 2,490

MANUAL TURNING MOVEMENT COUNT DATA

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# Accurate Counts

978-664-2565

N/S Street : Minuteman Rd / Shattuck Rd  
 E/W Street : River Road  
 City/State : Andover, MA  
 Weather : Rain

File Name : 76130003  
 Site Code : 76130003  
 Start Date : 10/26/2017  
 Page No : 1

## Groups Printed- Cars - Trucks

| Start Time  | Minuteman Rd<br>From North |      |       | River Rd<br>From East |      |       | Shattuck Rd<br>From South |      |       | River Rd<br>From West |      |       | Int. Total |
|-------------|----------------------------|------|-------|-----------------------|------|-------|---------------------------|------|-------|-----------------------|------|-------|------------|
|             | Left                       | Thru | Right | Left                  | Thru | Right | Left                      | Thru | Right | Left                  | Thru | Right |            |
| 04:00 PM    | 165                        | 2    | 7     | 12                    | 57   | 33    | 6                         | 2    | 101   | 3                     | 157  | 1     | 546        |
| 04:15 PM    | 152                        | 1    | 8     | 13                    | 69   | 25    | 6                         | 2    | 80    | 7                     | 141  | 2     | 506        |
| 04:30 PM    | 192                        | 1    | 8     | 8                     | 64   | 14    | 14                        | 0    | 126   | 2                     | 165  | 4     | 598        |
| 04:45 PM    | 152                        | 1    | 13    | 13                    | 50   | 16    | 10                        | 1    | 112   | 7                     | 101  | 3     | 479        |
| Total       | 661                        | 5    | 36    | 46                    | 240  | 88    | 36                        | 5    | 419   | 19                    | 564  | 10    | 2129       |
| 05:00 PM    | 228                        | 0    | 19    | 17                    | 84   | 17    | 21                        | 1    | 196   | 3                     | 170  | 5     | 761        |
| 05:15 PM    | 219                        | 0    | 13    | 22                    | 84   | 11    | 15                        | 0    | 148   | 2                     | 137  | 2     | 653        |
| 05:30 PM    | 187                        | 1    | 9     | 9                     | 69   | 7     | 13                        | 0    | 127   | 1                     | 133  | 3     | 559        |
| 05:45 PM    | 147                        | 1    | 10    | 5                     | 65   | 10    | 9                         | 0    | 86    | 5                     | 125  | 3     | 466        |
| Total       | 781                        | 2    | 51    | 53                    | 302  | 45    | 58                        | 1    | 557   | 11                    | 565  | 13    | 2439       |
| Grand Total | 1442                       | 7    | 87    | 99                    | 542  | 133   | 94                        | 6    | 976   | 30                    | 1129 | 23    | 4568       |
| Apprch %    | 93.9                       | 0.5  | 5.7   | 12.8                  | 70   | 17.2  | 8.7                       | 0.6  | 90.7  | 2.5                   | 95.5 | 1.9   |            |
| Total %     | 31.6                       | 0.2  | 1.9   | 2.2                   | 11.9 | 2.9   | 2.1                       | 0.1  | 21.4  | 0.7                   | 24.7 | 0.5   |            |
| Cars        | 1434                       | 7    | 87    | 99                    | 542  | 127   | 94                        | 5    | 975   | 30                    | 1128 | 23    | 4551       |
| % Cars      | 99.4                       | 100  | 100   | 100                   | 100  | 95.5  | 100                       | 83.3 | 99.9  | 100                   | 99.9 | 100   | 99.6       |
| Trucks      | 8                          | 0    | 0     | 0                     | 0    | 6     | 0                         | 1    | 1     | 0                     | 1    | 0     | 17         |
| % Trucks    | 0.6                        | 0    | 0     | 0                     | 0    | 4.5   | 0                         | 16.7 | 0.1   | 0                     | 0.1  | 0     | 0.4        |

# Accurate Counts

978-664-2565

N/S Street : Minuteman Rd / Shattuck Rd  
 E/W Street : River Road  
 City/State : Andover, MA  
 Weather : Rain

File Name : 76130003  
 Site Code : 76130003  
 Start Date : 10/26/2017  
 Page No : 2

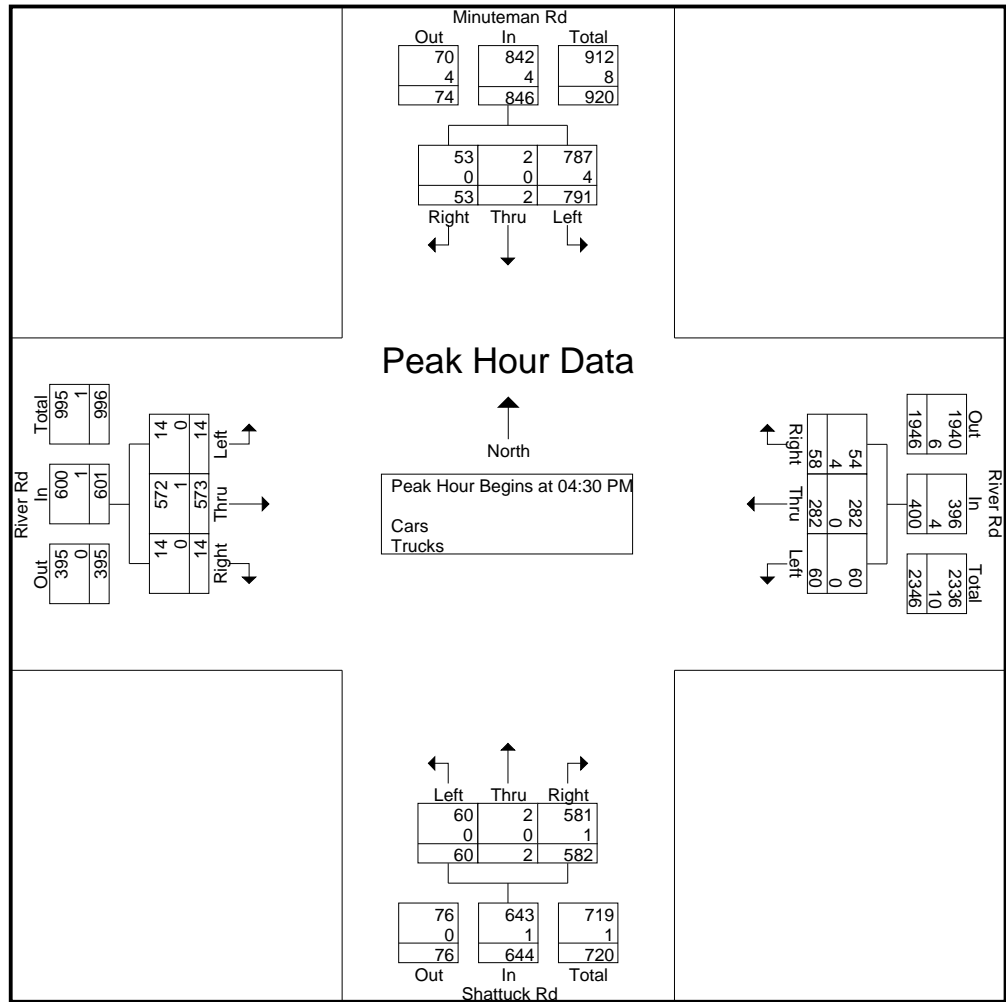
| Start Time   | Minuteman Rd<br>From North |          |           |            | River Rd<br>From East |           |           |            | Shattuck Rd<br>From South |          |            |            | River Rd<br>From West |            |          |            | Int. Total |
|--|----------------------------|----------|-----------|------------|-----------------------|-----------|-----------|------------|---------------------------|----------|------------|------------|-----------------------|------------|----------|------------|------------|
|  | Left                       | Thru     | Right     | App. Total | Left                  | Thru      | Right     | App. Total | Left                      | Thru     | Right      | App. Total | Left                  | Thru       | Right    | App. Total |            |
| Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1 |                            |          |           |            |                       |           |           |            |                           |          |            |            |                       |            |          |            |            |
| Peak Hour for Entire Intersection Begins at 04:30 PM       |                            |          |           |            |                       |           |           |            |                           |          |            |            |                       |            |          |            |            |
| 04:30 PM   | 192                        | <b>1</b> | 8         | 201        | 8                     | 64        | 14        | 86         | 14                        | 0        | 126        | 140        | 2                     | 165        | 4        | 171        | 598        |
| 04:45 PM   | 152                        | 1        | 13        | 166        | 13                    | 50        | 16        | 79         | 10                        | <b>1</b> | 112        | 123        | <b>7</b>              | 101        | 3        | 111        | 479        |
| 05:00 PM   | <b>228</b>                 | 0        | <b>19</b> | <b>247</b> | 17                    | <b>84</b> | <b>17</b> | <b>118</b> | <b>21</b>                 | <b>1</b> | <b>196</b> | <b>218</b> | 3                     | <b>170</b> | <b>5</b> | <b>178</b> | <b>761</b> |
| 05:15 PM   | 219                        | 0        | 13        | 232        | <b>22</b>             | 84        | 11        | 117        | 15                        | 0        | 148        | 163        | 2                     | 137        | 2        | 141        | 653        |
| Total Volume   | 791                        | 2        | 53        | 846        | 60                    | 282       | 58        | 400        | 60                        | 2        | 582        | 644        | 14                    | 573        | 14       | 601        | 2491       |
| % App. Total   | 93.5                       | 0.2      | 6.3       |            | 15                    | 70.5      | 14.5      |            | 9.3                       | 0.3      | 90.4       |            | 2.3                   | 95.3       | 2.3      |            |            |
| PHF  | .867                       | .500     | .697      | .856       | .682                  | .839      | .853      | .847       | .714                      | .500     | .742       | .739       | .500                  | .843       | .700     | .844       | .818       |
| Cars   | 787                        | 2        | 53        | 842        | 60                    | 282       | 54        | 396        | 60                        | 2        | 581        | 643        | 14                    | 572        | 14       | 600        | 2481       |
| % Cars   | 99.5                       | 100      | 100       | 99.5       | 100                   | 100       | 93.1      | 99.0       | 100                       | 100      | 99.8       | 99.8       | 100                   | 99.8       | 100      | 99.8       | 99.6       |
| Trucks   | 4                          | 0        | 0         | 4          | 0                     | 0         | 4         | 4          | 0                         | 0        | 1          | 1          | 0                     | 1          | 0        | 1          | 10         |
| % Trucks   | 0.5                        | 0        | 0         | 0.5        | 0                     | 0         | 6.9       | 1.0        | 0                         | 0        | 0.2        | 0.2        | 0                     | 0.2        | 0        | 0.2        | 0.4        |

# Accurate Counts

978-664-2565

File Name : 76130003  
 Site Code : 76130003  
 Start Date : 10/26/2017  
 Page No : 3

N/S Street : Minuteman Rd / Shattuck Rd  
 E/W Street : River Road  
 City/State : Andover, MA  
 Weather : Rain



Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1

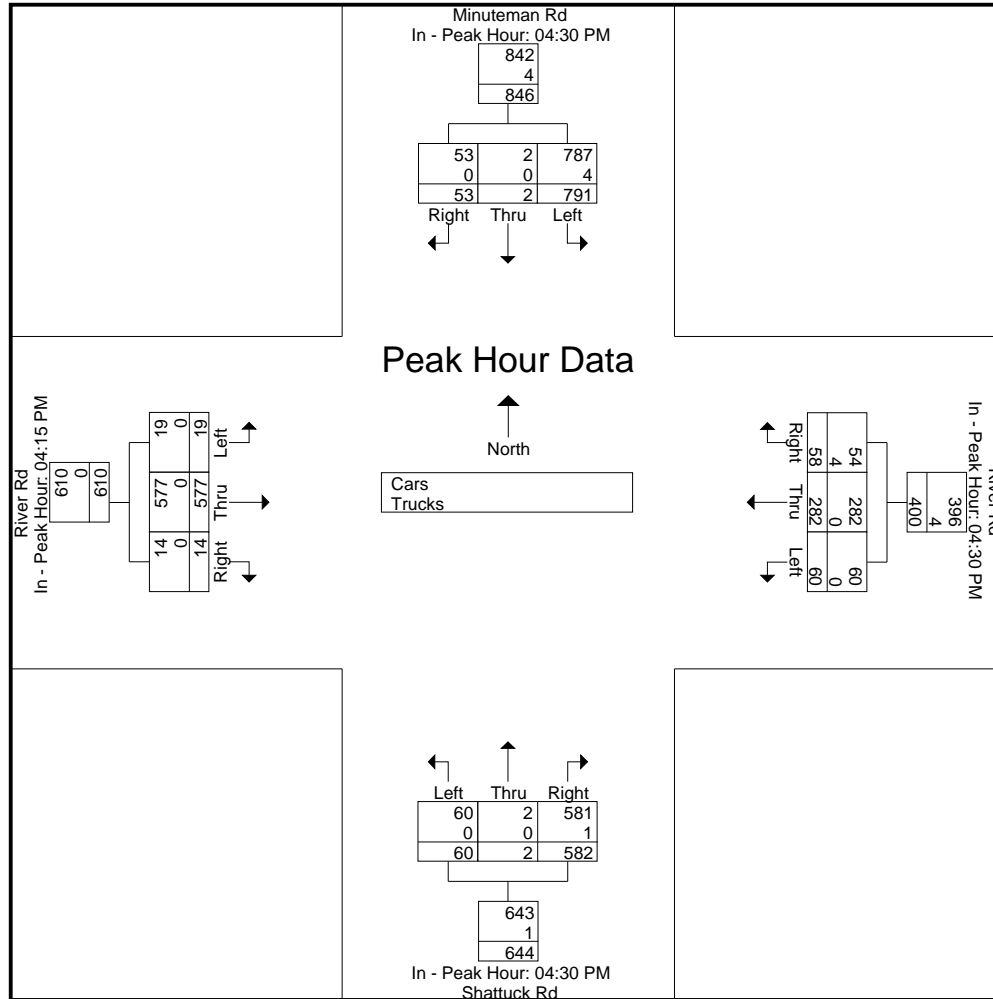
Peak Hour for Each Approach Begins at:

|              | 04:30 PM   |     |           |            | 04:30 PM  |           |           |            | 04:30 PM  |     |            |            | 04:15 PM |            |          |            |
|--------------|------------|-----|-----------|------------|-----------|-----------|-----------|------------|-----------|-----|------------|------------|----------|------------|----------|------------|
| +0 mins.     | 192        | 1   | 8         | 201        | 8         | 64        | 14        | 86         | 14        | 0   | 126        | 140        | 7        | 141        | 2        | 150        |
| +15 mins.    | 152        | 1   | 13        | 166        | 13        | 50        | 16        | 79         | 10        | 1   | 112        | 123        | 2        | 165        | 4        | 171        |
| +30 mins.    | <b>228</b> | 0   | <b>19</b> | <b>247</b> | 17        | <b>84</b> | <b>17</b> | <b>118</b> | <b>21</b> | 1   | <b>196</b> | <b>218</b> | 7        | 101        | 3        | 111        |
| +45 mins.    | 219        | 0   | 13        | 232        | <b>22</b> | 84        | 11        | 117        | 15        | 0   | 148        | 163        | 3        | <b>170</b> | <b>5</b> | <b>178</b> |
| Total Volume | 791        | 2   | 53        | 846        | 60        | 282       | 58        | 400        | 60        | 2   | 582        | 644        | 19       | 577        | 14       | 610        |
| % App. Total | 93.5       | 0.2 | 6.3       |            | 15        | 70.5      | 14.5      |            | 9.3       | 0.3 | 90.4       |            | 3.1      | 94.6       | 2.3      |            |

# Accurate Counts

978-664-2565

|          |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|----------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| PHF      | .867 | .500 | .697 | .856 | .682 | .839 | .853 | .847 | .714 | .500 | .742 | .739 | .679 | .849 | .700 | .857 |
| Cars     | 787  | 2    | 53   | 842  | 60   | 282  | 54   | 396  | 60   | 2    | 581  | 643  | 19   | 577  | 14   | 610  |
| % Cars   | 99.5 | 100  | 100  | 99.5 | 100  | 100  | 93.1 | 99   | 100  | 100  | 99.8 | 99.8 | 100  | 100  | 100  | 100  |
| Trucks   | 4    | 0    | 0    | 4    | 0    | 0    | 4    | 4    | 0    | 0    | 1    | 1    | 0    | 0    | 0    | 0    |
| % Trucks | 0.5  | 0    | 0    | 0.5  | 0    | 0    | 6.9  | 1    | 0    | 0    | 0.2  | 0.2  | 0    | 0    | 0    | 0    |



# Accurate Counts

978-664-2565

N/S Street : Minuteman Rd / Shattuck Rd  
 E/W Street : River Road  
 City/State : Andover, MA  
 Weather : Rain

File Name : 76130003  
 Site Code : 76130003  
 Start Date : 10/26/2017  
 Page No : 5

## Groups Printed- Cars

| Start Time  | Minuteman Rd<br>From North |      |       | River Rd<br>From East |      |       | Shattuck Rd<br>From South |      |       | River Rd<br>From West |      |       | Int. Total |
|-------------|----------------------------|------|-------|-----------------------|------|-------|---------------------------|------|-------|-----------------------|------|-------|------------|
|             | Left                       | Thru | Right | Left                  | Thru | Right | Left                      | Thru | Right | Left                  | Thru | Right |            |
| 04:00 PM    | 163                        | 2    | 7     | 12                    | 57   | 33    | 6                         | 1    | 101   | 3                     | 157  | 1     | 543        |
| 04:15 PM    | 152                        | 1    | 8     | 13                    | 69   | 25    | 6                         | 2    | 80    | 7                     | 141  | 2     | 506        |
| 04:30 PM    | 190                        | 1    | 8     | 8                     | 64   | 13    | 14                        | 0    | 126   | 2                     | 165  | 4     | 595        |
| 04:45 PM    | 152                        | 1    | 13    | 13                    | 50   | 13    | 10                        | 1    | 111   | 7                     | 101  | 3     | 475        |
| Total       | 657                        | 5    | 36    | 46                    | 240  | 84    | 36                        | 4    | 418   | 19                    | 564  | 10    | 2119       |
| 05:00 PM    | 227                        | 0    | 19    | 17                    | 84   | 17    | 21                        | 1    | 196   | 3                     | 170  | 5     | 760        |
| 05:15 PM    | 218                        | 0    | 13    | 22                    | 84   | 11    | 15                        | 0    | 148   | 2                     | 136  | 2     | 651        |
| 05:30 PM    | 186                        | 1    | 9     | 9                     | 69   | 6     | 13                        | 0    | 127   | 1                     | 133  | 3     | 557        |
| 05:45 PM    | 146                        | 1    | 10    | 5                     | 65   | 9     | 9                         | 0    | 86    | 5                     | 125  | 3     | 464        |
| Total       | 777                        | 2    | 51    | 53                    | 302  | 43    | 58                        | 1    | 557   | 11                    | 564  | 13    | 2432       |
| Grand Total | 1434                       | 7    | 87    | 99                    | 542  | 127   | 94                        | 5    | 975   | 30                    | 1128 | 23    | 4551       |
| Apprch %    | 93.8                       | 0.5  | 5.7   | 12.9                  | 70.6 | 16.5  | 8.8                       | 0.5  | 90.8  | 2.5                   | 95.5 | 1.9   |            |
| Total %     | 31.5                       | 0.2  | 1.9   | 2.2                   | 11.9 | 2.8   | 2.1                       | 0.1  | 21.4  | 0.7                   | 24.8 | 0.5   |            |

# Accurate Counts

978-664-2565

File Name : 76130003  
 Site Code : 76130003  
 Start Date : 10/26/2017  
 Page No : 6

N/S Street : Minuteman Rd / Shattuck Rd  
 E/W Street : River Road  
 City/State : Andover, MA  
 Weather : Rain

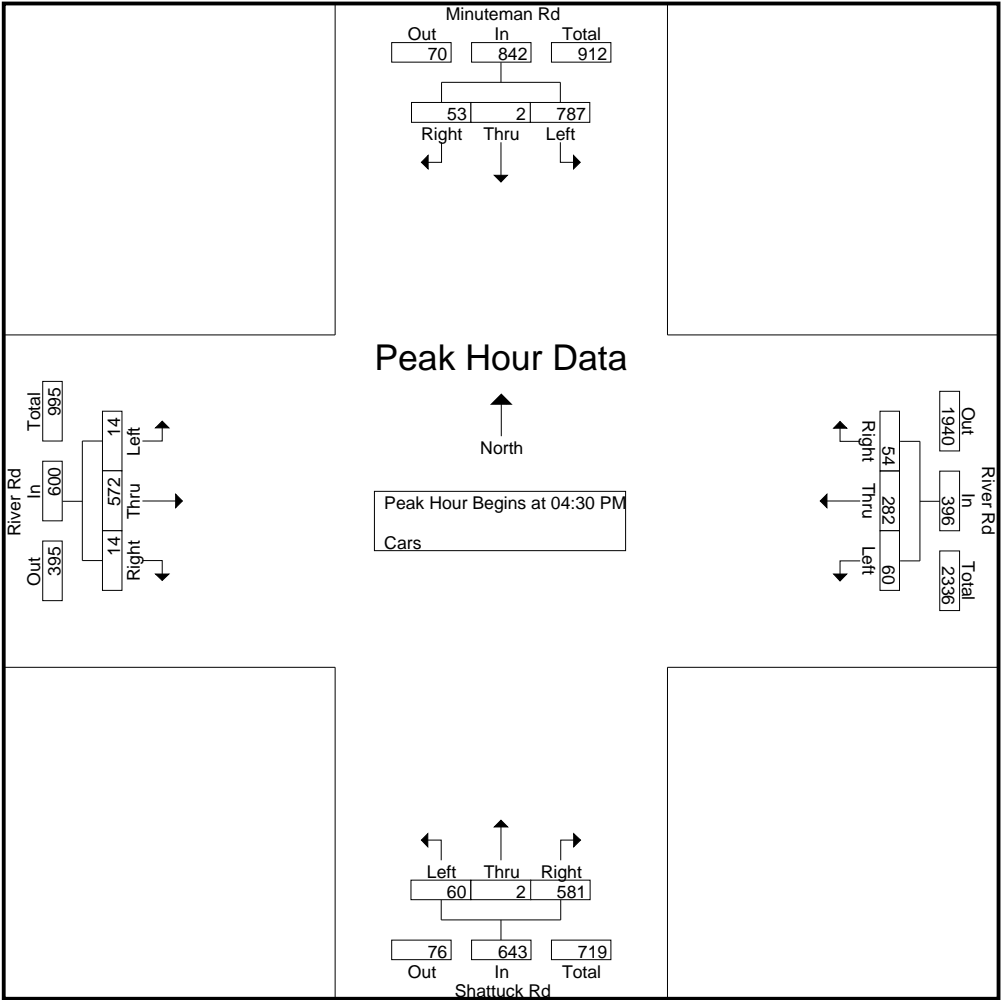
| Start Time   | Minuteman Rd<br>From North |          |           |            | River Rd<br>From East |           |           |            | Shattuck Rd<br>From South |          |            |            | River Rd<br>From West |            |          |            | Int. Total |
|--|----------------------------|----------|-----------|------------|-----------------------|-----------|-----------|------------|---------------------------|----------|------------|------------|-----------------------|------------|----------|------------|------------|
|  | Left                       | Thru     | Right     | App. Total | Left                  | Thru      | Right     | App. Total | Left                      | Thru     | Right      | App. Total | Left                  | Thru       | Right    | App. Total |            |
| Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1 |                            |          |           |            |                       |           |           |            |                           |          |            |            |                       |            |          |            |            |
| Peak Hour for Entire Intersection Begins at 04:30 PM       |                            |          |           |            |                       |           |           |            |                           |          |            |            |                       |            |          |            |            |
| 04:30 PM   | 190                        | <b>1</b> | 8         | 199        | 8                     | 64        | 13        | 85         | 14                        | 0        | 126        | 140        | 2                     | 165        | 4        | 171        | 595        |
| 04:45 PM   | 152                        | 1        | 13        | 166        | 13                    | 50        | 13        | 76         | 10                        | <b>1</b> | 111        | 122        | <b>7</b>              | 101        | 3        | 111        | 475        |
| 05:00 PM   | <b>227</b>                 | 0        | <b>19</b> | <b>246</b> | 17                    | <b>84</b> | <b>17</b> | <b>118</b> | <b>21</b>                 | <b>1</b> | <b>196</b> | <b>218</b> | 3                     | <b>170</b> | <b>5</b> | <b>178</b> | <b>760</b> |
| 05:15 PM   | 218                        | 0        | 13        | 231        | <b>22</b>             | 84        | 11        | 117        | 15                        | 0        | 148        | 163        | 2                     | 136        | 2        | 140        | 651        |
| Total Volume   | 787                        | 2        | 53        | 842        | 60                    | 282       | 54        | 396        | 60                        | 2        | 581        | 643        | 14                    | 572        | 14       | 600        | 2481       |
| % App. Total   | 93.5                       | 0.2      | 6.3       |            | 15.2                  | 71.2      | 13.6      |            | 9.3                       | 0.3      | 90.4       |            | 2.3                   | 95.3       | 2.3      |            |            |
| PHF  | .867                       | .500     | .697      | .856       | .682                  | .839      | .794      | .839       | .714                      | .500     | .741       | .737       | .500                  | .841       | .700     | .843       | .816       |

# Accurate Counts

978-664-2565

File Name : 76130003  
 Site Code : 76130003  
 Start Date : 10/26/2017  
 Page No : 7

N/S Street : Minuteman Rd / Shattuck Rd  
 E/W Street : River Road  
 City/State : Andover, MA  
 Weather : Rain



Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1

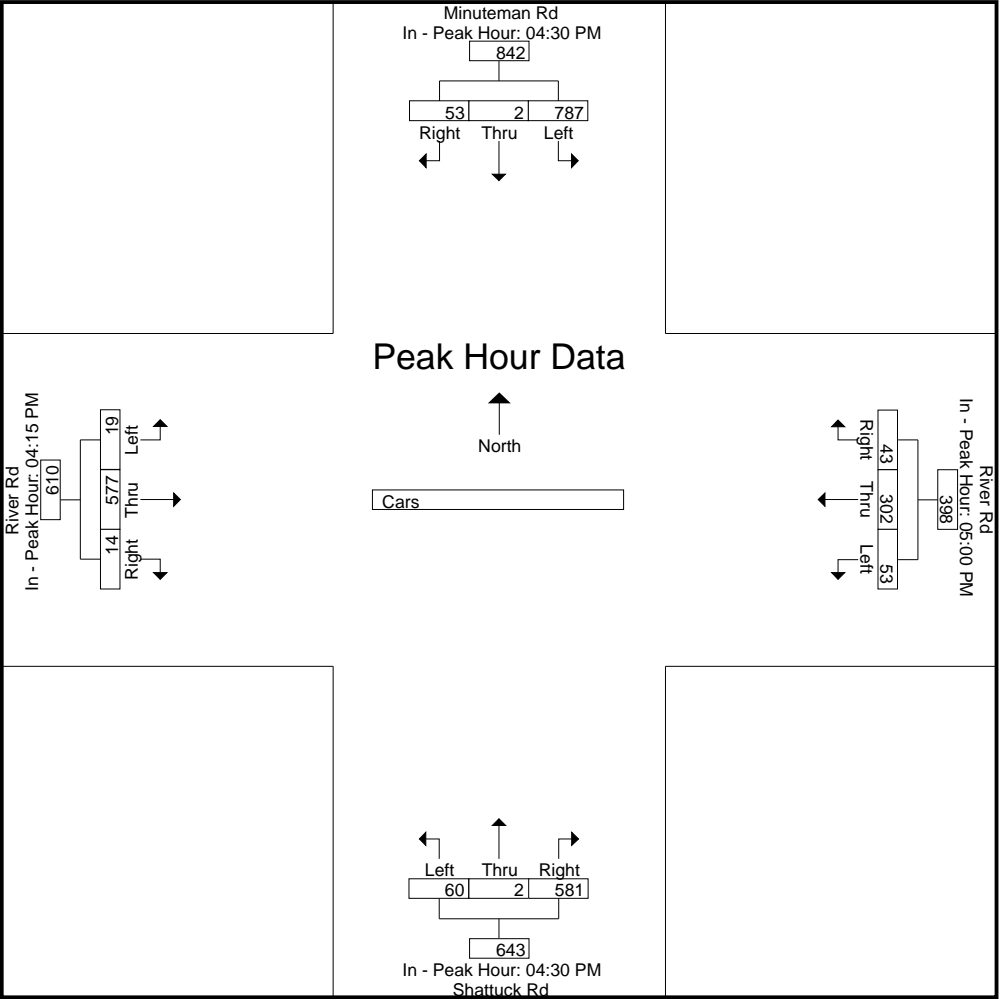
Peak Hour for Each Approach Begins at:

|              | 04:30 PM |     |     |     | 05:00 PM |      |      |     | 04:30 PM |     |      |     | 04:15 PM |      |     |     |
|--------------|----------|-----|-----|-----|----------|------|------|-----|----------|-----|------|-----|----------|------|-----|-----|
| +0 mins.     | 190      | 1   | 8   | 199 | 17       | 84   | 17   | 118 | 14       | 0   | 126  | 140 | 7        | 141  | 2   | 150 |
| +15 mins.    | 152      | 1   | 13  | 166 | 22       | 84   | 11   | 117 | 10       | 1   | 111  | 122 | 2        | 165  | 4   | 171 |
| +30 mins.    | 227      | 0   | 19  | 246 | 9        | 69   | 6    | 84  | 21       | 1   | 196  | 218 | 7        | 101  | 3   | 111 |
| +45 mins.    | 218      | 0   | 13  | 231 | 5        | 65   | 9    | 79  | 15       | 0   | 148  | 163 | 3        | 170  | 5   | 178 |
| Total Volume | 787      | 2   | 53  | 842 | 53       | 302  | 43   | 398 | 60       | 2   | 581  | 643 | 19       | 577  | 14  | 610 |
| % App. Total | 93.5     | 0.2 | 6.3 |     | 13.3     | 75.9 | 10.8 |     | 9.3      | 0.3 | 90.4 |     | 3.1      | 94.6 | 2.3 |     |

Accurate Counts

978-664-2565

PHF | .867 | .500 | .697 | .856 | .602 | .899 | .632 | .843 | .714 | .500 | .741 | .737 | .679 | .849 | .700 | .857



# Accurate Counts

978-664-2565

N/S Street : Minuteman Rd / Shattuck Rd  
 E/W Street : River Road  
 City/State : Andover, MA  
 Weather : Rain

File Name : 76130003  
 Site Code : 76130003  
 Start Date : 10/26/2017  
 Page No : 9

## Groups Printed- Trucks

| Start Time  | Minuteman Rd<br>From North |      |       | River Rd<br>From East |      |       | Shattuck Rd<br>From South |      |       | River Rd<br>From West |      |       | Int. Total |
|-------------|----------------------------|------|-------|-----------------------|------|-------|---------------------------|------|-------|-----------------------|------|-------|------------|
|             | Left                       | Thru | Right | Left                  | Thru | Right | Left                      | Thru | Right | Left                  | Thru | Right |            |
| 04:00 PM    | 2                          | 0    | 0     | 0                     | 0    | 0     | 0                         | 1    | 0     | 0                     | 0    | 0     | 3          |
| 04:15 PM    | 0                          | 0    | 0     | 0                     | 0    | 0     | 0                         | 0    | 0     | 0                     | 0    | 0     | 0          |
| 04:30 PM    | 2                          | 0    | 0     | 0                     | 0    | 1     | 0                         | 0    | 0     | 0                     | 0    | 0     | 3          |
| 04:45 PM    | 0                          | 0    | 0     | 0                     | 0    | 3     | 0                         | 0    | 1     | 0                     | 0    | 0     | 4          |
| Total       | 4                          | 0    | 0     | 0                     | 0    | 4     | 0                         | 1    | 1     | 0                     | 0    | 0     | 10         |
| 05:00 PM    | 1                          | 0    | 0     | 0                     | 0    | 0     | 0                         | 0    | 0     | 0                     | 0    | 0     | 1          |
| 05:15 PM    | 1                          | 0    | 0     | 0                     | 0    | 0     | 0                         | 0    | 0     | 0                     | 1    | 0     | 2          |
| 05:30 PM    | 1                          | 0    | 0     | 0                     | 0    | 1     | 0                         | 0    | 0     | 0                     | 0    | 0     | 2          |
| 05:45 PM    | 1                          | 0    | 0     | 0                     | 0    | 1     | 0                         | 0    | 0     | 0                     | 0    | 0     | 2          |
| Total       | 4                          | 0    | 0     | 0                     | 0    | 2     | 0                         | 0    | 0     | 0                     | 1    | 0     | 7          |
| Grand Total | 8                          | 0    | 0     | 0                     | 0    | 6     | 0                         | 1    | 1     | 0                     | 1    | 0     | 17         |
| Apprch %    | 100                        | 0    | 0     | 0                     | 0    | 100   | 0                         | 50   | 50    | 0                     | 100  | 0     |            |
| Total %     | 47.1                       | 0    | 0     | 0                     | 0    | 35.3  | 0                         | 5.9  | 5.9   | 0                     | 5.9  | 0     |            |

**Accurate Counts**

978-664-2565

File Name : 76130003  
 Site Code : 76130003  
 Start Date : 10/26/2017  
 Page No : 10

N/S Street : Minuteman Rd / Shattuck Rd  
 E/W Street : River Road  
 City/State : Andover, MA  
 Weather : Rain

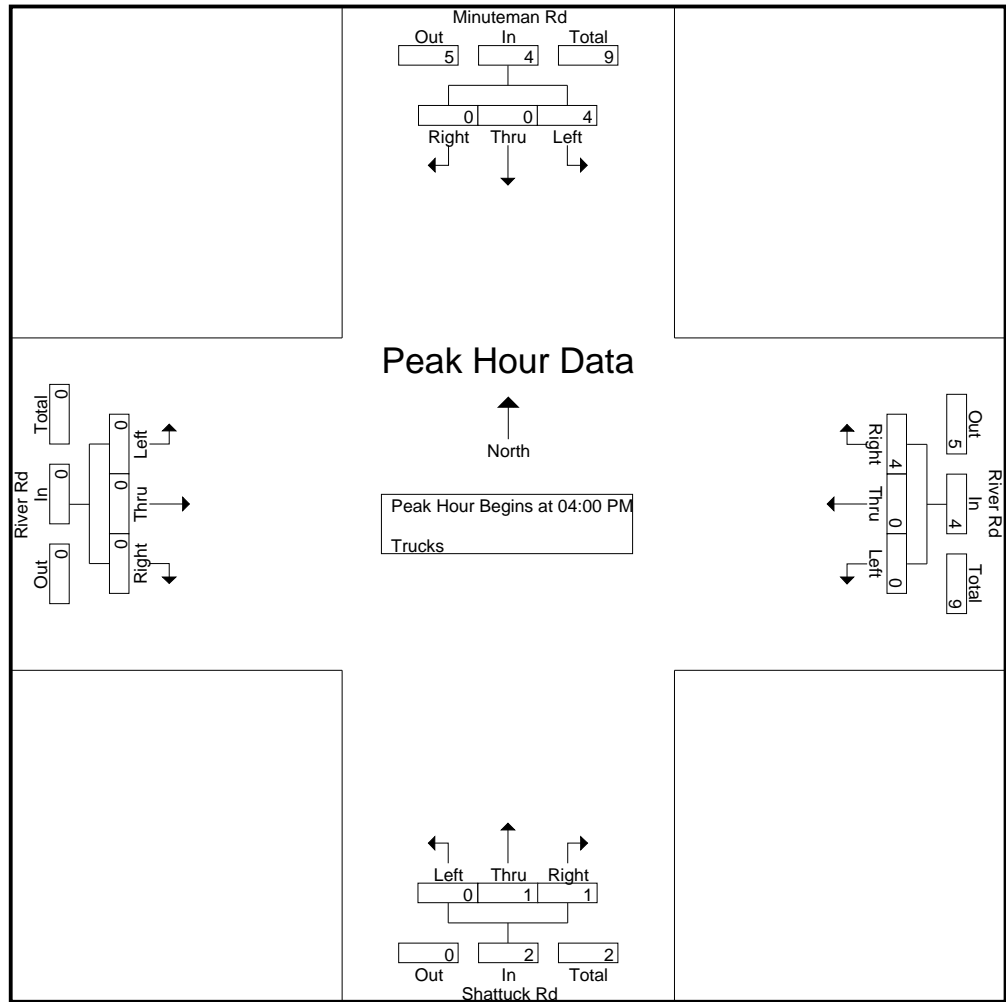
| Start Time   | Minuteman Rd<br>From North |      |       |            | River Rd<br>From East |      |       |            | Shattuck Rd<br>From South |      |       |            | River Rd<br>From West |      |       |            | Int. Total |
|--|----------------------------|------|-------|------------|-----------------------|------|-------|------------|---------------------------|------|-------|------------|-----------------------|------|-------|------------|------------|
|  | Left                       | Thru | Right | App. Total | Left                  | Thru | Right | App. Total | Left                      | Thru | Right | App. Total | Left                  | Thru | Right | App. Total |            |
| Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1 |                            |      |       |            |                       |      |       |            |                           |      |       |            |                       |      |       |            |            |
| Peak Hour for Entire Intersection Begins at 04:00 PM       |                            |      |       |            |                       |      |       |            |                           |      |       |            |                       |      |       |            |            |
| 04:00 PM   | 2                          | 0    | 0     | 2          | 0                     | 0    | 0     | 0          | 0                         | 1    | 0     | 1          | 0                     | 0    | 0     | 0          | 3          |
| 04:15 PM   | 0                          | 0    | 0     | 0          | 0                     | 0    | 0     | 0          | 0                         | 0    | 0     | 0          | 0                     | 0    | 0     | 0          | 0          |
| 04:30 PM   | 2                          | 0    | 0     | 2          | 0                     | 0    | 1     | 1          | 0                         | 0    | 0     | 0          | 0                     | 0    | 0     | 0          | 3          |
| 04:45 PM   | 0                          | 0    | 0     | 0          | 0                     | 0    | 3     | 3          | 0                         | 0    | 1     | 1          | 0                     | 0    | 0     | 0          | 4          |
| Total Volume   | 4                          | 0    | 0     | 4          | 0                     | 0    | 4     | 4          | 0                         | 1    | 1     | 2          | 0                     | 0    | 0     | 0          | 10         |
| % App. Total   | 100                        | 0    | 0     |            | 0                     | 0    | 100   |            | 0                         | 50   | 50    |            | 0                     | 0    | 0     |            |            |
| PHF  | .500                       | .000 | .000  | .500       | .000                  | .000 | .333  | .333       | .000                      | .250 | .250  | .500       | .000                  | .000 | .000  | .000       | .625       |

# Accurate Counts

978-664-2565

File Name : 76130003  
 Site Code : 76130003  
 Start Date : 10/26/2017  
 Page No : 11

N/S Street : Minuteman Rd / Shattuck Rd  
 E/W Street : River Road  
 City/State : Andover, MA  
 Weather : Rain



Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1

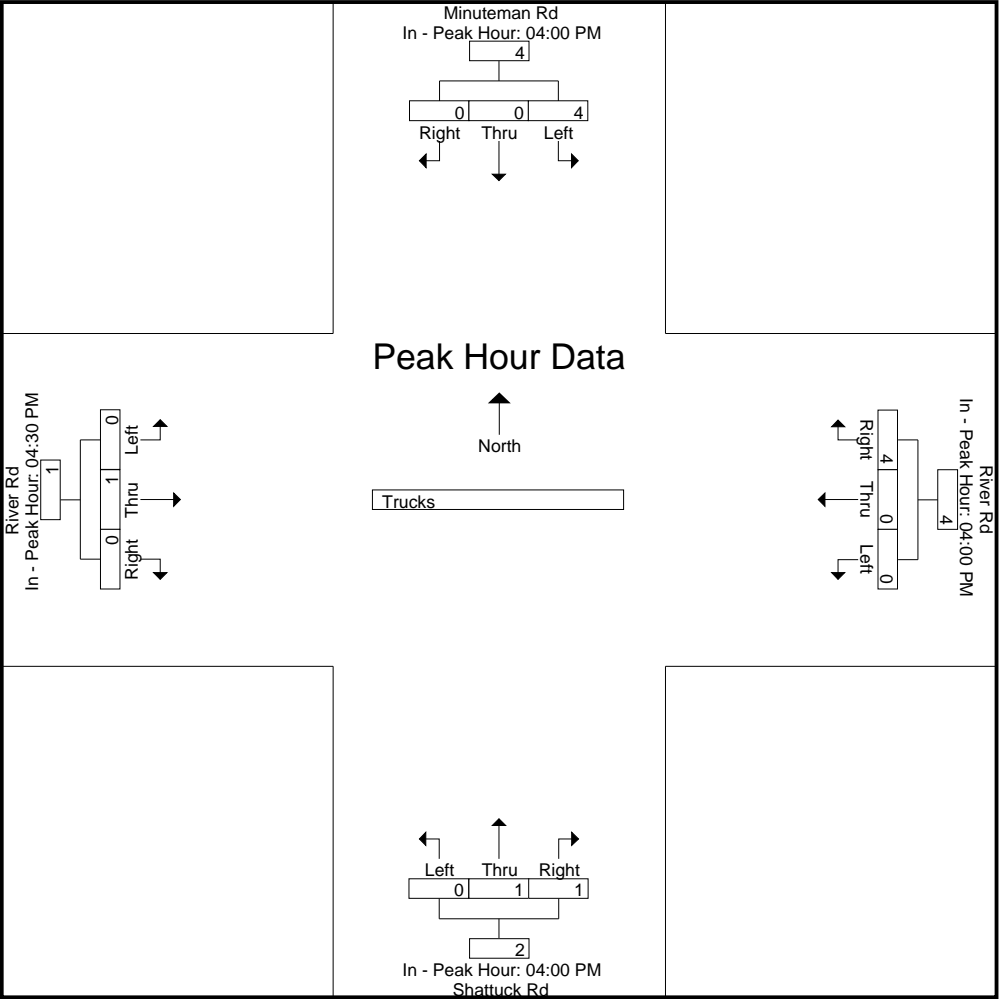
Peak Hour for Each Approach Begins at:

|              | 04:00 PM |   |   |   | 04:00 PM |   |     |   | 04:00 PM |    |    |   | 04:30 PM |     |   |   |
|--------------|----------|---|---|---|----------|---|-----|---|----------|----|----|---|----------|-----|---|---|
| +0 mins.     | 2        | 0 | 0 | 2 | 0        | 0 | 0   | 0 | 0        | 1  | 0  | 1 | 0        | 0   | 0 | 0 |
| +15 mins.    | 0        | 0 | 0 | 0 | 0        | 0 | 0   | 0 | 0        | 0  | 0  | 0 | 0        | 0   | 0 | 0 |
| +30 mins.    | 2        | 0 | 0 | 2 | 0        | 0 | 1   | 1 | 0        | 0  | 0  | 0 | 0        | 0   | 0 | 0 |
| +45 mins.    | 0        | 0 | 0 | 0 | 0        | 0 | 3   | 3 | 0        | 0  | 1  | 1 | 0        | 1   | 0 | 1 |
| Total Volume | 4        | 0 | 0 | 4 | 0        | 0 | 4   | 4 | 0        | 1  | 1  | 2 | 0        | 1   | 0 | 1 |
| % App. Total | 100      | 0 | 0 |   | 0        | 0 | 100 |   | 0        | 50 | 50 |   | 0        | 100 | 0 |   |

# Accurate Counts

978-664-2565

|     |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| PHF | .500 | .000 | .000 | .500 | .000 | .000 | .333 | .333 | .000 | .250 | .250 | .500 | .000 | .250 | .000 | .250 |
|-----|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|



**Accurate Counts**

978-664-2565

File Name : 76130003  
 Site Code : 76130003  
 Start Date : 10/26/2017  
 Page No : 13

N/S Street : Minuteman Rd / Shattuck Rd  
 E/W Street : River Road  
 City/State : Andover, MA  
 Weather : Rain

Groups Printed- Bikes Peds

| Start Time         | Minuteman Rd<br>From North |      |       |      | River Rd<br>From East |      |       |      | Shattuck Rd<br>From South |      |       |      | River Rd<br>From West |      |       |      | Exclu. Total | Inclu. Total | Int. Total |
|--------------------|----------------------------|------|-------|------|-----------------------|------|-------|------|---------------------------|------|-------|------|-----------------------|------|-------|------|--------------|--------------|------------|
|                    | Left                       | Thru | Right | Peds | Left                  | Thru | Right | Peds | Left                      | Thru | Right | Peds | Left                  | Thru | Right | Peds |              |              |            |
| 04:00 PM           | 0                          | 0    | 0     | 0    | 0                     | 0    | 0     | 0    | 0                         | 0    | 0     | 0    | 0                     | 0    | 0     | 0    | 0            | 0            | 0          |
| 04:15 PM           | 0                          | 0    | 0     | 1    | 0                     | 0    | 0     | 0    | 0                         | 0    | 0     | 0    | 0                     | 0    | 0     | 1    | 2            | 0            | 2          |
| 04:30 PM           | 0                          | 0    | 0     | 0    | 0                     | 0    | 0     | 0    | 0                         | 0    | 0     | 0    | 0                     | 0    | 0     | 0    | 0            | 0            | 0          |
| 04:45 PM           | 0                          | 0    | 0     | 0    | 0                     | 0    | 0     | 0    | 0                         | 0    | 0     | 0    | 0                     | 0    | 0     | 0    | 0            | 0            | 0          |
| <b>Total</b>       | 0                          | 0    | 0     | 1    | 0                     | 0    | 0     | 0    | 0                         | 0    | 0     | 0    | 0                     | 0    | 0     | 1    | 2            | 0            | 2          |
| 05:00 PM           | 0                          | 0    | 0     | 0    | 0                     | 0    | 0     | 0    | 0                         | 0    | 0     | 0    | 0                     | 0    | 0     | 0    | 0            | 0            | 0          |
| 05:15 PM           | 0                          | 0    | 0     | 0    | 0                     | 0    | 0     | 0    | 0                         | 0    | 0     | 0    | 0                     | 0    | 0     | 0    | 0            | 0            | 0          |
| 05:30 PM           | 0                          | 0    | 0     | 0    | 0                     | 0    | 0     | 0    | 0                         | 0    | 0     | 0    | 0                     | 0    | 0     | 0    | 0            | 0            | 0          |
| 05:45 PM           | 0                          | 0    | 0     | 0    | 0                     | 0    | 0     | 0    | 0                         | 0    | 0     | 0    | 0                     | 0    | 0     | 0    | 0            | 0            | 0          |
| <b>Total</b>       | 0                          | 0    | 0     | 0    | 0                     | 0    | 0     | 0    | 0                         | 0    | 0     | 0    | 0                     | 0    | 0     | 0    | 0            | 0            | 0          |
| <b>Grand Total</b> | 0                          | 0    | 0     | 1    | 0                     | 0    | 0     | 0    | 0                         | 0    | 0     | 0    | 0                     | 0    | 0     | 1    | 2            | 0            | 2          |
| Apprch %           | 0                          | 0    | 0     |      | 0                     | 0    | 0     |      | 0                         | 0    | 0     |      | 0                     | 0    | 0     |      |              |              |            |
| Total %            |                            |      |       |      |                       |      |       |      |                           |      |       |      |                       |      |       |      | 100          | 0            |            |

**Accurate Counts**

978-664-2565

File Name : 76130003  
 Site Code : 76130003  
 Start Date : 10/26/2017  
 Page No : 14

N/S Street : Minuteman Rd / Shattuck Rd  
 E/W Street : River Road  
 City/State : Andover, MA  
 Weather : Rain

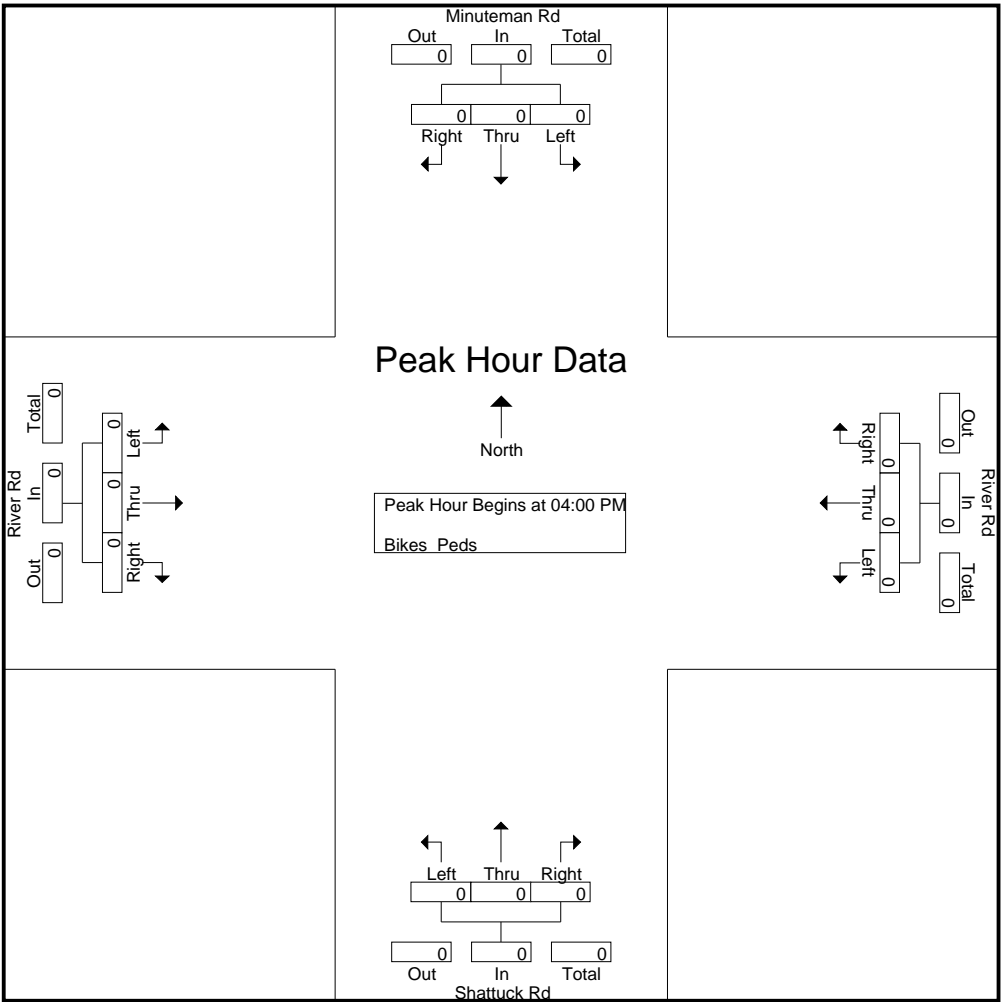
| Start Time   | Minuteman Rd<br>From North |      |       |            | River Rd<br>From East |      |       |            | Shattuck Rd<br>From South |      |       |            | River Rd<br>From West |      |       |            | Int. Total |
|--|----------------------------|------|-------|------------|-----------------------|------|-------|------------|---------------------------|------|-------|------------|-----------------------|------|-------|------------|------------|
|  | Left                       | Thru | Right | App. Total | Left                  | Thru | Right | App. Total | Left                      | Thru | Right | App. Total | Left                  | Thru | Right | App. Total |            |
| Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1 |                            |      |       |            |                       |      |       |            |                           |      |       |            |                       |      |       |            |            |
| Peak Hour for Entire Intersection Begins at 04:00 PM       |                            |      |       |            |                       |      |       |            |                           |      |       |            |                       |      |       |            |            |
| 04:00 PM   | 0                          | 0    | 0     | 0          | 0                     | 0    | 0     | 0          | 0                         | 0    | 0     | 0          | 0                     | 0    | 0     | 0          | 0          |
| 04:15 PM   | 0                          | 0    | 0     | 0          | 0                     | 0    | 0     | 0          | 0                         | 0    | 0     | 0          | 0                     | 0    | 0     | 0          | 0          |
| 04:30 PM   | 0                          | 0    | 0     | 0          | 0                     | 0    | 0     | 0          | 0                         | 0    | 0     | 0          | 0                     | 0    | 0     | 0          | 0          |
| 04:45 PM   | 0                          | 0    | 0     | 0          | 0                     | 0    | 0     | 0          | 0                         | 0    | 0     | 0          | 0                     | 0    | 0     | 0          | 0          |
| Total Volume   | 0                          | 0    | 0     | 0          | 0                     | 0    | 0     | 0          | 0                         | 0    | 0     | 0          | 0                     | 0    | 0     | 0          | 0          |
| % App. Total   | 0                          | 0    | 0     |            | 0                     | 0    | 0     |            | 0                         | 0    | 0     |            | 0                     | 0    | 0     |            |            |
| PHF  | .000                       | .000 | .000  | .000       | .000                  | .000 | .000  | .000       | .000                      | .000 | .000  | .000       | .000                  | .000 | .000  | .000       | .000       |

# Accurate Counts

978-664-2565

File Name : 76130003  
 Site Code : 76130003  
 Start Date : 10/26/2017  
 Page No : 15

N/S Street : Minuteman Rd / Shattuck Rd  
 E/W Street : River Road  
 City/State : Andover, MA  
 Weather : Rain



Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1

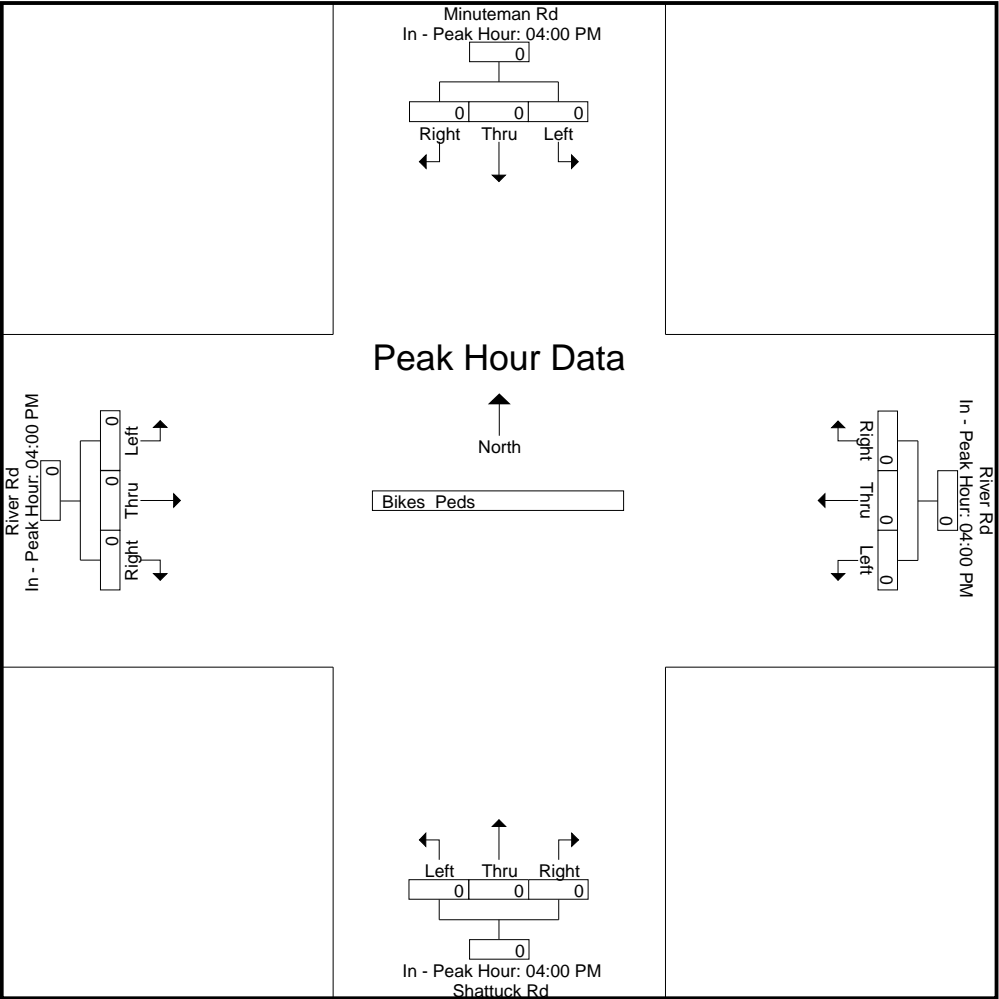
Peak Hour for Each Approach Begins at:

|              | 04:00 PM |   |   |   | 04:00 PM |   |   |   | 04:00 PM |   |   |   | 04:00 PM |   |   |   |
|--------------|----------|---|---|---|----------|---|---|---|----------|---|---|---|----------|---|---|---|
| +0 mins.     | 0        | 0 | 0 | 0 | 0        | 0 | 0 | 0 | 0        | 0 | 0 | 0 | 0        | 0 | 0 | 0 |
| +15 mins.    | 0        | 0 | 0 | 0 | 0        | 0 | 0 | 0 | 0        | 0 | 0 | 0 | 0        | 0 | 0 | 0 |
| +30 mins.    | 0        | 0 | 0 | 0 | 0        | 0 | 0 | 0 | 0        | 0 | 0 | 0 | 0        | 0 | 0 | 0 |
| +45 mins.    | 0        | 0 | 0 | 0 | 0        | 0 | 0 | 0 | 0        | 0 | 0 | 0 | 0        | 0 | 0 | 0 |
| Total Volume | 0        | 0 | 0 | 0 | 0        | 0 | 0 | 0 | 0        | 0 | 0 | 0 | 0        | 0 | 0 | 0 |
| % App. Total | 0        | 0 | 0 |   | 0        | 0 | 0 |   | 0        | 0 | 0 |   | 0        | 0 | 0 |   |

# Accurate Counts

978-664-2565

PHF | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000



SEASONAL ADJUSTMENT DATA

---



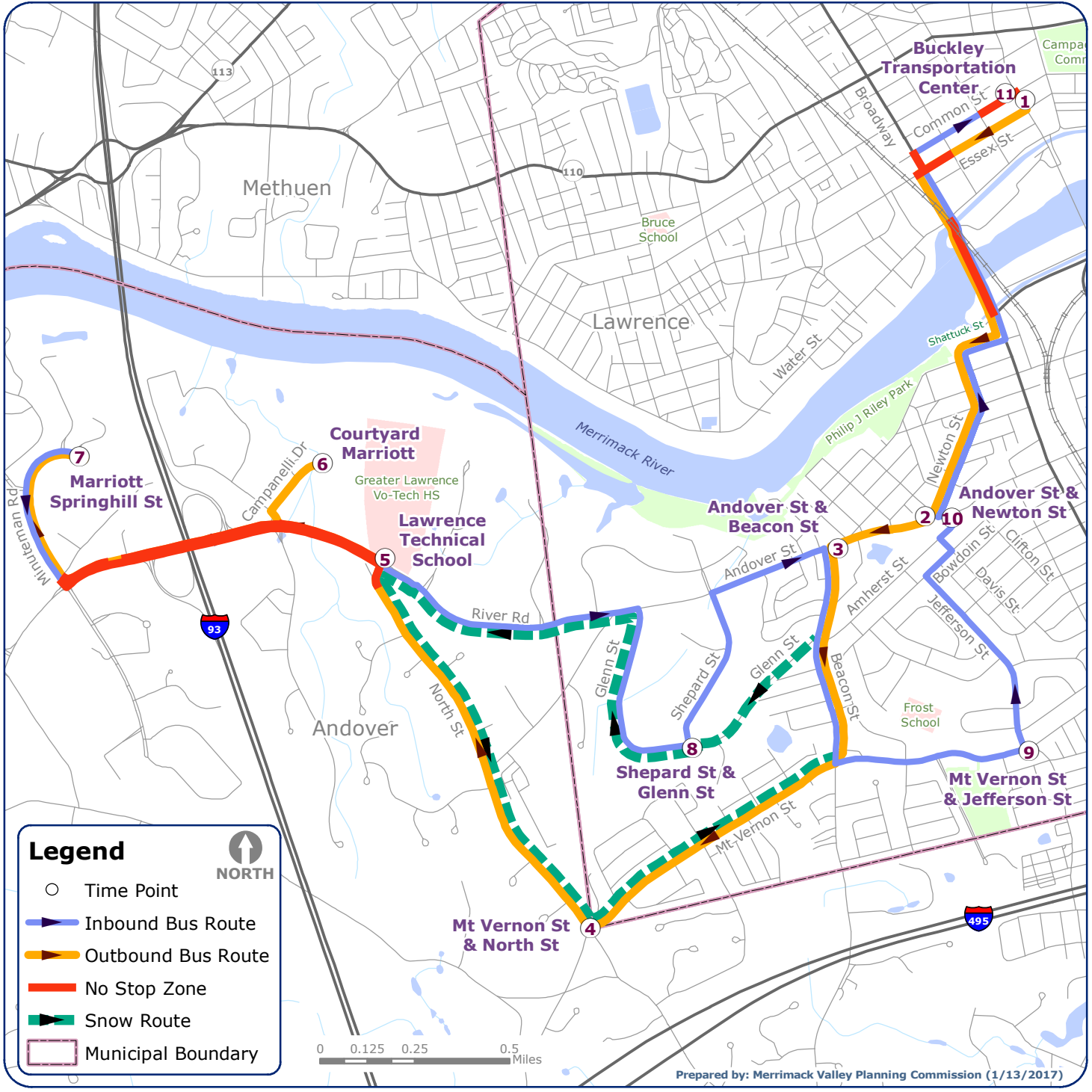




PUBLIC TRANSPORTATION INFORMATION

---





**Legend**

- Time Point
- ▶ Inbound Bus Route
- ▶ Outbound Bus Route
- No Stop Zone
- Snow Route
- Municipal Boundary





# Fares

|                       |   |
|-----------------------|---|
| Fares                 | ▼ |
| Statewide Access Pass | ▼ |
| How to Ride           | ▼ |
| More                  | ▼ |

All fares are one-way. All-Day and 31-Day Passes are available.

The MBTA Charlie Card is also accepted at these fares. [Learn more about the CharlieCard here.](#)

[Click here to learn how to use the MVRTA Charlie Card.](#)

Si necesita esta información en español, contacte a la Coordinadora del Título VI de la MVRTA al 978- 469- 6878 x134 o por correo electrónico a: [mchester@mvrta.com](mailto:mchester@mvrta.com).

Nếu quý vị cần thông tin này bằng tiếng Việt, vui lòng liên hệ với Điều phối viên Luật VI của MVRTA theo số 978- 469- 6878 x134 hoặc địa chỉ email: [mchester@mvrta.com](mailto:mchester@mvrta.com).

如果需要简体中文信息, 请联系MVRTA Title VI协调员, 电话: 978- 469- 6878 x134, 电子邮件: [mchester@mvrta.com](mailto:mchester@mvrta.com).

## Fixed Route Fares

| FIXED ROUTE FARE                | CASH   | CHARLIE CARD |
|---------------------------------|--------|--------------|
| Full Fare                       | \$1.25 | \$1.00       |
| Reduced Fare*                   | \$.60  | \$.50        |
| Children 5 & under (with adult) | Free   | Free         |
| Transfers                       | Free   | Free         |

\*Reduced fare available to:

- Senior Citizens (60+)
- Passengers with disabilities
- Passengers with valid Medicare Card
- Students (13-17)
- Children (6-12)
- Passengers with Statewide Access Pass

Any state-issued ID with your date of birth may be used as proof of age for reduced fare

## Beach Bus Fares

| BEACH BUS FARE          | CASH / CHARLIE CARD | REDUCED FARE |
|-------------------------|---------------------|--------------|
| To/From Salisbury Beach | \$2.00              | \$1.00       |
| To/From Hampton Beach   | \$3.00              | \$1.50       |

- No transfers
- Day passes not accepted
- Monthly passes can only be used up to Salisbury Beach

## Passes

| TYPE | PRICE |
|------|-------|
|------|-------|

| TYPE                        | PRICE   |
|-----------------------------|---------|
| 31-Day Pass Full Fare       | \$30.00 |
| 31-Day Pass, Reduced Fare*  | \$15.00 |
| All-Day Pass Full Fare      | \$3.00  |
| All-Day Pass, Reduced Fare* | \$1.50  |

\*Reduced fare available to:

- Senior Citizens (60+)
- Passengers with disabilities
- Passengers with valid Medicare Card
- Students (13-17)
- Children (6-12)
- Passengers with Statewide Access Pass

Any state-issued ID with your date of birth may be used as proof of age for reduced fare

All Day Passes allow one passenger unlimited rides for an entire day. When boarding the MVRTA bus, simply advise the bus operator that you would like to purchase an All-Day Pass. The All-Day Pass will then be issued directly from the farebox once you deposit the appropriate fare. To use the pass, simply swipe it through the farebox each time you board the bus.

[Haga clic aquí para tarifas.](#)

[点击这里查看票价。](#)

[Bấm vào đây để giá vé.](#)

## Pass Purchase Locations:

Washington Square Transit Station  
12 Washington Sq.  
Haverhill, Ma. 01830  
(978) 372-3900

Buckley Transportation Center  
295 Common St.  
Lawrence, Ma. 01840  
(978) 688-8903

## Lost & Damaged Tickets

Tickets are not refundable and lost, stolen, or damaged tickets cannot be replaced.

## Lost & Damaged Charlie Cards

Lost, stolen, and damaged Charlie Cards should be reported immediately to preserve as much value as possible. Riders are responsible for fares while lost, stolen, or damaged Charlie Cards issues are resolved.

## Contact Us

MVRTA Administrative Offices

🕒 Monday - Friday  
8:00AM - 5:00PM

📍 85 Railroad Avenue  
Haverhill, MA 01835

📞 (978) 469-6878

📠 (978) 521-5956

✉️ [marketing@mvrta.com](mailto:marketing@mvrta.com)

## Administration

Advisory Board Meeting  
Careers  
Contact Us

## Follow Us

👍 Like us on Facebook

🐦 Follow @MVRTA\_on Twitter

## About MVRTA

The MVRTA serves the northeast corner of Massachusetts with over 1 million miles of scheduled bus routes, and elderly and disabled transportation.

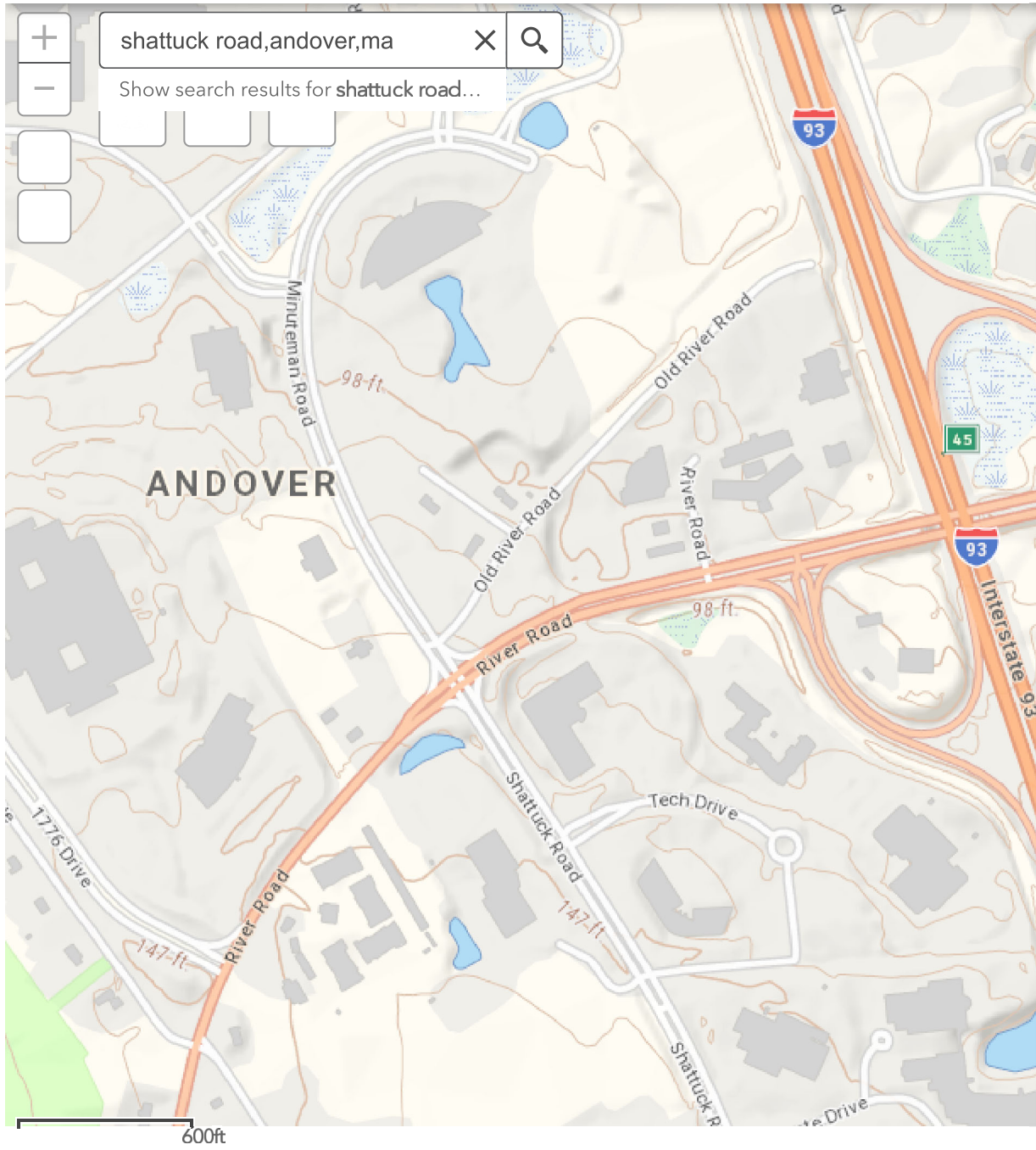
MASSDOT CRASH RATE WORKSHEETS AND HIGH CRASH LOCATION MAPPING





# Top Crash Locations

Accessible Version



-71.199 42.692 Degrees

## Legend

### Crash Clusters

Top 200 Intersection Cluster 2015-2017



2015-2017 HSIP Cluster



2008-2017 HSIP Bicycle Clusters



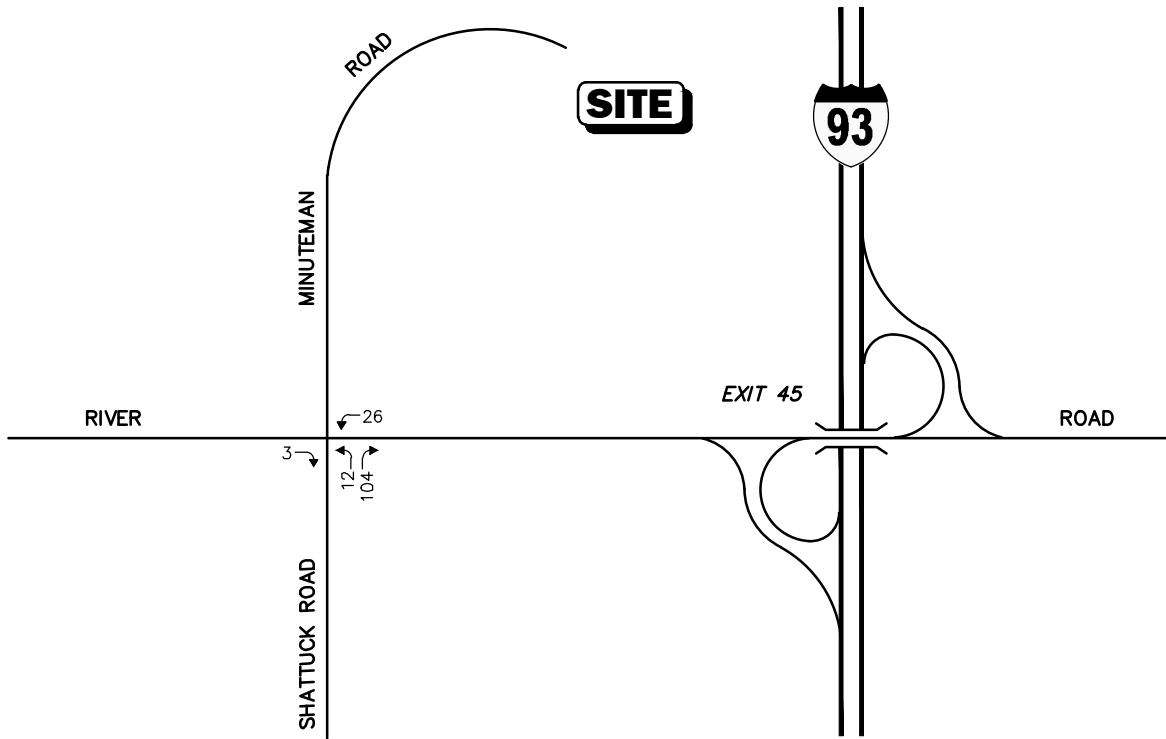
2008-2017 HSIP Pedestrian Cluster



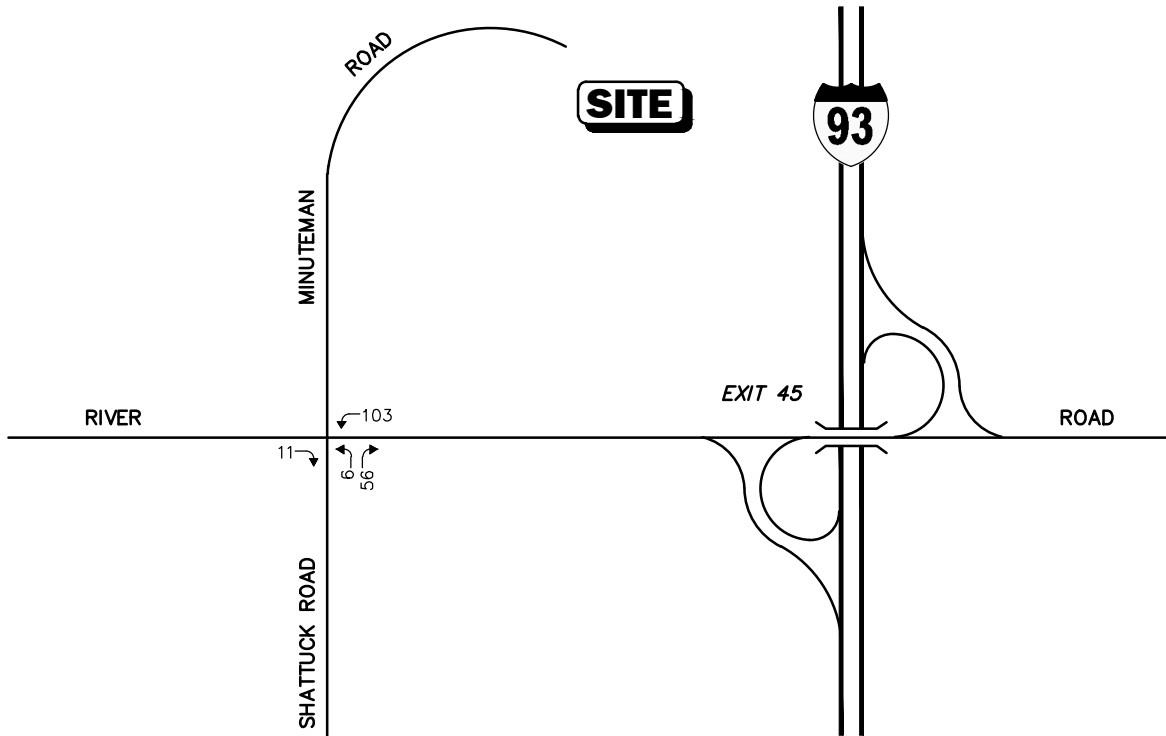
BACKGROUND DEVELOPMENT TRAFFIC-VOLUME NETWORKS



WEEKDAY MORNING PEAK HOUR (7:30 - 8:30 AM)



WEEKDAY EVENING PEAK HOUR (4:30 - 5:30 PM)



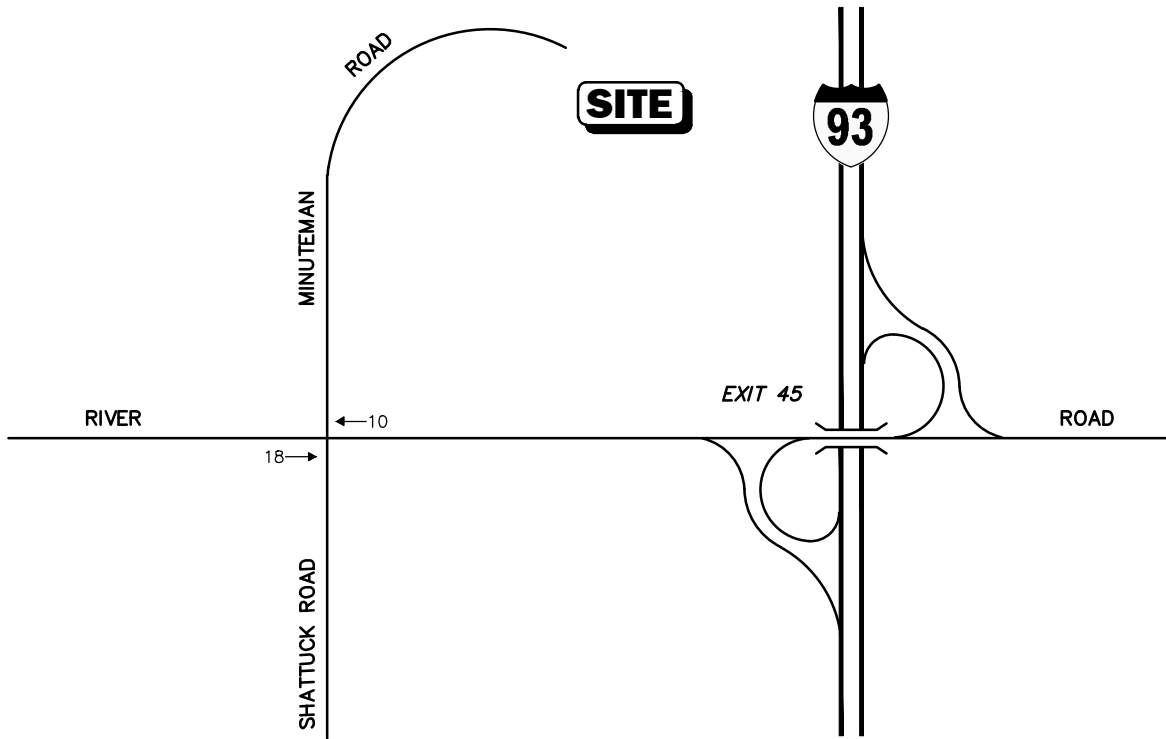
 Not To Scale

Figure A-1

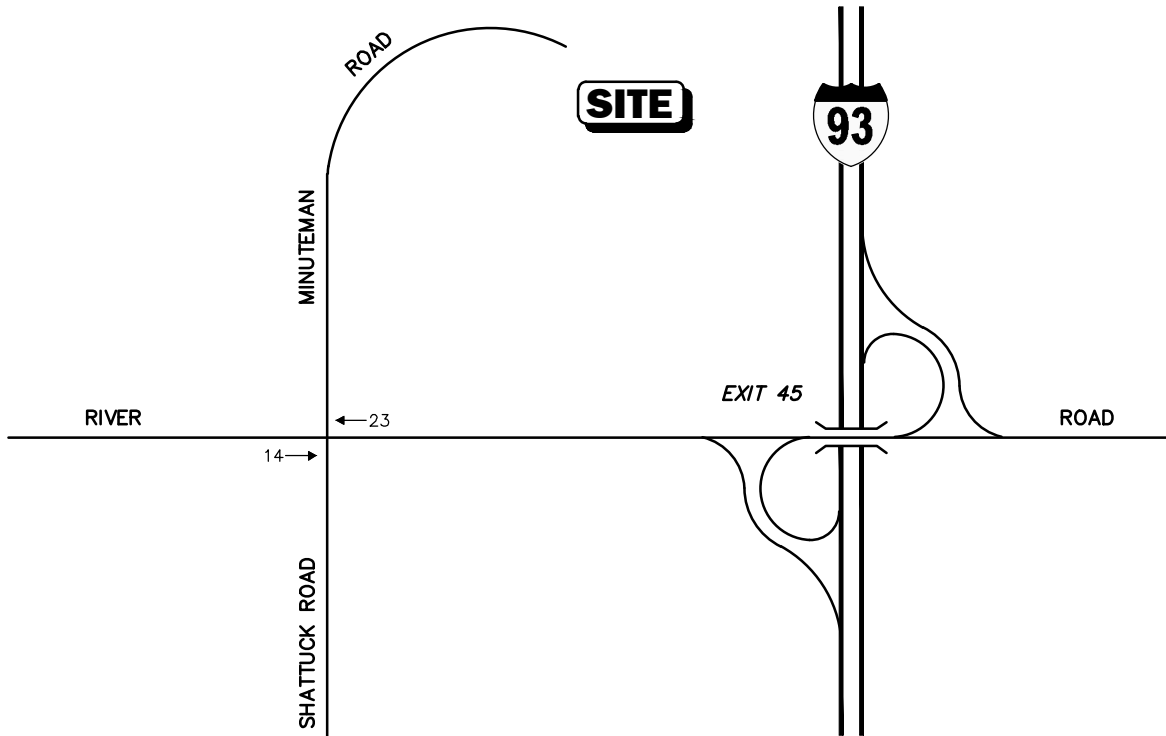


The Lodge at Andover  
30 Shattuck Road  
Peak-Hour Traffic Volumes

WEEKDAY MORNING PEAK HOUR (7:30 - 8:30 AM)



WEEKDAY EVENING PEAK HOUR (4:30 - 5:30 PM)

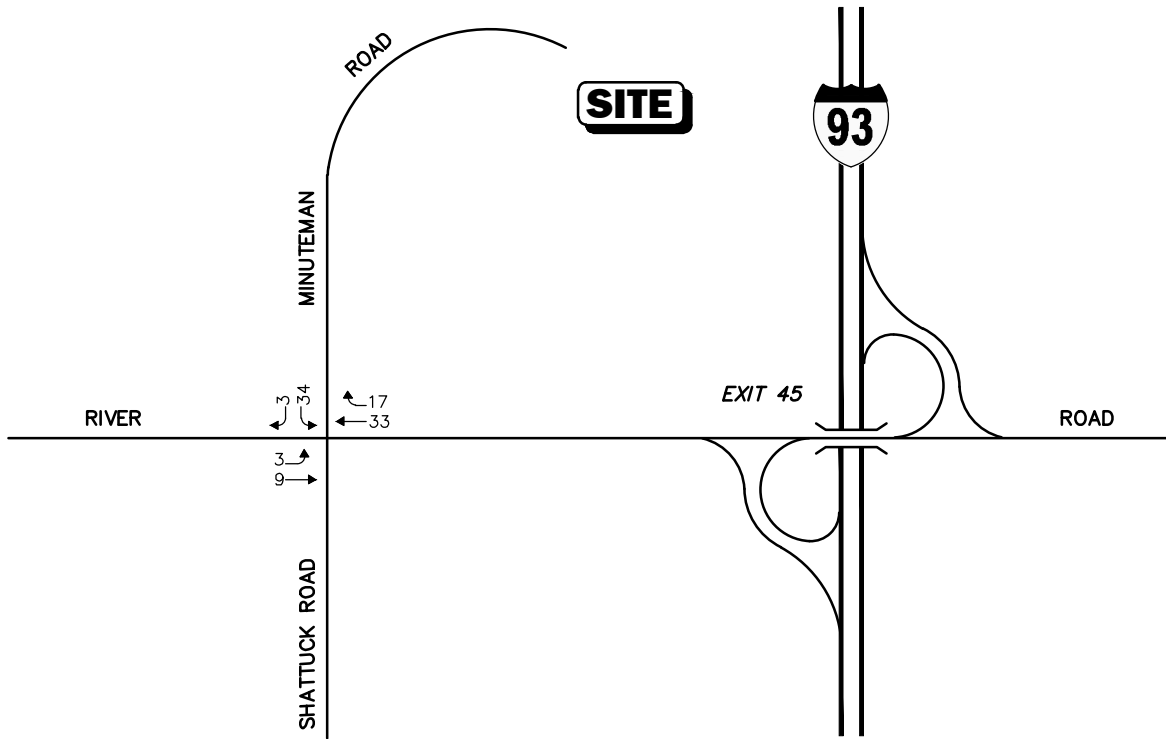


 Not To Scale

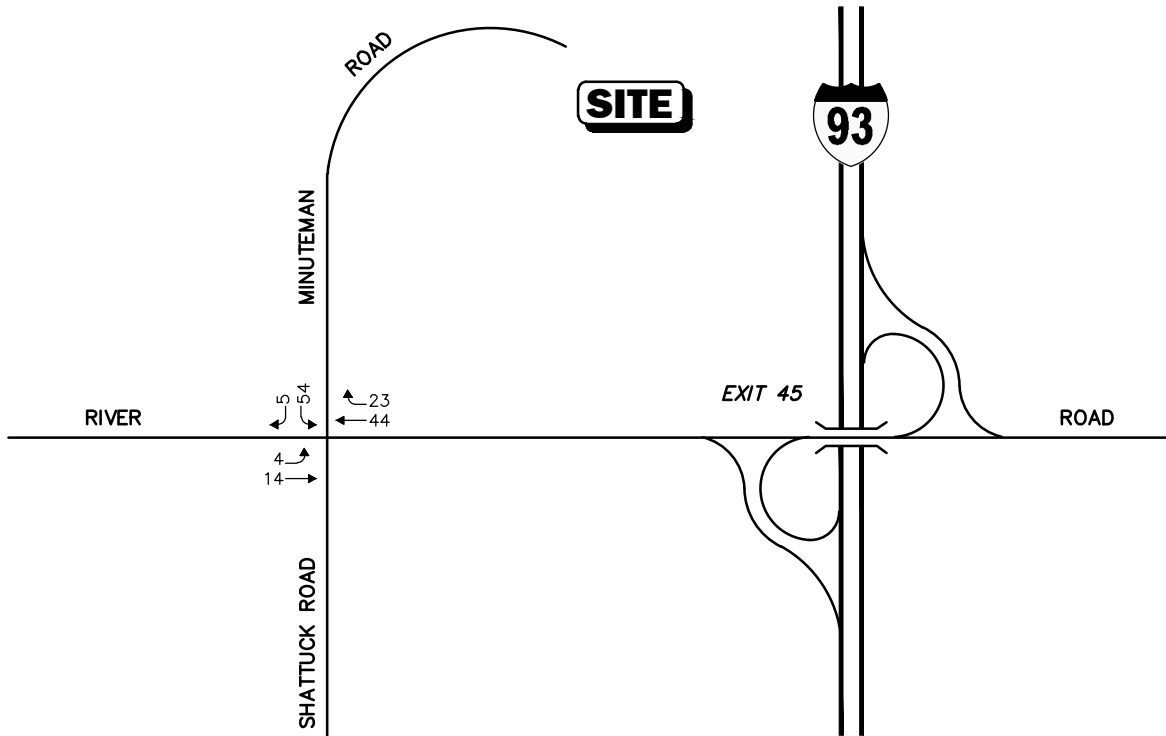
Figure A-2

R:\8853\8853NT1.dwg, 5/12/2021 11:53:56 AM

WEEKDAY MORNING PEAK HOUR (7:30 - 8:30 AM)



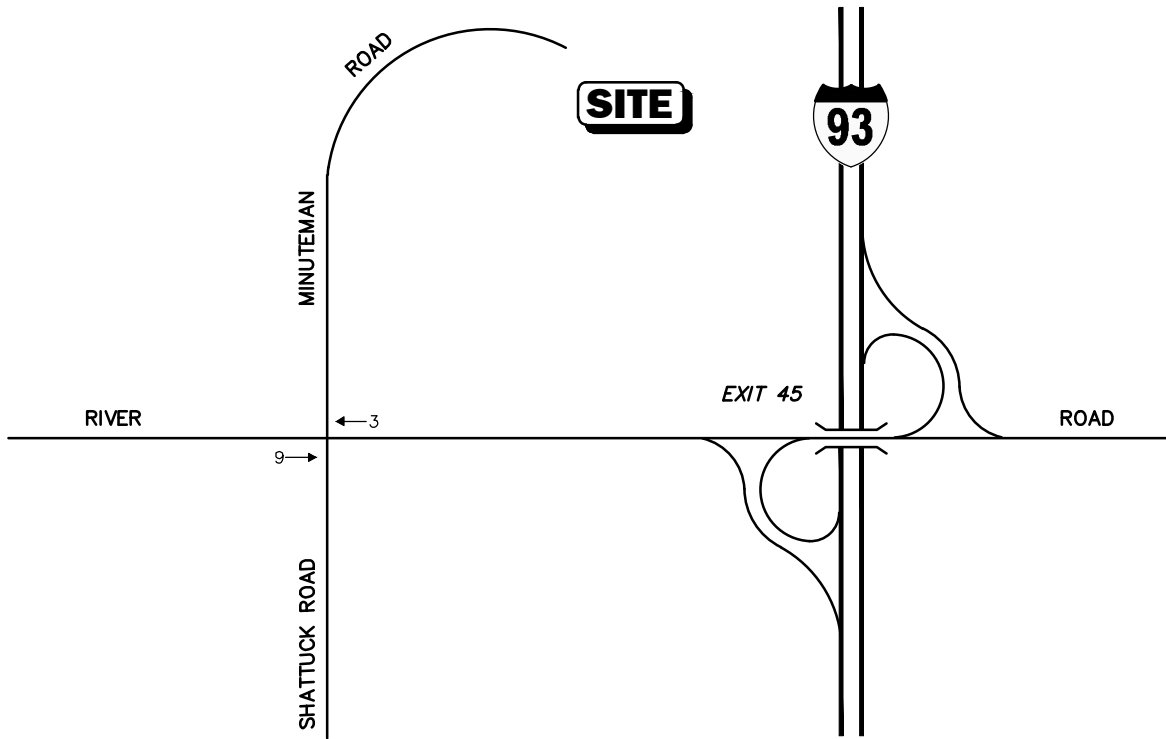
WEEKDAY EVENING PEAK HOUR (4:30 - 5:30 PM)



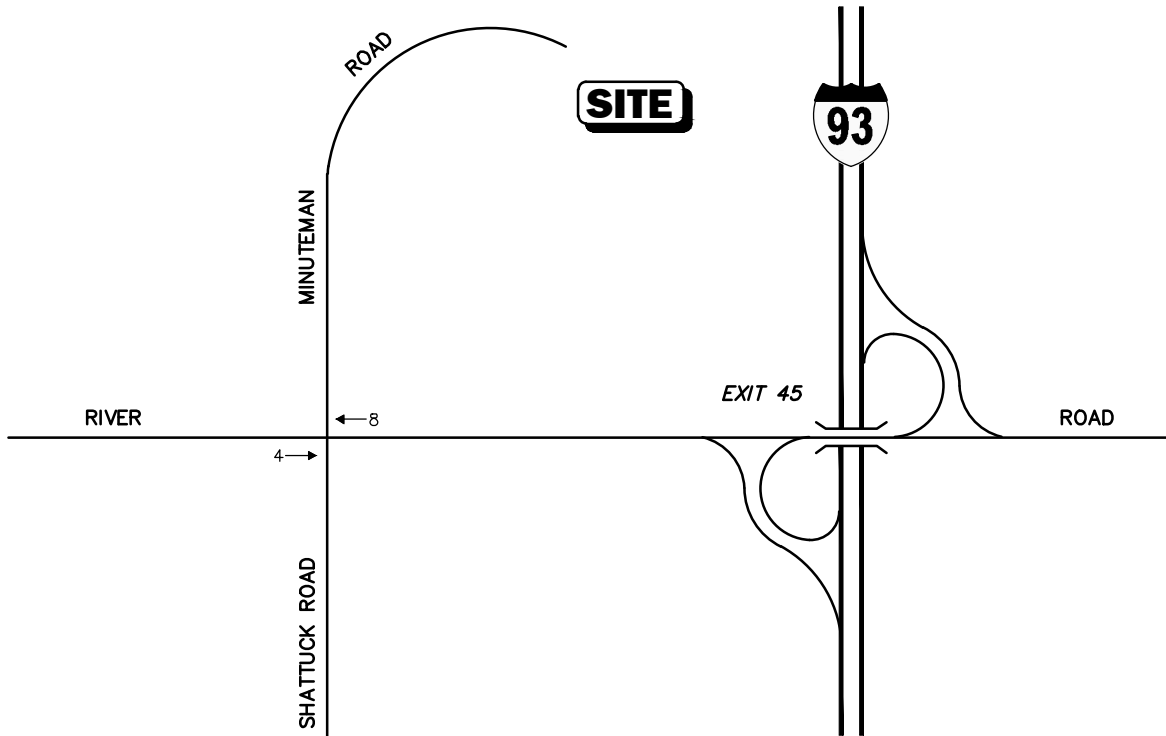
 Not To Scale

Figure A-3

WEEKDAY MORNING PEAK HOUR (7:30 - 8:30 AM)



WEEKDAY EVENING PEAK HOUR (4:30 - 5:30 PM)



 Not To Scale

Figure A-4

GENERAL BACKGROUND TRAFFIC GROWTH

---



**General Background Traffic Growth - Daily Traffic Volumes**

| CITY/TOWN | ROUTE/STREET    | LOCATION                   | 2009    | 2010    | 2011 | 2012    | 2013    | 2014    | 2015    | 2016    | 2017   | 2018    | 2019    | Average Annual |
|-----------|-----------------|----------------------------|---------|---------|------|---------|---------|---------|---------|---------|--------|---------|---------|----------------|
| Andover   | I-93 (STA 5124) | South of Methuen City Line | 123,633 | 124,488 |      | 123,295 | 121,630 | 123,614 | 126,235 | 129,908 | 130817 | 132,947 | 134,409 | 1.02%          |

TRIP-GENERATION CALCULATIONS

---



**Institute of Transportation Engineers (ITE)**  
**Trip Generation, 11 th Edition**  
**Land Use Code (LUC) 710 - General Office Building**

Average Vehicle Trips Ends vs: 1,000 Square Feet Gross Floor Area  
 Independent Variable (X): 67.990

**AVERAGE WEEKDAY DAILY**

$$\ln T = 0.87 \ln(X) + 3.05$$

$$\ln T = 0.87 \ln(67.990) + (3.05)$$

$$\ln T = 6.72$$

$$T = 829.52$$

$$T = 830 \text{ vehicle trips}$$

with 50% ( 415 vpd) entering and 50% ( 415 vpd) exiting.

**WEEKDAY MORNING PEAK HOUR**

$$\ln T = 0.86 \ln(X) + 1.16$$

$$\ln T = 0.86 \ln(67.990) + (1.16)$$

$$\ln T = 4.79$$

$$T = 120.14$$

$$T = 120 \text{ vehicle trips}$$

with 88% ( 106 vpd) entering and 12% ( 14 vpd) exiting.

**WEEKDAY EVENING PEAK HOUR**

$$\ln T = 0.83 \ln(X) + 1.29$$

$$\ln T = 0.83 * \ln(67.990) + (1.29)$$

$$\ln T = 4.79$$

$$T = 120.55$$

$$T = 121 \text{ vehicle trips}$$

with 17% ( 21 vph) entering and 83% ( 100 vph) exiting.

**SATURDAY DAILY**

$$T = 2.21 * (X)$$

$$T = 2.21 * 67.990$$

$$T = 150.26$$

$$T = 150 \text{ vehicle trips}$$

with 50% ( 75 vph) entering and 50% ( 75 vph) exiting.

**SATURDAY PEAK HOUR OF GENERATOR**

$$T = 0.53 * (X)$$

$$T = 0.53 * 67.990$$

$$T = 36.03$$

$$T = 36 \text{ vehicle trips}$$

with 54% ( 19 vph) entering and 46% ( 17 vph) exiting.

**Institute of Transportation Engineers (ITE)**  
**Trip Generation, 11th Edition**  
**Land Use Code (LUC) 140 - Manufacturing**

Average Vehicle Trips Ends vs: 1000 Sq. Feet Gross Floor Area  
Independent Variable (X): 88.640

**AVERAGE WEEKDAY DAILY**

$$T = 4.75 * (X)$$

$$T = 4.75 * 88.64$$

$$T = 421.04$$

$$T = 422 \text{ vehicle trips}$$

with 50% ( 211 vph) entering and 50% ( 211 vph) exiting.

**WEEKDAY MORNING PEAK HOUR OF ADJACENT STREET TRAFFIC**

$$T = 0.68 * (X)$$

$$T = 0.68 * 88.64$$

$$T = 60.28$$

$$T = 60 \text{ vehicle trips}$$

with 76% ( 46 vph) entering and 23% ( 14 vph) exiting.

**WEEKDAY EVENING PEAK HOUR OF ADJACENT STREET TRAFFIC**

$$T = 0.74 * (X)$$

$$T = 0.74 * 88.64$$

$$T = 65.59$$

$$T = 66 \text{ vehicle trips}$$

with 31% ( 20 vph) entering and 69% ( 46 vph) exiting.

**SATURDAY DAILY**

$$T = 1.49 * (X)$$

$$T = 1.49 * 88.64$$

$$T = 132.07$$

$$T = 132 \text{ vehicle trips}$$

with 50% ( 66 vph) entering and 50% ( 66 vph) exiting.

**SATURDAY MIDDAY PEAK HOUR OF GENERATOR**

$$T = 0.18 * (X)$$

$$T = 0.18 * 88.64$$

$$T = 15.96$$

$$T = 16 \text{ vehicle trips}$$

with 52% ( 8 vph) entering and 48% ( 8 vph) exiting.

**Institute of Transportation Engineers (ITE) - 11th Edition**  
**Land Use Code (LUC) 760 - Research and Development Center**

Average Vehicle Trips Ends vs: 1000 Sq. Feet Gross Floor Area  
Independent Variable (X): 67.89

**AVERAGE WEEKDAY DAILY**

$T = 11.08 * (X)$   
 $T = 11.08 * 67.89$   
 $T = 752.17$   
 $T = 752$  vehicle trips  
with 50% ( 376 vpd) entering and 50% ( 376 vpd) exiting.

**WEEKDAY MORNING PEAK HOUR**

$T = 1.03 * (X)$   
 $T = 1.03 * 67.89$   
 $T = 69.92$   
 $T = 70$  vehicle trips  
with 82% ( 57 vph) entering and 18% ( 13 vph) exiting.

**WEEKDAY EVENING PEAK HOUR**

$T = 0.98 * (X)$   
 $T = 0.98 * 67.89$   
 $T = 66.53$   
 $T = 67.00$   
 $T = 67$  vehicle trips  
with 16% ( 11 vph) entering and 84% ( 56 vph) exiting.

**SATURDAY DAILY**

$T = 1.91 * (X)$   
 $T = 1.91 * 67.89$   
 $T = 129.66$   
 $T = 130$  vehicle trips  
with 50% ( 65 vpd) entering and 50% ( 65 vpd) exiting.

**SATURDAY MIDDAY PEAK HOUR OF GENERATOR**

$T = 0.24 * (X)$   
 $T = 0.24 * 67.89$   
 $T = 16.29$   
 $T = 16$  vehicle trips  
with 50% ( 8 vph) entering and 50% ( 8 vph) exiting.

**Trip Generation Summary - Proposed Research & Development Facility - Andover, Massachusetts**

| Land Use                  | Existing | Proposed | Proposed      | Proposed | Delta |
|---------------------------|----------|----------|---------------|----------|-------|
| Size                      | Office   | R&D      | Manufacturing | Total    |       |
|                           | 67990    | 67885    | 95640         | 163525   |       |
| Weekday Morning Peak Hour |          |          |               |          |       |
| Entering                  | 106      | 57       | 46            | 103      | -3    |
| Exiting                   | 14       | 13       | 14            | 27       | 13    |
| Total                     | 120      | 70       | 60            | 130      | 10    |
| Weekday Evening Peak Hour |          |          |               |          |       |
| Entering                  | 21       | 11       | 20            | 31       | 10    |
| Exiting                   | 100      | 56       | 46            | 102      | 2     |
| Total                     | 121      | 67       | 66            | 133      | 12    |
| Weekday Daily             | 830      | 752      | 422           | 1,174    | 344   |

CAPACITY ANALYSIS WORKSHEETS























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HCM Signalized Intersection Capacity Analysis  
 3: River Road & Shattuck Road/Minuteman Road

2022 AM EX

01/31/2022

|                                   |  |  |  |  |  |  |  |  |  |  |  |  |
|-----------------------------------|---|---|---|---|---|---|--|---|---|---|---|---|
| Movement                          | NBL   | NBT   | NBR   | SBL   | SBT   | SBR   | NEL  | NET   | NER   | SWL   | SWT   | SWR   |
| Lane Configurations               |   |  |  |  |  |  |  |  |   |  |  |  |
| Traffic Volume (vph)              | 15  | 2   | 62  | 63  | 2   | 15  | 55   | 338   | 62  | 606   | 537   | 823   |
| Future Volume (vph)               | 15  | 2   | 62  | 63  | 2   | 15  | 55   | 338   | 62  | 606   | 537   | 823   |
| Ideal Flow (vphpl)                | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  | 1900   | 1900  | 1900  | 1900  | 1900  | 1900  |
| Lane Width                        | 10  | 10  | 11  | 13  | 12  | 11  | 13   | 12  | 12  | 11  | 11  | 11  |
| Total Lost time (s)               |   | 4.0   | 4.0   | 4.0   | 4.0   | 3.0   | 4.0  | 4.0   |   | 4.0   | 4.0   | 3.0   |
| Lane Util. Factor                 |   | 1.00  | 0.88  | 0.95  | 0.95  | 1.00  | 1.00   | 0.95  |   | 0.97  | 1.00  | 1.00  |
| Frt                               |   | 1.00  | 0.85  | 1.00  | 1.00  | 0.85  | 1.00   | 0.98  |   | 1.00  | 1.00  | 0.85  |
| Flt Protected                     |   | 0.96  | 1.00  | 0.95  | 0.96  | 1.00  | 0.95   | 1.00  |   | 0.95  | 1.00  | 1.00  |
| Satd. Flow (prot)                 |   | 1519  | 2592  | 1720  | 1668  | 1358  | 1829   | 3467  |   | 3351  | 1818  | 1546  |
| Flt Permitted                     |   | 0.71  | 1.00  | 0.95  | 0.96  | 1.00  | 0.95   | 1.00  |   | 0.95  | 1.00  | 1.00  |
| Satd. Flow (perm)                 |   | 1128  | 2592  | 1720  | 1668  | 1358  | 1829   | 3467  |   | 3351  | 1818  | 1546  |
| Peak-hour factor, PHF             | 0.84  | 0.84  | 0.84  | 0.66  | 0.66  | 0.66  | 0.97   | 0.97  | 0.97  | 0.96  | 0.96  | 0.96  |
| Adj. Flow (vph)                   | 18  | 2   | 74  | 95  | 3   | 23  | 57   | 348   | 64  | 631   | 559   | 857   |
| RTOR Reduction (vph)              | 0   | 0   | 68  | 0   | 0   | 0   | 0  | 15  | 0   | 0   | 0   | 0   |
| Lane Group Flow (vph)             | 0   | 20  | 6   | 49  | 49  | 23  | 57   | 397   | 0   | 631   | 559   | 857   |
| Heavy Vehicles (%)                | 13%   | 0%  | 6%  | 3%  | 9%  | 15%   | 2%   | 2%  | 0%  | 1%  | 1%  | 1%  |
| Turn Type                         | Perm  | NA  | Perm  | Split   | NA  | Free  | Prot   | NA  |   | Prot  | NA  | Free  |
| Protected Phases                  |   | 8   |   | 3   | 3   |   | 5  | 2   |   | 1   | 6   |   |
| Permitted Phases                  | 8   |   | 8   |   |   | Free  |  |   |   |   |   | Free  |
| Actuated Green, G (s)             |   | 5.4   | 5.4   | 6.0   | 6.0   | 80.0  | 4.9  | 29.5  |   | 19.1  | 43.7  | 80.0  |
| Effective Green, g (s)            |   | 6.4   | 6.4   | 7.0   | 7.0   | 80.0  | 5.9  | 30.5  |   | 20.1  | 44.7  | 80.0  |
| Actuated g/C Ratio                |   | 0.08  | 0.08  | 0.09  | 0.09  | 1.00  | 0.07   | 0.38  |   | 0.25  | 0.56  | 1.00  |
| Clearance Time (s)                |   | 5.0   | 5.0   | 5.0   | 5.0   |   | 5.0  | 5.0   |   | 5.0   | 5.0   |   |
| Vehicle Extension (s)             |   | 2.0   | 2.0   | 2.0   | 2.0   |   | 2.0  | 2.0   |   | 2.0   | 2.0   |   |
| Lane Grp Cap (vph)                |   | 90  | 207   | 150   | 145   | 1358  | 134  | 1321  |   | 841   | 1015  | 1546  |
| v/s Ratio Prot                    |   |   |   | 0.03  | 0.03  |   | 0.03   | 0.11  |   | c0.19   | 0.31  |   |
| v/s Ratio Perm                    |   | 0.02  | 0.00  |   |   | 0.02  |  |   |   |   |   | c0.55   |
| v/c Ratio                         |   | 0.22  | 0.03  | 0.33  | 0.34  | 0.02  | 0.43   | 0.30  |   | 0.75  | 0.55  | 0.55  |
| Uniform Delay, d1                 |   | 34.5  | 33.9  | 34.3  | 34.3  | 0.0   | 35.4   | 17.3  |   | 27.6  | 11.2  | 0.0   |
| Progression Factor                |   | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00   | 1.00  |   | 1.03  | 0.87  | 1.00  |
| Incremental Delay, d2             |   | 0.5   | 0.0   | 0.5   | 0.5   | 0.0   | 0.8  | 0.6   |   | 0.3   | 0.2   | 0.1   |
| Delay (s)                         |   | 34.9  | 34.0  | 34.8  | 34.8  | 0.0   | 36.2   | 17.9  |   | 28.8  | 10.0  | 0.1   |
| Level of Service                  |   | C   | C   | C   | C   | A   | D  | B   |   | C   | B   | A   |
| Approach Delay (s)                |   | 34.2  |   |   | 28.2  |   |  | 20.1  |   |   | 11.7  |   |
| Approach LOS                      |   | C   |   |   | C   |   |  | C   |   |   | B   |   |
| <b>Intersection Summary</b>       |   |   |   |   |   |   |  |   |   |   |   |   |
| HCM 2000 Control Delay            |   |   | 14.6  |   |   |   |  |   |   |   |   | HCM 2000 Level of Service B   |
| HCM 2000 Volume to Capacity ratio |   |   | 0.72  |   |   |   |  |   |   |   |   |   |
| Actuated Cycle Length (s)         |   |   | 80.0  |   |   |   |  |   |   |   | 16.0  | Sum of lost time (s)  |
| Intersection Capacity Utilization |   |   | 51.7%   |   |   |   |  |   |   |   |   | ICU Level of Service A  |
| Analysis Period (min)             |   |   | 15  |   |   |   |  |   |   |   |   |   |

c Critical Lane Group

Queues

2022 AM EX

3: River Road & Shattuck Road/Minuteman Road

01/31/2022



| Lane Group              | NBT  | NBR  | SBL  | SBT  | SBR  | NEL  | NET  | SWL  | SWT  | SWR  |
|-------------------------|------|------|------|------|------|------|------|------|------|------|
| Lane Group Flow (vph)   | 20   | 74   | 49   | 49   | 23   | 57   | 412  | 631  | 559  | 857  |
| v/c Ratio               | 0.19 | 0.19 | 0.28 | 0.29 | 0.02 | 0.30 | 0.29 | 0.75 | 0.50 | 0.55 |
| Control Delay           | 37.4 | 1.1  | 36.7 | 37.0 | 0.0  | 36.8 | 19.1 | 28.6 | 12.2 | 0.2  |
| Queue Delay             | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  |
| Total Delay             | 37.4 | 1.1  | 36.7 | 37.0 | 0.0  | 36.8 | 19.1 | 28.6 | 12.2 | 0.2  |
| Queue Length 50th (ft)  | 9    | 0    | 24   | 24   | 0    | 27   | 71   | 151  | 153  | 0    |
| Queue Length 95th (ft)  | 28   | 0    | 40   | 41   | 0    | 60   | 130  | m138 | m208 | m0   |
| Internal Link Dist (ft) | 2059 |      | 1169 |      |      | 124  |      | 409  |      |      |
| Turn Bay Length (ft)    |      |      |      |      |      | 120  |      |      |      |      |
| Base Capacity (vph)     | 183  | 558  | 236  | 229  | 1358 | 480  | 1421 | 922  | 1124 | 1546 |
| Starvation Cap Reductn  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| Spillback Cap Reductn   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| Storage Cap Reductn     | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| Reduced v/c Ratio       | 0.11 | 0.13 | 0.21 | 0.21 | 0.02 | 0.12 | 0.29 | 0.68 | 0.50 | 0.55 |
























Intersection Summary

m Volume for 95th percentile queue is metered by upstream signal.

HCM Signalized Intersection Capacity Analysis  
 3: River Road & Shattuck Road/Minuteman Road

2022 PM EX

01/31/2022

|                                   |  |  |  |  |  |  |  |  |  |  |  |  |
|-----------------------------------|---|---|---|---|---|---|--|---|---|---|---|---|
| Movement                          | NBL   | NBT   | NBR   | SBL   | SBT   | SBR   | NEL  | NET   | NER   | SWL   | SWT   | SWR   |
| Lane Configurations               |   |  |  |  |  |  |  |  |  |  |  |  |
| Traffic Volume (vph)              | 62  | 2   | 606   | 823   | 2   | 55  | 15   | 609   | 15  | 62  | 296   | 63  |
| Future Volume (vph)               | 62  | 2   | 606   | 823   | 2   | 55  | 15   | 609   | 15  | 62  | 296   | 63  |
| Ideal Flow (vphpl)                | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  | 1900   | 1900  | 1900  | 1900  | 1900  | 1900  |
| Lane Width                        | 10  | 10  | 11  | 12  | 12  | 12  | 12   | 12  | 12  | 11  | 11  | 11  |
| Total Lost time (s)               |   | 4.0   | 4.0   | 4.0   | 4.0   | 3.0   | 4.0  | 4.0   |   | 4.0   | 4.0   | 3.0   |
| Lane Util. Factor                 |   | 1.00  | 0.88  | 0.95  | 0.95  | 1.00  | 1.00   | 0.95  |   | 0.97  | 1.00  | 1.00  |
| Fr <sub>t</sub>                   |   | 1.00  | 0.85  | 1.00  | 1.00  | 0.85  | 1.00   | 1.00  |   | 1.00  | 1.00  | 0.85  |
| Fl <sub>t</sub> Protected         |   | 0.95  | 1.00  | 0.95  | 0.95  | 1.00  | 0.95   | 1.00  |   | 0.95  | 1.00  | 1.00  |
| Satd. Flow (prot)                 |   | 1692  | 2748  | 1698  | 1702  | 1615  | 1805   | 3597  |   | 3351  | 1837  | 1459  |
| Fl <sub>t</sub> Permitted         |   | 0.71  | 1.00  | 0.95  | 0.95  | 1.00  | 0.95   | 1.00  |   | 0.95  | 1.00  | 1.00  |
| Satd. Flow (perm)                 |   | 1256  | 2748  | 1698  | 1702  | 1615  | 1805   | 3597  |   | 3351  | 1837  | 1459  |
| Peak-hour factor, PHF             | 0.74  | 0.74  | 0.74  | 0.87  | 0.87  | 0.87  | 0.84   | 0.84  | 0.84  | 0.85  | 0.85  | 0.85  |
| Adj. Flow (vph)                   | 84  | 3   | 819   | 946   | 2   | 63  | 18   | 725   | 18  | 73  | 348   | 74  |
| RTOR Reduction (vph)              | 0   | 0   | 67  | 0   | 0   | 0   | 0  | 2   | 0   | 0   | 0   | 0   |
| Lane Group Flow (vph)             | 0   | 87  | 752   | 473   | 475   | 63  | 18   | 741   | 0   | 73  | 348   | 74  |
| Heavy Vehicles (%)                | 0%  | 0%  | 0%  | 1%  | 0%  | 0%  | 0%   | 0%  | 0%  | 1%  | 0%  | 7%  |
| Turn Type                         | Perm  | NA  | pm+ov   | Split   | NA  | Free  | Prot   | NA  |   | Prot  | NA  | Free  |
| Protected Phases                  |   | 8   | 1   | 3   | 3   |   | 5  | 2   |   | 1   | 6   |   |
| Permitted Phases                  | 8   |   | 8   |   |   | Free  |  |   |   |   |   | Free  |
| Actuated Green, G (s)             |   | 8.9   | 21.4  | 22.7  | 22.7  | 80.0  | 1.4  | 15.9  |   | 12.5  | 27.0  | 80.0  |
| Effective Green, g (s)            |   | 9.9   | 23.4  | 23.7  | 23.7  | 80.0  | 2.4  | 16.9  |   | 13.5  | 28.0  | 80.0  |
| Actuated g/C Ratio                |   | 0.12  | 0.29  | 0.30  | 0.30  | 1.00  | 0.03   | 0.21  |   | 0.17  | 0.35  | 1.00  |
| Clearance Time (s)                |   | 5.0   | 5.0   | 5.0   | 5.0   |   | 5.0  | 5.0   |   | 5.0   | 5.0   |   |
| Vehicle Extension (s)             |   | 2.0   | 2.0   | 2.0   | 2.0   |   | 2.0  | 2.0   |   | 2.0   | 2.0   |   |
| Lane Grp Cap (vph)                |   | 155   | 941   | 503   | 504   | 1615  | 54   | 759   |   | 565   | 642   | 1459  |
| v/s Ratio Prot                    |   |   | c0.13   | 0.28  | c0.28   |   | 0.01   | c0.21   |   | 0.02  | 0.19  |   |
| v/s Ratio Perm                    |   | 0.07  | 0.14  |   |   | 0.04  |  |   |   |   |   | 0.05  |
| v/c Ratio                         |   | 0.56  | 0.80  | 0.94  | 0.94  | 0.04  | 0.33   | 0.98  |   | 0.13  | 0.54  | 0.05  |
| Uniform Delay, d <sub>1</sub>     |   | 33.0  | 26.1  | 27.5  | 27.5  | 0.0   | 38.0   | 31.3  |   | 28.3  | 20.9  | 0.0   |
| Progression Factor                |   | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00   | 1.00  |   | 0.62  | 0.82  | 1.00  |
| Incremental Delay, d <sub>2</sub> |   | 2.8   | 4.5   | 25.7  | 26.0  | 0.0   | 1.3  | 27.3  |   | 0.0   | 3.2   | 0.1   |
| Delay (s)                         |   | 35.8  | 30.6  | 53.2  | 53.5  | 0.0   | 39.3   | 58.6  |   | 17.4  | 20.3  | 0.1   |
| Level of Service                  |   | D   | C   | D   | D   | A   | D  | E   |   | B   | C   | A   |
| Approach Delay (s)                |   | 31.1  |   |   | 50.0  |   |  | 58.2  |   |   | 16.9  |   |
| Approach LOS                      |   | C   |   |   | D   |   |  | E   |   |   | B   |   |
| <b>Intersection Summary</b>       |   |   |   |   |   |   |  |   |   |   |   |   |
| HCM 2000 Control Delay            |   |   | 41.4  |   |   |   |  |   |   |   |   | HCM 2000 Level of Service D   |
| HCM 2000 Volume to Capacity ratio |   |   | 0.95  |   |   |   |  |   |   |   |   |   |
| Actuated Cycle Length (s)         |   |   | 80.0  |   |   |   |  |   |   |   | 16.0  | Sum of lost time (s)  |
| Intersection Capacity Utilization |   |   | 71.4%   |   |   |   |  |   |   |   |   | ICU Level of Service C  |
| Analysis Period (min)             |   |   | 15  |   |   |   |  |   |   |   |   |   |

c Critical Lane Group



| Lane Group              | NBT  | NBR  | SBL  | SBT  | SBR  | NEL  | NET  | SWL  | SWT  | SWR  |
|-------------------------|------|------|------|------|------|------|------|------|------|------|
| Lane Group Flow (vph)   | 87   | 819  | 473  | 475  | 63   | 18   | 743  | 73   | 348  | 74   |
| v/c Ratio               | 0.50 | 0.85 | 0.94 | 0.94 | 0.04 | 0.11 | 0.92 | 0.13 | 0.46 | 0.05 |
| Control Delay           | 41.0 | 31.1 | 57.7 | 58.0 | 0.0  | 35.1 | 50.5 | 19.5 | 21.2 | 0.1  |
| Queue Delay             | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  |
| Total Delay             | 41.0 | 31.1 | 57.7 | 58.0 | 0.0  | 35.1 | 50.5 | 19.5 | 21.2 | 0.1  |
| Queue Length 50th (ft)  | 41   | 184  | 240  | 241  | 0    | 9    | ~212 | 13   | 110  | 0    |
| Queue Length 95th (ft)  | 64   | 192  | #406 | #408 | 0    | 26   | #288 | 27   | #313 | 0    |
| Internal Link Dist (ft) | 990  |      |      | 574  |      |      | 124  |      | 409  |      |
| Turn Bay Length (ft)    |      | 190  | 125  |      |      | 120  |      | 350  |      |      |
| Base Capacity (vph)     | 251  | 969  | 509  | 510  | 1615 | 180  | 808  | 565  | 759  | 1459 |
| Starvation Cap Reductn  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| Spillback Cap Reductn   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| Storage Cap Reductn     | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |
| Reduced v/c Ratio       | 0.35 | 0.85 | 0.93 | 0.93 | 0.04 | 0.10 | 0.92 | 0.13 | 0.46 | 0.05 |























**Intersection Summary**

- ~ Volume exceeds capacity, queue is theoretically infinite.  
Queue shown is maximum after two cycles.
- # 95th percentile volume exceeds capacity, queue may be longer.  
Queue shown is maximum after two cycles.

HCM Signalized Intersection Capacity Analysis  
 3: River Road & Shattuck Road/Minuteman Road

2029 AM NB

01/31/2022

|                                   |  |  |  |  |  |  |  |  |  |  |  |  |
|-----------------------------------|---|---|---|---|---|---|--|---|---|---|---|---|
| Movement                          | NBL   | NBT   | NBR   | SBL   | SBT   | SBR   | NEL  | NET   | NER   | SWL   | SWT   | SWR   |
| Lane Configurations               |   |  |  |  |  |  |  |  |   |  |  |  |
| Traffic Volume (vph)              | 28  | 2   | 170   | 131   | 2   | 26  | 97   | 399   | 69  | 676   | 644   | 1039  |
| Future Volume (vph)               | 28  | 2   | 170   | 131   | 2   | 26  | 97   | 399   | 69  | 676   | 644   | 1039  |
| Ideal Flow (vphpl)                | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  | 1900   | 1900  | 1900  | 1900  | 1900  | 1900  |
| Lane Width                        | 10  | 10  | 11  | 13  | 12  | 11  | 13   | 12  | 12  | 11  | 11  | 11  |
| Total Lost time (s)               |   | 4.0   | 4.0   | 4.0   | 4.0   | 3.0   | 4.0  | 4.0   |   | 4.0   | 4.0   | 3.0   |
| Lane Util. Factor                 |   | 1.00  | 0.88  | 0.95  | 0.95  | 1.00  | 1.00   | 0.95  |   | 0.97  | 1.00  | 1.00  |
| Fr <sub>t</sub>                   |   | 1.00  | 0.85  | 1.00  | 1.00  | 0.85  | 1.00   | 0.98  |   | 1.00  | 1.00  | 0.85  |
| Fl <sub>t</sub> Protected         |   | 0.96  | 1.00  | 0.95  | 0.95  | 1.00  | 0.95   | 1.00  |   | 0.95  | 1.00  | 1.00  |
| Satd. Flow (prot)                 |   | 1510  | 2592  | 1720  | 1668  | 1358  | 1829   | 3471  |   | 3351  | 1818  | 1546  |
| Fl <sub>t</sub> Permitted         |   | 0.68  | 1.00  | 0.95  | 0.95  | 1.00  | 0.95   | 1.00  |   | 0.95  | 1.00  | 1.00  |
| Satd. Flow (perm)                 |   | 1082  | 2592  | 1720  | 1668  | 1358  | 1829   | 3471  |   | 3351  | 1818  | 1546  |
| Peak-hour factor, PHF             | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92   | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  |
| Adj. Flow (vph)                   | 30  | 2   | 185   | 142   | 2   | 28  | 105  | 434   | 75  | 735   | 700   | 1129  |
| RTOR Reduction (vph)              | 0   | 0   | 166   | 0   | 0   | 0   | 0  | 16  | 0   | 0   | 0   | 0   |
| Lane Group Flow (vph)             | 0   | 32  | 19  | 72  | 72  | 28  | 105  | 493   | 0   | 735   | 700   | 1129  |
| Heavy Vehicles (%)                | 13%   | 0%  | 6%  | 3%  | 9%  | 15%   | 2%   | 2%  | 0%  | 1%  | 1%  | 1%  |
| Turn Type                         | Perm  | NA  | Perm  | Split   | NA  | Free  | Prot   | NA  |   | Prot  | NA  | Free  |
| Protected Phases                  |   | 8   |   | 3   | 3   |   | 5  | 2   |   | 1   | 6   |   |
| Permitted Phases                  | 8   |   | 8   |   |   | Free  |  |   |   |   |   | Free  |
| Actuated Green, G (s)             |   | 7.3   | 7.3   | 6.7   | 6.7   | 80.0  | 7.9  | 25.0  |   | 21.0  | 38.1  | 80.0  |
| Effective Green, g (s)            |   | 8.3   | 8.3   | 7.7   | 7.7   | 80.0  | 8.9  | 26.0  |   | 22.0  | 39.1  | 80.0  |
| Actuated g/C Ratio                |   | 0.10  | 0.10  | 0.10  | 0.10  | 1.00  | 0.11   | 0.32  |   | 0.28  | 0.49  | 1.00  |
| Clearance Time (s)                |   | 5.0   | 5.0   | 5.0   | 5.0   |   | 5.0  | 5.0   |   | 5.0   | 5.0   |   |
| Vehicle Extension (s)             |   | 2.0   | 2.0   | 2.0   | 2.0   |   | 2.0  | 2.0   |   | 2.0   | 2.0   |   |
| Lane Grp Cap (vph)                |   | 112   | 268   | 165   | 160   | 1358  | 203  | 1128  |   | 921   | 888   | 1546  |
| v/s Ratio Prot                    |   |   |   | 0.04  | 0.04  |   | 0.06   | 0.14  |   | 0.22  | c0.38   |   |
| v/s Ratio Perm                    |   | 0.03  | 0.01  |   |   | 0.02  |  |   |   |   |   | c0.73   |
| v/c Ratio                         |   | 0.29  | 0.07  | 0.44  | 0.45  | 0.02  | 0.52   | 0.44  |   | 0.80  | 0.79  | 0.73  |
| Uniform Delay, d <sub>1</sub>     |   | 33.1  | 32.4  | 34.1  | 34.1  | 0.0   | 33.5   | 21.2  |   | 26.9  | 17.0  | 0.0   |
| Progression Factor                |   | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00   | 1.00  |   | 0.99  | 0.87  | 1.00  |
| Incremental Delay, d <sub>2</sub> |   | 0.5   | 0.0   | 0.7   | 0.7   | 0.0   | 0.9  | 1.2   |   | 0.4   | 0.7   | 0.3   |
| Delay (s)                         |   | 33.6  | 32.4  | 34.8  | 34.9  | 0.0   | 34.5   | 22.5  |   | 27.2  | 15.5  | 0.3   |
| Level of Service                  |   | C   | C   | C   | C   | A   | C  | C   |   | C   | B   | A   |
| Approach Delay (s)                |   | 32.6  |   |   | 29.2  |   |  | 24.5  |   |   | 12.1  |   |
| Approach LOS                      |   | C   |   |   | C   |   |  | C   |   |   | B   |   |
| <b>Intersection Summary</b>       |   |   |   |   |   |   |  |   |   |   |   |   |
| HCM 2000 Control Delay            |   |   | 16.3  |   |   |   |  |   |   |   |   | HCM 2000 Level of Service B   |
| HCM 2000 Volume to Capacity ratio |   |   | 0.92  |   |   |   |  |   |   |   |   |   |
| Actuated Cycle Length (s)         |   |   | 80.0  |   |   |   |  |   |   | 16.0  |   |   |
| Intersection Capacity Utilization |   |   | 59.6%   |   |   |   |  |   |   |   |   | ICU Level of Service B  |
| Analysis Period (min)             |   |   | 15  |   |   |   |  |   |   |   |   |   |

c Critical Lane Group

|                         | ↑    | ↗    | ↖    | ↓    | ↘    | ↙    | ↖    | ↘    | ↙     | ↗    |
|-------------------------|------|------|------|------|------|------|------|------|-------|------|
| Lane Group              | NBT  | NBR  | SBL  | SBT  | SBR  | NEL  | NET  | SWL  | SWT   | SWR  |
| Lane Group Flow (vph)   | 32   | 185  | 72   | 72   | 28   | 105  | 509  | 735  | 700   | 1129 |
| v/c Ratio               | 0.29 | 0.43 | 0.38 | 0.39 | 0.02 | 0.45 | 0.43 | 0.80 | 0.75  | 0.73 |
| Control Delay           | 39.2 | 8.7  | 38.3 | 38.8 | 0.0  | 38.0 | 23.1 | 27.4 | 20.1  | 1.1  |
| Queue Delay             | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0   | 0.0  |
| Total Delay             | 39.2 | 8.7  | 38.3 | 38.8 | 0.0  | 38.0 | 23.1 | 27.4 | 20.1  | 1.1  |
| Queue Length 50th (ft)  | 15   | 0    | 35   | 35   | 0    | 50   | 102  | 164  | 259   | 15   |
| Queue Length 95th (ft)  | 40   | 30   | 74   | 75   | 0    | 92   | 164  | m174 | m#398 | m17  |
| Internal Link Dist (ft) | 2059 |      |      | 1169 |      |      | 124  |      | 409   |      |
| Turn Bay Length (ft)    |      |      |      |      |      | 120  |      |      |       |      |
| Base Capacity (vph)     | 175  | 576  | 236  | 229  | 1358 | 480  | 1189 | 947  | 934   | 1546 |
| Starvation Cap Reductn  | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0     | 0    |
| Spillback Cap Reductn   | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0     | 0    |
| Storage Cap Reductn     | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0    | 0     | 0    |
| Reduced v/c Ratio       | 0.18 | 0.32 | 0.31 | 0.31 | 0.02 | 0.22 | 0.43 | 0.78 | 0.75  | 0.73 |

**Intersection Summary**























# 95th percentile volume exceeds capacity, queue may be longer.  
 Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

HCM Signalized Intersection Capacity Analysis  
 3: River Road & Shattuck Road/Minuteman Road

2029 PM NB

01/31/2022

|                                   |  |  |  |  |  |  |   |  |  |  |  |  |
|-----------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement                          | NBL   | NBT   | NBR   | SBL   | SBT   | SBR   | NEL   | NET   | NER   | SWL   | SWT   | SWR   |
| Lane Configurations               |   |  |  |  |  |  |  |  |   |  |  |  |
| Traffic Volume (vph)              | 72  | 2   | 706   | 1102  | 2   | 105   | 28  | 685   | 27  | 169   | 393   | 122   |
| Future Volume (vph)               | 72  | 2   | 706   | 1102  | 2   | 105   | 28  | 685   | 27  | 169   | 393   | 122   |
| Ideal Flow (vphpl)                | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  |
| Lane Width                        | 10  | 10  | 11  | 12  | 12  | 12  | 12  | 12  | 12  | 11  | 11  | 11  |
| Total Lost time (s)               |   | 4.0   | 4.0   | 4.0   | 4.0   | 3.0   | 4.0   | 4.0   |   | 4.0   | 4.0   | 3.0   |
| Lane Util. Factor                 |   | 1.00  | 0.88  | 0.95  | 0.95  | 1.00  | 1.00  | 0.95  |   | 0.97  | 1.00  | 1.00  |
| Frt                               |   | 1.00  | 0.85  | 1.00  | 1.00  | 0.85  | 1.00  | 0.99  |   | 1.00  | 1.00  | 0.85  |
| Flt Protected                     |   | 0.95  | 1.00  | 0.95  | 0.95  | 1.00  | 0.95  | 1.00  |   | 0.95  | 1.00  | 1.00  |
| Satd. Flow (prot)                 |   | 1691  | 2748  | 1698  | 1702  | 1615  | 1805  | 3590  |   | 3351  | 1837  | 1459  |
| Flt Permitted                     |   | 0.64  | 1.00  | 0.95  | 0.95  | 1.00  | 0.95  | 1.00  |   | 0.95  | 1.00  | 1.00  |
| Satd. Flow (perm)                 |   | 1132  | 2748  | 1698  | 1702  | 1615  | 1805  | 3590  |   | 3351  | 1837  | 1459  |
| Peak-hour factor, PHF             | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  |
| Adj. Flow (vph)                   | 78  | 2   | 767   | 1198  | 2   | 114   | 30  | 745   | 29  | 184   | 427   | 133   |
| RTOR Reduction (vph)              | 0   | 0   | 68  | 0   | 0   | 0   | 0   | 3   | 0   | 0   | 0   | 0   |
| Lane Group Flow (vph)             | 0   | 80  | 699   | 599   | 601   | 114   | 30  | 771   | 0   | 184   | 427   | 133   |
| Heavy Vehicles (%)                | 0%  | 0%  | 0%  | 1%  | 0%  | 0%  | 0%  | 0%  | 0%  | 1%  | 0%  | 7%  |
| Turn Type                         | Perm  | NA  | pm+ov   | Split   | NA  | Free  | Prot  | NA  |   | Prot  | NA  | Free  |
| Protected Phases                  |   | 8   | 1   | 3   | 3   |   | 5   | 2   |   | 1   | 6   |   |
| Permitted Phases                  | 8   |   | 8   |   |   | Free  |   |   |   |   |   | Free  |
| Actuated Green, G (s)             |   | 9.0   | 20.9  | 23.0  | 23.0  | 80.0  | 2.7   | 16.1  |   | 11.9  | 25.3  | 80.0  |
| Effective Green, g (s)            |   | 10.0  | 22.9  | 24.0  | 24.0  | 80.0  | 3.7   | 17.1  |   | 12.9  | 26.3  | 80.0  |
| Actuated g/C Ratio                |   | 0.12  | 0.29  | 0.30  | 0.30  | 1.00  | 0.05  | 0.21  |   | 0.16  | 0.33  | 1.00  |
| Clearance Time (s)                |   | 5.0   | 5.0   | 5.0   | 5.0   |   | 5.0   | 5.0   |   | 5.0   | 5.0   |   |
| Vehicle Extension (s)             |   | 2.0   | 2.0   | 2.0   | 2.0   |   | 2.0   | 2.0   |   | 2.0   | 2.0   |   |
| Lane Grp Cap (vph)                |   | 141   | 924   | 509   | 510   | 1615  | 83  | 767   |   | 540   | 603   | 1459  |
| v/s Ratio Prot                    |   |   | c0.12   | 0.35  | c0.35   |   | 0.02  | c0.21   |   | 0.05  | 0.23  |   |
| v/s Ratio Perm                    |   | 0.07  | 0.13  |   |   | 0.07  |   |   |   |   |   | 0.09  |
| v/c Ratio                         |   | 0.57  | 0.76  | 1.18  | 1.18  | 0.07  | 0.36  | 1.01  |   | 0.34  | 0.71  | 0.09  |
| Uniform Delay, d1                 |   | 33.0  | 26.0  | 28.0  | 28.0  | 0.0   | 37.0  | 31.4  |   | 29.8  | 23.5  | 0.0   |
| Progression Factor                |   | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |   | 0.70  | 0.90  | 1.00  |
| Incremental Delay, d2             |   | 3.1   | 3.2   | 98.6  | 99.2  | 0.1   | 1.0   | 33.7  |   | 0.1   | 6.9   | 0.1   |
| Delay (s)                         |   | 36.1  | 29.2  | 126.6   | 127.2   | 0.1   | 38.0  | 65.2  |   | 20.9  | 27.9  | 0.1   |
| Level of Service                  |   | D   | C   | F   | F   | A   | D   | E   |   | C   | C   | A   |
| Approach Delay (s)                |   | 29.8  |   |   | 115.9   |   |   | 64.2  |   |   | 21.2  |   |
| Approach LOS                      |   | C   |   |   | F   |   |   | E   |   |   | C   |   |
| <b>Intersection Summary</b>       |   |   |   |   |   |   |   |   |   |   |   |   |
| HCM 2000 Control Delay            |   |   | 66.0  |   |   |   |   |   |   |   |   | HCM 2000 Level of Service E   |
| HCM 2000 Volume to Capacity ratio |   |   | 1.03  |   |   |   |   |   |   |   |   |   |
| Actuated Cycle Length (s)         |   |   | 80.0  |   |   |   |   |   |   | 16.0  |   |   |
| Intersection Capacity Utilization |   |   | 85.1%   |   |   |   |   |   |   |   |   | ICU Level of Service E  |
| Analysis Period (min)             |   |   | 15  |   |   |   |   |   |   |   |   |   |

c Critical Lane Group

Queues

2029 PM NB

3: River Road & Shattuck Road/Minuteman Road

01/31/2022



| Lane Group              | NBT  | NBR  | SBL   | SBT   | SBR  | NEL  | NET  | SWL  | SWT  | SWR  |
|-------------------------|------|------|-------|-------|------|------|------|------|------|------|
| Lane Group Flow (vph)   | 80   | 767  | 599   | 601   | 114  | 30   | 774  | 184  | 427  | 133  |
| v/c Ratio               | 0.51 | 0.80 | 1.18  | 1.18  | 0.07 | 0.18 | 0.95 | 0.34 | 0.61 | 0.09 |
| Control Delay           | 42.2 | 28.6 | 127.2 | 127.8 | 0.1  | 36.2 | 55.4 | 23.8 | 29.2 | 0.1  |
| Queue Delay             | 0.0  | 0.0  | 0.0   | 0.0   | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  |
| Total Delay             | 42.2 | 28.6 | 127.2 | 127.8 | 0.1  | 36.2 | 55.4 | 23.8 | 29.2 | 0.1  |
| Queue Length 50th (ft)  | 38   | 166  | ~383  | ~384  | 0    | 14   | ~230 | 35   | 206  | 0    |
| Queue Length 95th (ft)  | 76   | 240  | #586  | #588  | 0    | 39   | #343 | 66   | #447 | 0    |
| Internal Link Dist (ft) | 990  |      |       | 574   |      |      | 124  |      | 409  |      |
| Turn Bay Length (ft)    |      | 190  | 125   |       |      | 120  |      | 350  |      |      |
| Base Capacity (vph)     | 226  | 953  | 509   | 510   | 1615 | 180  | 814  | 541  | 695  | 1459 |
| Starvation Cap Reductn  | 0    | 0    | 0     | 0     | 0    | 0    | 0    | 0    | 0    | 0    |
| Spillback Cap Reductn   | 0    | 0    | 0     | 0     | 0    | 0    | 0    | 0    | 0    | 0    |
| Storage Cap Reductn     | 0    | 0    | 0     | 0     | 0    | 0    | 0    | 0    | 0    | 0    |
| Reduced v/c Ratio       | 0.35 | 0.80 | 1.18  | 1.18  | 0.07 | 0.17 | 0.95 | 0.34 | 0.61 | 0.09 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
























Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.











HCM Signalized Intersection Capacity Analysis  
 3: River Road & Shattuck Road/Minuteman Road

2029 AM BU  
 02/08/2022

|                        |  |  |  |  |  |  |  |  |  |  |  |  |
|------------------------|---|---|---|---|---|---|--|---|---|---|---|---|
| Movement               | NBL   | NBT   | NBR   | SBL   | SBT   | SBR   | NEL  | NET   | NER   | SWL   | SWT   | SWR   |
| Lane Configurations    |   |  |  |  |  |  |  |  |  |  |  |  |
| Traffic Volume (vph)   | 31  | 2   | 180   | 131   | 2   | 26  | 97   | 399   | 68  | 674   | 644   | 1039  |
| Future Volume (vph)    | 31  | 2   | 180   | 131   | 2   | 26  | 97   | 399   | 68  | 674   | 644   | 1039  |
| Ideal Flow (vphpl)     | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  | 1900   | 1900  | 1900  | 1900  | 1900  | 1900  |
| Lane Width             | 10  | 10  | 11  | 13  | 12  | 11  | 13   | 12  | 12  | 11  | 11  | 11  |
| Total Lost time (s)    |   | 4.0   | 4.0   | 4.0   | 4.0   | 3.0   | 4.0  | 4.0   |   | 4.0   | 4.0   | 3.0   |
| Lane Util. Factor      |   | 1.00  | 0.88  | 0.95  | 0.95  | 1.00  | 1.00   | 0.95  |   | 0.97  | 1.00  | 1.00  |
| Frt                    |   | 1.00  | 0.85  | 1.00  | 1.00  | 0.85  | 1.00   | 0.98  |   | 1.00  | 1.00  | 0.85  |
| Flt Protected          |   | 0.95  | 1.00  | 0.95  | 0.95  | 1.00  | 0.95   | 1.00  |   | 0.95  | 1.00  | 1.00  |
| Satd. Flow (prot)      |   | 1508  | 2592  | 1720  | 1668  | 1358  | 1829   | 3472  |   | 3351  | 1818  | 1546  |
| Flt Permitted          |   | 0.68  | 1.00  | 0.95  | 0.95  | 1.00  | 0.95   | 1.00  |   | 0.95  | 1.00  | 1.00  |
| Satd. Flow (perm)      |   | 1079  | 2592  | 1720  | 1668  | 1358  | 1829   | 3472  |   | 3351  | 1818  | 1546  |
| Peak-hour factor, PHF  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92   | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  |
| Adj. Flow (vph)        | 34  | 2   | 196   | 142   | 2   | 28  | 105  | 434   | 74  | 733   | 700   | 1129  |
| RTOR Reduction (vph)   | 0   | 0   | 175   | 0   | 0   | 0   | 0  | 16  | 0   | 0   | 0   | 0   |
| Lane Group Flow (vph)  | 0   | 36  | 21  | 72  | 72  | 28  | 105  | 492   | 0   | 733   | 700   | 1129  |
| Heavy Vehicles (%)     | 13%   | 0%  | 6%  | 3%  | 9%  | 15%   | 2%   | 2%  | 0%  | 1%  | 1%  | 1%  |
| Turn Type              | Perm  | NA  | Perm  | Split   | NA  | Free  | Prot   | NA  |   | Prot  | NA  | Free  |
| Protected Phases       |   | 8   |   | 3   | 3   |   | 5  | 2   |   | 1   |   | 6   |
| Permitted Phases       | 8   |   | 8   |   |   | Free  |  |   |   |   |   | Free  |
| Actuated Green, G (s)  |   | 7.5   | 7.5   | 6.7   | 6.7   | 80.0  | 7.9  | 25.0  |   | 20.8  | 37.9  | 80.0  |
| Effective Green, g (s) |   | 8.5   | 8.5   | 7.7   | 7.7   | 80.0  | 8.9  | 26.0  |   | 21.8  | 38.9  | 80.0  |
| Actuated g/C Ratio     |   | 0.11  | 0.11  | 0.10  | 0.10  | 1.00  | 0.11   | 0.32  |   | 0.27  | 0.49  | 1.00  |
| Clearance Time (s)     |   | 5.0   | 5.0   | 5.0   | 5.0   |   | 5.0  | 5.0   |   | 5.0   | 5.0   |   |
| Vehicle Extension (s)  |   | 2.0   | 2.0   | 2.0   | 2.0   |   | 2.0  | 2.0   |   | 2.0   | 2.0   |   |
| Lane Grp Cap (vph)     |   | 114   | 275   | 165   | 160   | 1358  | 203  | 1128  |   | 913   | 884   | 1546  |
| v/s Ratio Prot         |   |   |   | 0.04  | 0.04  |   | 0.06   | 0.14  |   | 0.22  | c0.38   |   |
| v/s Ratio Perm         |   | 0.03  | 0.01  |   |   | 0.02  |  |   |   |   |   | c0.73   |
| v/c Ratio              |   | 0.32  | 0.08  | 0.44  | 0.45  | 0.02  | 0.52   | 0.44  |   | 0.80  | 0.79  | 0.73  |
| Uniform Delay, d1      |   | 33.1  | 32.2  | 34.1  | 34.1  | 0.0   | 33.5   | 21.2  |   | 27.1  | 17.2  | 0.0   |
| Progression Factor     |   | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00   | 1.00  |   | 0.99  | 0.87  | 1.00  |
| Incremental Delay, d2  |   | 0.6   | 0.0   | 0.7   | 0.7   | 0.0   | 0.9  | 1.2   |   | 0.5   | 0.7   | 0.3   |
| Delay (s)              |   | 33.6  | 32.3  | 34.8  | 34.9  | 0.0   | 34.5   | 22.5  |   | 27.4  | 15.7  | 0.3   |
| Level of Service       |   | C   | C   | C   | C   | A   | C  | C   |   | C   | B   | A   |
| Approach Delay (s)     |   | 32.5  |   |   | 29.2  |   |  | 24.5  |   |   | 12.2  |   |
| Approach LOS           |   | C   |   |   | C   |   |  | C   |   |   | B   |   |

| Intersection Summary              |       |                           |
|-----------------------------------|-------|---------------------------|
| HCM 2000 Control Delay            | 16.5  | HCM 2000 Level of Service |
| HCM 2000 Volume to Capacity ratio | 0.92  | B                         |
| Actuated Cycle Length (s)         | 80.0  | Sum of lost time (s)      |
| Intersection Capacity Utilization | 59.6% | 16.0                      |
| Analysis Period (min)             | 15    | ICU Level of Service      |
|                                   |       | B                         |

c Critical Lane Group

|                         |  |  |  |  |  |  |  |  |  |  |
|-------------------------|---|---|---|---|---|---|--|---|---|---|
| Lane Group              | NBT   | NBR   | SBL   | SBT   | SBR   | NEL   | NET  | SWL   | SWT   | SWR   |
| Lane Group Flow (vph)   | 36  | 196   | 72  | 72  | 28  | 105   | 508  | 733   | 700   | 1129  |
| v/c Ratio               | 0.32  | 0.43  | 0.38  | 0.39  | 0.02  | 0.45  | 0.43   | 0.80  | 0.75  | 0.73  |
| Control Delay           | 39.8  | 8.4   | 38.3  | 38.8  | 0.0   | 38.0  | 23.3   | 27.7  | 20.4  | 1.1   |
| Queue Delay             | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0  | 0.0   | 0.0   | 0.0   |
| Total Delay             | 39.8  | 8.4   | 38.3  | 38.8  | 0.0   | 38.0  | 23.3   | 27.7  | 20.4  | 1.1   |
| Queue Length 50th (ft)  | 17  | 0   | 35  | 35  | 0   | 50  | 102  | 164   | 259   | 15  |
| Queue Length 95th (ft)  | 44  | 30  | 74  | 75  | 0   | 92  | 164  | m176  | m#405   | m17   |
| Internal Link Dist (ft) | 2059  |   |   | 1169  |   |   | 124  |   | 409   |   |
| Turn Bay Length (ft)    |   |   |   |   |   | 120   |  |   |   |   |
| Base Capacity (vph)     | 175   | 585   | 236   | 229   | 1358  | 480   | 1185   | 943   | 928   | 1546  |
| Starvation Cap Reductn  | 0   | 0   | 0   | 0   | 0   | 0   | 0  | 0   | 0   | 0   |
| Spillback Cap Reductn   | 0   | 0   | 0   | 0   | 0   | 0   | 0  | 0   | 0   | 0   |
| Storage Cap Reductn     | 0   | 0   | 0   | 0   | 0   | 0   | 0  | 0   | 0   | 0   |
| Reduced v/c Ratio       | 0.21  | 0.34  | 0.31  | 0.31  | 0.02  | 0.22  | 0.43   | 0.78  | 0.75  | 0.73  |

## Intersection Summary























# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

HCM Signalized Intersection Capacity Analysis  
3: River Road & Shattuck Road/Minuteman Road

2029 PM BU  
02/09/2022

|                        |  |  |  |  |  |  |   |  |  |  |  |  |
|------------------------|---|---|---|---|---|---|---|---|---|---|---|---|
| Movement               | NBL   | NBT   | NBR   | SBL   | SBT   | SBR   | NEL   | NET   | NER   | SWL   | SWT   | SWR   |
| Lane Configurations    |   |  |  |  |  |  |  |  |   |  |  |  |
| Traffic Volume (vph)   | 72  | 2   | 708   | 1102  | 2   | 105   | 28  | 685   | 29  | 177   | 393   | 122   |
| Future Volume (vph)    | 72  | 2   | 708   | 1102  | 2   | 105   | 28  | 685   | 29  | 177   | 393   | 122   |
| Ideal Flow (vphpl)     | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  | 1900  |
| Lane Width             | 10  | 10  | 11  | 12  | 12  | 12  | 12  | 12  | 12  | 11  | 11  | 11  |
| Total Lost time (s)    |   | 4.0   | 4.0   | 4.0   | 4.0   | 3.0   | 4.0   | 4.0   |   | 4.0   | 4.0   | 3.0   |
| Lane Util. Factor      |   | 1.00  | 0.88  | 0.95  | 0.95  | 1.00  | 1.00  | 0.95  |   | 0.97  | 1.00  | 1.00  |
| Frt                    |   | 1.00  | 0.85  | 1.00  | 1.00  | 0.85  | 1.00  | 0.99  |   | 1.00  | 1.00  | 0.85  |
| Flt Protected          |   | 0.95  | 1.00  | 0.95  | 0.95  | 1.00  | 0.95  | 1.00  |   | 0.95  | 1.00  | 1.00  |
| Satd. Flow (prot)      |   | 1691  | 2748  | 1698  | 1702  | 1615  | 1805  | 3588  |   | 3351  | 1837  | 1459  |
| Flt Permitted          |   | 0.63  | 1.00  | 0.95  | 0.95  | 1.00  | 0.95  | 1.00  |   | 0.95  | 1.00  | 1.00  |
| Satd. Flow (perm)      |   | 1123  | 2748  | 1698  | 1702  | 1615  | 1805  | 3588  |   | 3351  | 1837  | 1459  |
| Peak-hour factor, PHF  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  | 0.92  |
| Adj. Flow (vph)        | 78  | 2   | 770   | 1198  | 2   | 114   | 30  | 745   | 32  | 192   | 427   | 133   |
| RTOR Reduction (vph)   | 0   | 0   | 68  | 0   | 0   | 0   | 0   | 4   | 0   | 0   | 0   | 0   |
| Lane Group Flow (vph)  | 0   | 80  | 702   | 599   | 601   | 114   | 30  | 773   | 0   | 192   | 427   | 133   |
| Heavy Vehicles (%)     | 0%  | 0%  | 0%  | 1%  | 0%  | 0%  | 0%  | 0%  | 0%  | 1%  | 0%  | 7%  |
| Turn Type              | Perm  | NA  | pm+ov   | Split   | NA  | Free  | Prot  | NA  |   | Prot  | NA  | Free  |
| Protected Phases       |   | 8   | 1   | 3   | 3   |   | 5   | 2   |   | 1   |   | 6   |
| Permitted Phases       | 8   |   | 8   |   |   | Free  |   |   |   |   |   | Free  |
| Actuated Green, G (s)  |   | 9.0   | 20.9  | 23.0  | 23.0  | 80.0  | 2.7   | 16.1  |   | 11.9  | 25.3  | 80.0  |
| Effective Green, g (s) |   | 10.0  | 22.9  | 24.0  | 24.0  | 80.0  | 3.7   | 17.1  |   | 12.9  | 26.3  | 80.0  |
| Actuated g/C Ratio     |   | 0.12  | 0.29  | 0.30  | 0.30  | 1.00  | 0.05  | 0.21  |   | 0.16  | 0.33  | 1.00  |
| Clearance Time (s)     |   | 5.0   | 5.0   | 5.0   | 5.0   |   | 5.0   | 5.0   |   | 5.0   | 5.0   |   |
| Vehicle Extension (s)  |   | 2.0   | 2.0   | 2.0   | 2.0   |   | 2.0   | 2.0   |   | 2.0   | 2.0   |   |
| Lane Grp Cap (vph)     |   | 140   | 924   | 509   | 510   | 1615  | 83  | 766   |   | 540   | 603   | 1459  |
| v/s Ratio Prot         |   |   | c0.12   | 0.35  | c0.35   |   | 0.02  | c0.22   |   | 0.06  | 0.23  |   |
| v/s Ratio Perm         |   | 0.07  | 0.13  |   |   | 0.07  |   |   |   |   |   | 0.09  |
| v/c Ratio              |   | 0.57  | 0.76  | 1.18  | 1.18  | 0.07  | 0.36  | 1.01  |   | 0.36  | 0.71  | 0.09  |
| Uniform Delay, d1      |   | 33.0  | 26.0  | 28.0  | 28.0  | 0.0   | 37.0  | 31.4  |   | 29.9  | 23.5  | 0.0   |
| Progression Factor     |   | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  | 1.00  |   | 0.70  | 0.90  | 1.00  |
| Incremental Delay, d2  |   | 3.5   | 3.2   | 98.6  | 99.2  | 0.1   | 1.0   | 34.8  |   | 0.1   | 6.9   | 0.1   |
| Delay (s)              |   | 36.4  | 29.3  | 126.6   | 127.2   | 0.1   | 38.0  | 66.3  |   | 21.2  | 27.9  | 0.1   |
| Level of Service       |   | D   | C   | F   | F   | A   | D   | E   |   | C   | C   | A   |
| Approach Delay (s)     |   | 30.0  |   |   | 115.9   |   |   | 65.2  |   |   | 21.3  |   |
| Approach LOS           |   | C   |   |   | F   |   |   | E   |   |   | C   |   |

Intersection Summary

|                                   |       |                           |      |
|-----------------------------------|-------|---------------------------|------|
| HCM 2000 Control Delay            | 66.2  | HCM 2000 Level of Service | E    |
| HCM 2000 Volume to Capacity ratio | 1.03  |                           |      |
| Actuated Cycle Length (s)         | 80.0  | Sum of lost time (s)      | 16.0 |
| Intersection Capacity Utilization | 85.2% | ICU Level of Service      | E    |
| Analysis Period (min)             | 15    |                           |      |

c Critical Lane Group

Queues  
3: River Road & Shattuck Road/Minuteman Road

2029 PM BU  
02/09/2022



| Lane Group              | NBT  | NBR  | SBL   | SBT   | SBR  | NEL  | NET  | SWL  | SWT  | SWR  |
|-------------------------|------|------|-------|-------|------|------|------|------|------|------|
| Lane Group Flow (vph)   | 80   | 770  | 599   | 601   | 114  | 30   | 777  | 192  | 427  | 133  |
| v/c Ratio               | 0.51 | 0.81 | 1.18  | 1.18  | 0.07 | 0.18 | 0.95 | 0.36 | 0.62 | 0.09 |
| Control Delay           | 42.3 | 28.7 | 127.2 | 127.8 | 0.1  | 36.2 | 56.0 | 24.1 | 29.3 | 0.1  |
| Queue Delay             | 0.0  | 0.0  | 0.0   | 0.0   | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  | 0.0  |
| Total Delay             | 42.3 | 28.7 | 127.2 | 127.8 | 0.1  | 36.2 | 56.0 | 24.1 | 29.3 | 0.1  |
| Queue Length 50th (ft)  | 38   | 167  | ~383  | ~384  | 0    | 14   | ~231 | 37   | 206  | 0    |
| Queue Length 95th (ft)  | 76   | 241  | #586  | #588  | 0    | 39   | #345 | 70   | #448 | 0    |
| Internal Link Dist (ft) | 990  |      |       | 574   |      |      | 124  |      | 409  |      |
| Turn Bay Length (ft)    |      | 190  | 125   |       |      | 120  |      | 350  |      |      |
| Base Capacity (vph)     | 224  | 954  | 509   | 510   | 1615 | 180  | 814  | 540  | 694  | 1459 |
| Starvation Cap Reductn  | 0    | 0    | 0     | 0     | 0    | 0    | 0    | 0    | 0    | 0    |
| Spillback Cap Reductn   | 0    | 0    | 0     | 0     | 0    | 0    | 0    | 0    | 0    | 0    |
| Storage Cap Reductn     | 0    | 0    | 0     | 0     | 0    | 0    | 0    | 0    | 0    | 0    |
| Reduced v/c Ratio       | 0.36 | 0.81 | 1.18  | 1.18  | 0.07 | 0.17 | 0.95 | 0.36 | 0.62 | 0.09 |

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.