

MEMORANDUM

DATE: January 22, 2015

TO: Mr. Ben Stevens
Trask Development
30 Turnpike Road, Suite 8
Southborough, MA 01772

FROM: Robert J. Michaud, P.E. – Managing Principal
Daniel A. Dumais, P.E. – Senior Transportation Engineer

RE: **Traffic Impact Statement**
Proposed 40B Residential Development
247 Washington Street – Sherborn, Massachusetts

MDM Transportation Consultants, Inc. (MDM) has conducted a Traffic Impact Statement (TIS) with respect to the 40B residential development to be located at 247 Washington Street (Route 16) in Sherborn, Massachusetts. This memorandum describes existing (baseline) traffic volumes along Washington Street, summarizes observed speed data characteristics along Washington Street adjacent to the Site, summarizes trip generation characteristics of the proposed development, evaluates sight lines for the proposed site driveway intersection with Washington Street and quantifies operational traffic impacts of the Site development.

Key findings of the assessment are as follows:

- *Baseline Traffic Volumes.* The weekday daily traffic volume on Washington Street adjacent to the Site is approximately 12,280 vehicles per day (vpd) on a weekday with travel patterns highly directional eastbound during the weekday morning peak hour and highly direction westbound during the weekday evening peak hour which is consistent with commuter traffic relative to major travel routes in the area. Peak hour traffic flow on Washington Street ranges from approximately 1,105 vehicles per hour (vph) during the weekday morning peak hour to 990 vph during the weekday evening peak hour representing 8 to 9 percent of daily traffic flow.

- *Measured Travel Speeds.* The 85th percentile travel speed was observed to be 44 mph for the eastbound travel direction and 43 mph for the westbound travel direction which are slightly higher but consistent with the posted (regulatory) speed limit of 40 mph on Washington Street in the study area. The sight line requirement criteria set by the American Association of State Highway and Transportation Officials (AASHTO) based on the regulatory (posted) and observed 85th percentile travel speeds was utilized in this assessment.
- *Adequate Sight Lines.* With clearing and grading associated with the construction the subdivision roadway, available sight lines at the site driveway intersections Washington Street will exceed the recommended minimum and ideal sight line requirements from AASHTO for the posted speed limit and observed travel speeds.
- *Trip-Generation.* The proposed development is estimated to generate approximately 16 vehicle trips during the weekday morning peak hour and 19 vehicle trips during the weekday evening peak hour. On a daily basis, the development is estimated to generate approximately 210 vehicle trips on a weekday with 50 percent entering and exiting.
- *Adequate Roadway Capacity.* The proposed development is not expected to materially impact the unsignalized Washington Street (Route 16)/Knollcrest Farm Lane intersection under Design Year conditions when compared to Baseline conditions. Specifically, the project will result in a nominal 1 new exiting vehicle trip every 5 to 10 minutes during the peak hours. Under Design Year conditions, the northbound (proposed Site Driveway) approach will operate at LOS C or better while the southbound (Knollcrest Farm Lane) approach will operate at LOS D or better during the peak hours.

In summary, the proposed 36-unit residential development is estimated to generate approximately 13 new vehicle-trips during the weekday morning peak hour and 19 new vehicle-trips during the weekday evening peak hour. MDM finds that incremental traffic associated with the proposed development is not expected to materially impact operating conditions at the study intersection. Specifically, the project will result in a nominal 1 new exiting vehicle trip every 5 to 10 minutes during the peak hours. - a level that falls well within normal day-to-day traffic fluctuation along Washington Street. Safe stopping sight distance (SSD) is available for oncoming vehicles to detect, react and stop for vehicles exiting the proposed subdivision roadway onto Washington Street based on the regulatory speed limit and observed travel speeds.

Project Description

The project site is an approximate 17.6-acre tract of land located along Washington Street in Sherborn, Massachusetts. The site is currently comprised of an undeveloped parcel of land located directly across from Knollcrest Farm Lane. The location of the site relative to adjacent roadways is shown in **Figure 1**.

The projects include the construction of 36 residential condominium units. Parking will be supported within individual unit driveways as well as 11± additional visitor parking spaces. A single, full-access, paved driveway along Washington Street directly across from Knollcrest Farm Lane will be constructed. The preliminary site layout prepared by Bruce Saluk and Associates, Inc. is presented in **Figure 2**.

Washington Street (Route 16)

Washington Street is a two-lane roadway under local (Town) jurisdiction and is classified by the Massachusetts Department of Transportation (MassDOT) as an Urban Other Principal Arterial roadway. The roadway is generally straight within the study area with a gentle vertical curve adjacent to the Site. Pavement markings include a double yellow centerline and single white edge lines. There are no sidewalks provided along Washington Street in the study area. The posted speed limit in the Site vicinity is 40 miles per hour (mph) in both the eastbound and westbound travel directions. Land uses along Washington Street in the immediate study area are primarily residential homes.

Daily and peak hour traffic volumes along Washington Street in the site vicinity were obtained using a radar-based automatic traffic recorder (ATR) in December 2014. The results of the ATR counts are summarized in **Table 1**, and are discussed below.

TABLE 1
EXISTING TRAFFIC VOLUME SUMMARY
WASHINGTON STREET ADJACENT TO SITE

Time Period	Daily Volume (vpd) ¹	Percent Daily Traffic ²	Peak Hour Volume (vph) ³	Peak Flow Direction ⁴	Peak Hour Directional Volume (vph)
Weekday Morning Peak Hour	12,280	9%	1,105	79% EB	873
Weekday Evening Peak Hour	12,280	8%	990	70% WB	689

¹Two-way daily traffic expressed in vehicles per day without seasonal adjustment.

²The percent of daily traffic that occurs during the peak hour.

³Two-way peak-hour volume expressed in vehicles per hour.

⁴EB = Eastbound, WB = Westbound

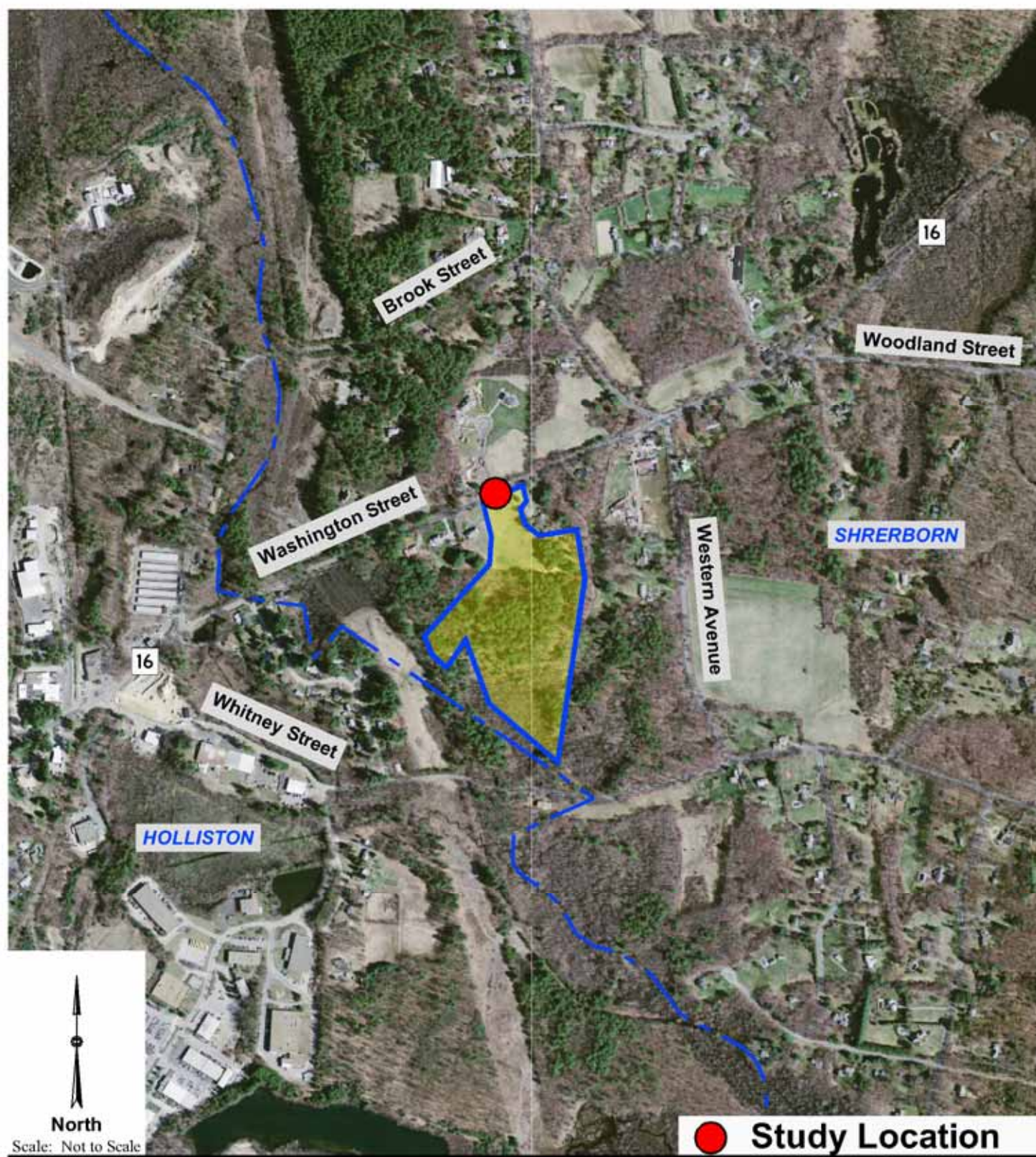


Figure 1

Site Location



North

Scale: Not to Scale

N/F
EUGENE & ELIZABETH T. HAM

Site Plan Source: Bruce Saluk & Assoc., Inc.

Figure 2

MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers

Preliminary Site Layout

As summarized in **Table 1**, The weekday daily traffic volume on Washington Street adjacent to the Site is approximately 12,280 vehicles per day (vpd) on a weekday with travel patterns highly directional eastbound during the weekday morning peak hour and highly direction westbound during the weekday evening peak hour which is consistent with commuter traffic relative to major travel routes in the area. Peak hour traffic flow on Washington Street ranges from approximately 1,105 vehicles per hour (vph) during the weekday morning peak hour to 990 vph during the weekday evening peak hour representing 8 to 9 percent of daily traffic flow.

Peak Hour Traffic

Traffic volume data was collected in December 2014. Review of MassDOT permanent count station data indicates that December is a below-average traffic month (approximately 5 percent below average month conditions). In order to provide an analysis of average traffic conditions, a seasonal adjustment increase of 5% was made to the December traffic volume counts. Traffic volumes were estimated for the three single family homes located along Knollcrest Farm Lane using industry standard rates published in ITE's *Trip Generation*¹ and added to the networks based on existing travel patterns along Washington Street. The resulting baseline weekday morning and weekday evening peak-hour traffic volumes for the study intersection are depicted in **Figure 3**.

Measured Travel Speeds

Vehicle speeds were obtained for Washington Street adjacent to the Site over a 72-hour period using a radar recorder device. These measured travel speeds provide a basis for determining sight line requirements at the proposed site driveway. **Table 2** presents a summary of the travel speed data collected for Washington Street in the site vicinity. Collected speed data are provided in the **Attachments**.

TABLE 2
SPEED STUDY RESULTS – WASHINGTON STREET

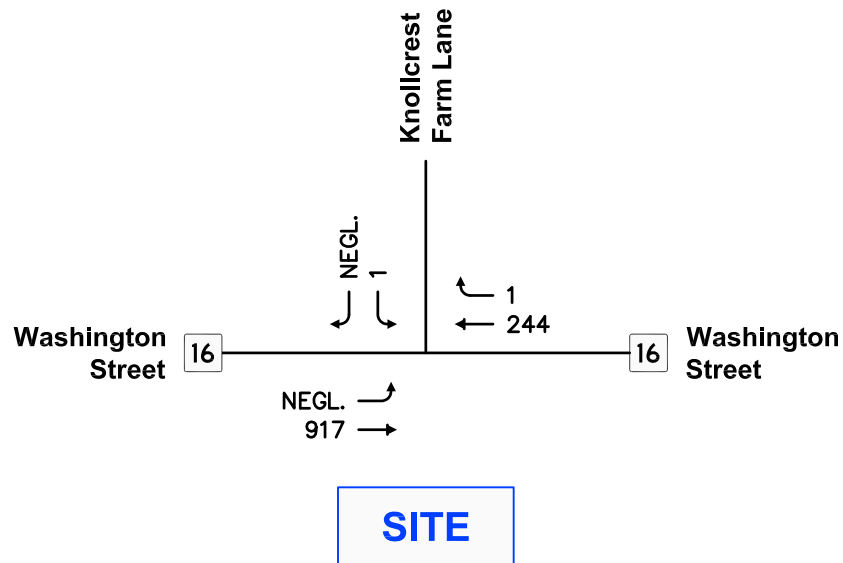
Travel Direction	Speed Limit ¹	Travel Speed	
		Mean ²	85 th Percentile ³
Eastbound	40	39	44
Westbound	40	39	43

¹ Regulatory (Posted) Speed limit in miles per hour (mph)

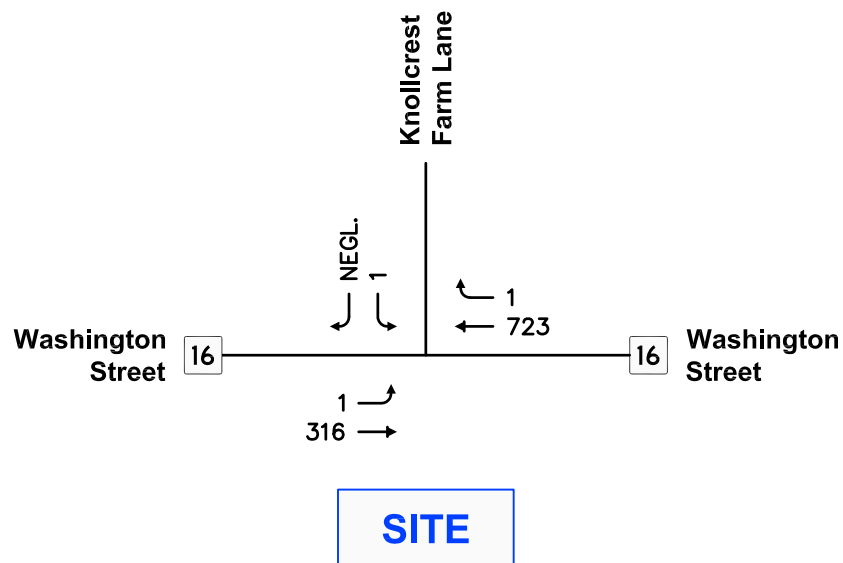
² Arithmetic mean

³ The speed at or below which 85 percent of the vehicles are traveling

¹*Trip Generation*, Ninth Edition; Institute of Transportation Engineers; Washington, DC; 2012.



Weekday Morning Peak Hour



Weekday Evening Peak Hour



North

Scale: Not to Scale

Figure 3

Baseline Peak Hour Traffic Volumes

As summarized in **Table 2**, the 85th percentile travel speed was observed to be 44 mph for the eastbound travel direction and 43 mph for the westbound travel direction which are slightly higher but consistent with the posted (regulatory) speed limit of 40 mph on Washington Street in the study area. The sight line requirement criteria set by the American Association of State Highway and Transportation Officials (AASHTO) based on the regulatory (posted) and observed 85th percentile travel speeds was utilized in this assessment.

Sight Line Evaluation

The evaluation documents existing sight distances at the location of each of the proposed subdivision roadways for vehicles entering Washington Street with comparison to recommended guidelines for the posted speed limit and measured travel speeds.

The American Association of State Highway and Transportation Officials' (AASHTO) standards² references recommended criteria for intersection stopping sight distance (SSD) for roadway grades and ambient travels speeds. Sight lines for critical vehicle movements at study intersections were compared to minimum SSD for the regulatory speed limit and measured travel speeds along Washington Street as described below.

Stopping Sight Distance

Sight distance is the length of roadway visible to the motorist to a fixed object. The minimum sight distance available on a roadway should be sufficiently long enough to enable a below-average operator, traveling at or near a regulatory speed limit, to stop safely before reaching a stationary object in its path, in this case, a vehicle exiting from side street approaches onto Washington Street. The SSD criteria are defined by AASHTO based on design and operating speeds, anticipated driver behavior and vehicle performance, as well as physical roadway conditions. SSD includes the length of roadway traveled during the perception and reaction time of a driver to an object, and the distance traveled during brake application on wet, level pavements. Adjustment factors are applied to account for roadway grades.

SSD was estimated in the field using AASHTO standards for driver's eye (3.5 feet) and object height equivalent to the taillight height of a passenger car (2.0 feet) for the eastbound and westbound Washington Street approaches to the proposed subdivision roadway. **Table 3** presents a summary of the available SSD for the Washington Street roadway segments and AASHTO's recommended SSD for the posted (regulatory) speed limit and observed average and 85th percentile travel speeds.

² A policy on Geometric Design of Highways and Streets, American Association of State Highway and Transportation Officials (AASHTO), 2011.

TABLE 3
STOPPING SIGHT DISTANCE SUMMARY
WASHINGTON STREET APPROACH TO PROPOSED SITE DRIVE

Approach/ Travel Direction	Available Stopping Sight Distance	AASHTO Recommended ¹		
		Regulatory Speed (40 mph)	Average Travel Speed ²	85 th Percentile Travel Speed ³
Eastbound	700+ Feet	305 Feet	290 Feet	350 Feet
Westbound	700+ Feet	305 Feet	290 Feet	340 Feet

¹ Recommended sight distance based on AASHTO, A Policy on Geometric Design of Highways and Streets. Based on driver height of eye of 3.5 feet to object height of 2.0 feet and adjustments for roadway grade.

² Average Speed is 39 mph EB and WB.

³ 85th Percentile travel speed is 44mph EB and 43 mph WB

As summarized in **Table 3** analysis results indicate that the existing available sight lines exceed AASHTO's recommended SSD criteria for the proposed subdivision roadway based on the regulatory speed limit and observed travel speeds along Washington Street.

Intersection Sight Distance

Clear sight lines provide sufficient sight distance for a stopped driver on a minor-road approach to depart from the intersection and enter or cross the major road. As stated under AASHTO's Intersection Sight Distance (ISD) considerations, "...If the available sight distance for an entering ...vehicle is at least equal to the appropriate stopping sight distance for the major road, then drivers have sufficient sight distance to avoid collisions...To enhance traffic operations, intersection sight distances that exceed stopping sight distances are desirable along the major road." AASHTO's ISD criteria are defined into several "cases". For each of the unsignalized subdivision roadway locations, which is proposed to be under STOP sign control, the ISD in question relates to the ability to turn left or turn right from the proposed roadway at its intersection with Washington Street.

Available ISD was estimated in the field using AASHTO standards for driver's eye (3.5 feet), object height (3.5 feet) and decision point (8 feet from the edge of the travel way) for the eastbound and westbound directions along Washington Street. **Table 4** presents a summary of the available ISD for the departure from the proposed subdivision roadway and AASHTO's minimum recommended ISD.

TABLE 4
INTERSECTION SIGHT DISTANCE SUMMARY
PROPOSED SITE DRIVEWAY DEPARTURE TO WASHINGTON STREET

Approach/ Travel Direction	Available SSD	AASHTO Minimum ¹		AASHTO Ideal ¹
		Posted Speed Limit (40 mph)	85 th Percentile Observed Speed ²	Posted Speed Limit (40 mph)
<i>Looking East</i>	700+ Feet	305 Feet	340 Feet	445 Feet
<i>Looking West</i>	700+ Feet	305 Feet	350 Feet	445 Feet

¹Recommended sight distance based on AASHTO, A Policy on Geometric Design of Highways and Streets. Based on driver height of eye of 3.5 feet and an object height of 3.5 feet and adjustments for roadway grade if required. Minimum value as noted represents SSD per AASHTO guidance.

² Average Speed is 39 mph EB and WB.

³ 85th Percentile travel speed is 44mph EB and 43 mph WB

The results of the ISD analysis presented in **Table 4** indicate that, with clearing and minor grading associated with the construction the subdivision roadway, the available sight lines looking east and west from said driveway onto Washington Street will exceed the recommended minimum and ideal sight line requirements from AASHTO for the posted speed limit and observed travel speeds. MDM recommends that any new plantings (shrubs, bushes) or physical landscape features to be located within the driveway sight lines should also be maintained at a height of 2 feet or less above the adjacent existing roadway grade to ensure unobstructed lines of sight.

Trip Generation

The trip generation estimates for the proposed development are provided for the weekday morning and weekday evening periods, which correspond to the critical analysis periods for the proposed uses and adjacent street traffic flow. New traffic generated by the project was estimated using trip rates published in ITE's *Trip Generation*³ for the best-fit Land Use Code for the proposed use (LUC) 230 Residential Condominium/Townhouse. **Table 5** presents the trip-generation estimate for the proposed development based on ITE methodology.

TABLE 5
TRIP-GENERATION SUMMARY¹

<u>Peak Hour/Direction</u>	<u>Site Trips (Residential Condo/Townhouse)²</u>
<i>Weekday Morning Peak Hour:</i>	
Entering	3
<u>Exiting</u>	<u>13</u>
Total	16
<i>Weekday Evening Peak Hour:</i>	
Entering	13
<u>Exiting</u>	<u>6</u>
Total	19
<i>Weekday Daily (24 hours)</i>	210

¹Source: ITE *Trip Generation*, Ninth Edition; 2012.

²ITE LUC 230 – Residential Condominium/ Townhouse applied to 36 units.

As summarized in **Table 5**, the development is estimated to generate approximately 16 vehicle trips (3 entering and 13 exiting) during the weekday morning peak hour and 19 vehicle trips (13 entering and 6 exiting) during the weekday evening peak hour. On a daily basis, the development is estimated to generate approximately 210 vehicle trips on a weekday with 50 percent entering and exiting. Trip generation calculations are provided in the **Attachments**.

³*Ibid*

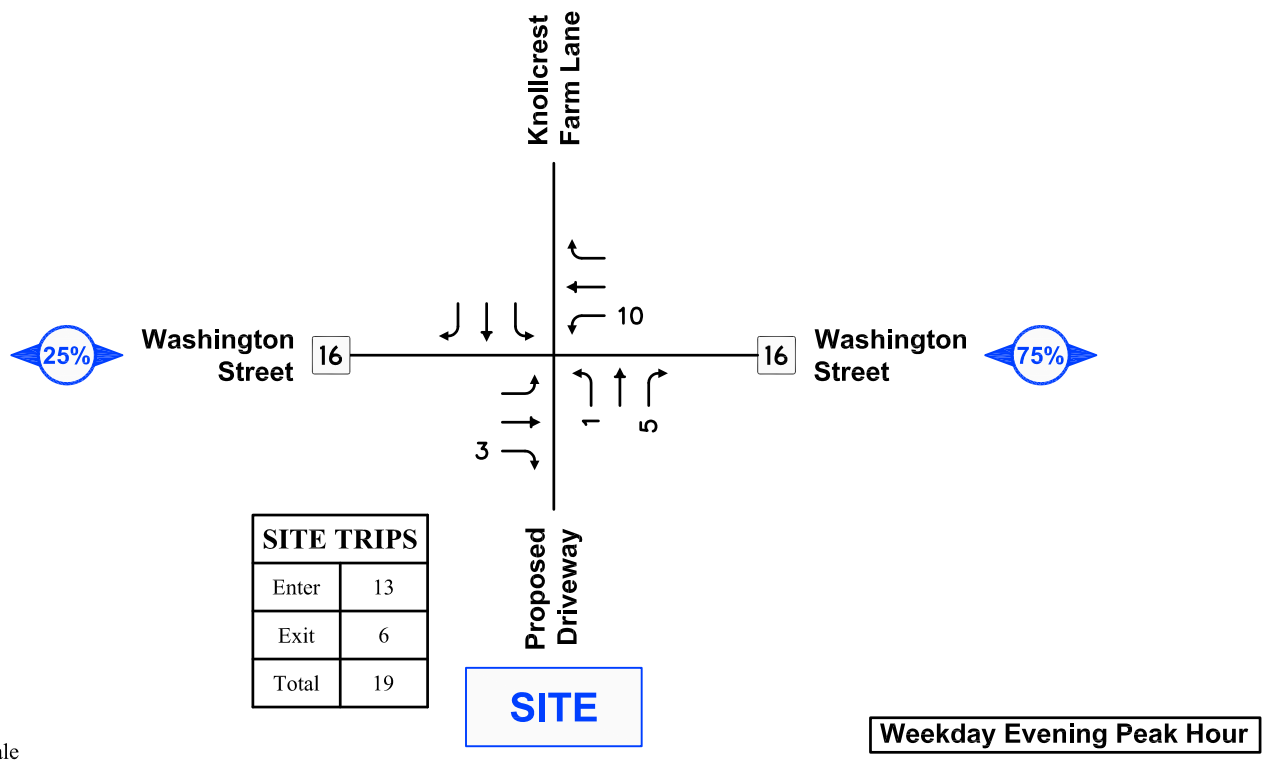
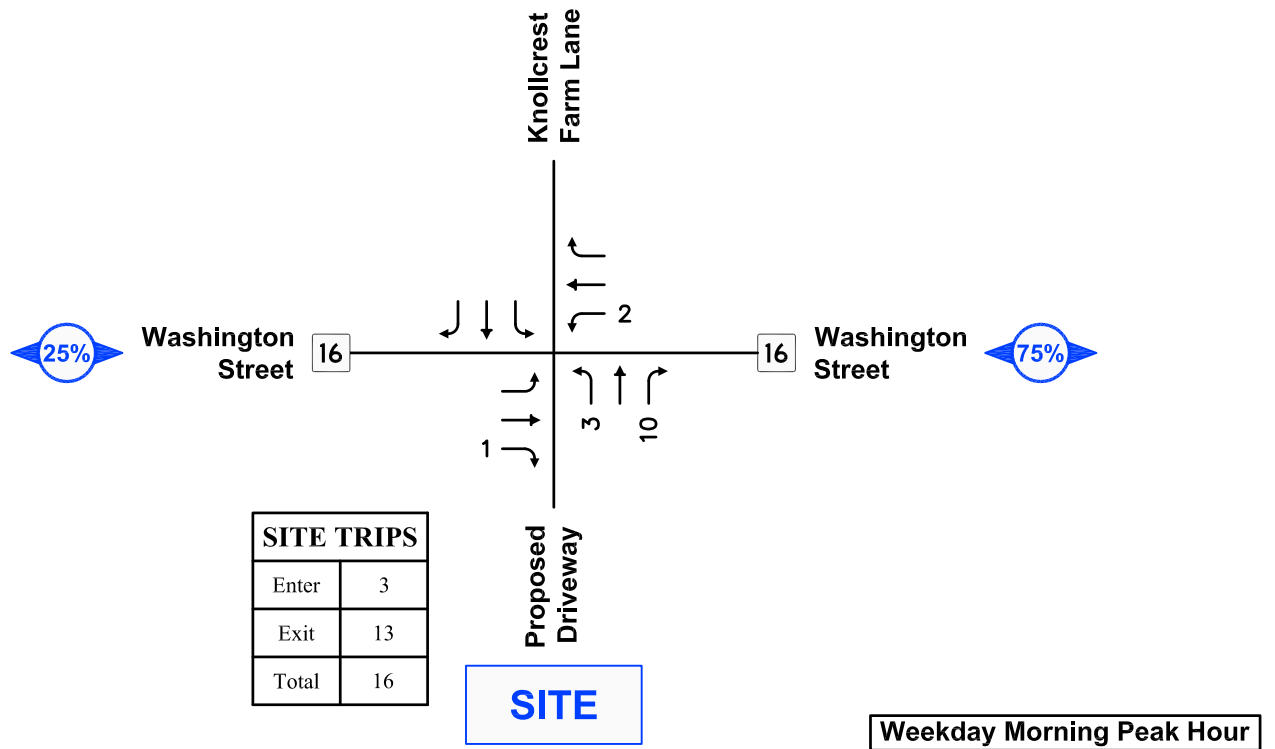
Trip Distribution

The directional distribution of development-generated trips on the roadway network is a function of a number of variables including local area populations and the efficiency of the roadways leading to the Site. Existing (baseline) travel patterns and volumes of the adjacent roadway system as well as Journey to work census data served as the primary basis for determining the trip distribution pattern for the proposed development. Trip distribution calculations are provided in the **Attachments**.

Development-related trips for the proposed Site are assigned to the roadway network using the ITE trip-generation estimates shown in **Table 5** and the distribution patterns for the Site. Development-related trips at each intersection approach for the weekday morning, and weekday evening peak hours are quantified in **Figure 4**.

2015 Design Year Traffic Conditions

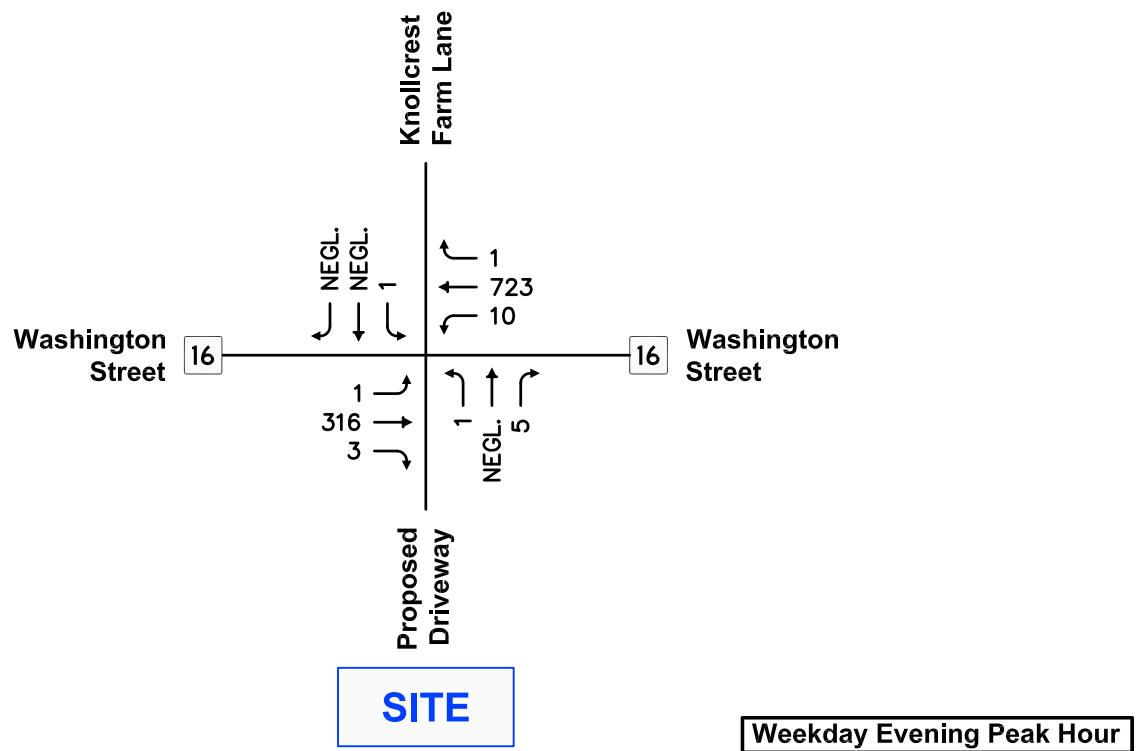
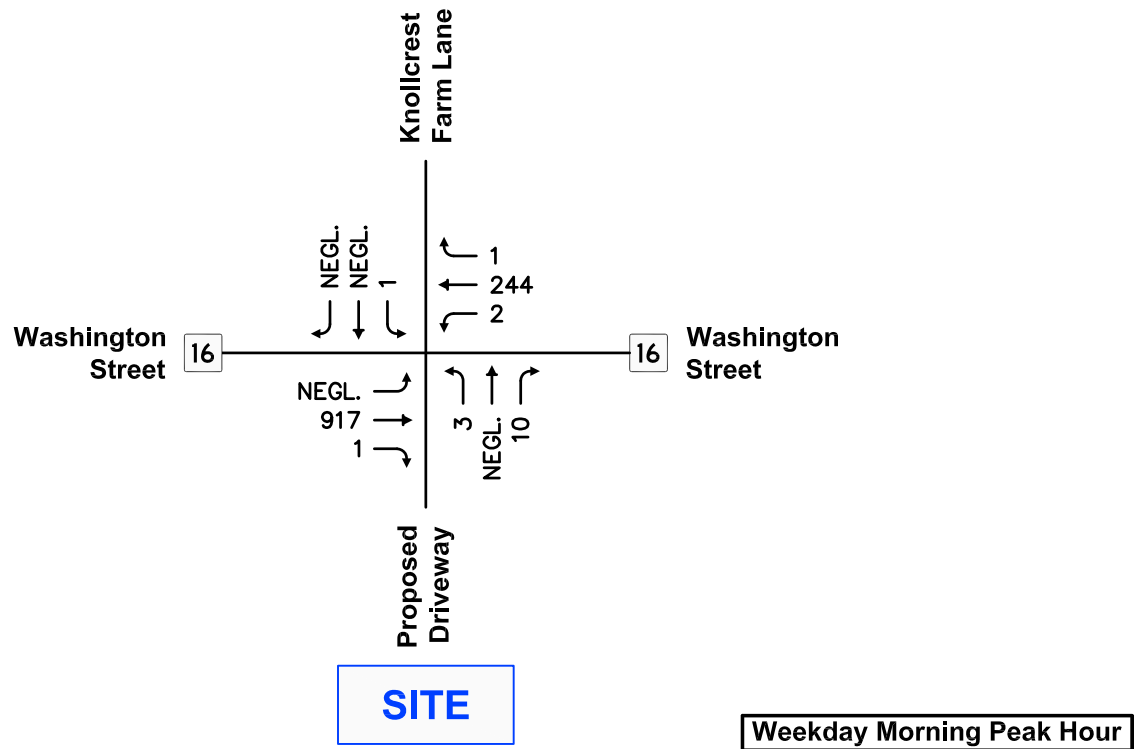
2015 Design Year condition traffic volumes are derived by adding the incremental traffic increases for the residential units at the Site to the 2015 Baseline conditions. **Figure 5** present the 2015 Design Year condition traffic-volume networks for the weekday morning and weekday evening peak hours.



North
 Scale: Not to Scale

Figure 4

**Site Generated Trips
 Peak Hour Traffic Volumes**



North

Scale: Not to Scale

Figure 5

**2015 Design Year
 Peak Hour Traffic Volumes**

Operations Analysis

This section provides an overview of operational analysis methodology, an assessment of driveway operations under existing (baseline) Design Year conditions.

Analysis Methodology

Intersection capacity analyses are presented in this section for the Baseline and Design Year traffic-volume conditions. Capacity analyses, conducted in accordance with EEA/MassDOT guidelines, provide an index of how well the roadway facilities serve the traffic demands placed upon them. The operational results provide the basis for recommended access and roadway improvements in the following section.

Capacity analysis of intersections is developed using the Synchro® computer software, which implements the methods of the 2010 Highway Capacity Manual (HCM). The resulting analysis presents a level-of-service (LOS) designation for individual intersection movements. The LOS is a letter designation that provides a qualitative measure of operating conditions based on several factors including roadway geometry, speeds, ambient traffic volumes, traffic controls, and driver characteristics. Since the LOS of a traffic facility is a function of the traffic flows placed upon it, such a facility may operate at a wide range of LOS, depending on the time of day, day of week, or period of year. A range of six levels of service are defined on the basis of average delay, ranging from LOS A (the least delay) to LOS F (delays greater than 50 seconds for unsignalized movements). The specific control delays and associated LOS designations are presented in the **Attachments**.

Analysis Results

Level-of-Service (LOS) analyses were conducted for the Baseline and Design Year conditions for the study intersection. The results of the intersection capacity are summarized below in **Table 6**. Detailed analysis results are presented in the **Attachments**.

TABLE 6
INTERSECTION CAPACITY ANALYSIS RESULTS

Period	Approach	Baseline				2015 Design Year			
		v/c ¹	Delay ²	LOS ³	95 TH Q ⁴	v/c	Delay	LOS	95 TH Q
Weekday Morning Peak Hour									
Washington Street at	Eastbound	0.00	<5	A	Negl.	0.00	<5	A	Negl.
Knollcrest Farm Lane/	Westbound	n/a ⁵	n/a	n/a	n/a	0.00	<5	A	Negl.
Proposed Site Driveway	NB L/R Exit	n/a	n/a	n/a	n/a	0.06	20	C	5
	SB L/R Exit	0.01	23	C	Negl.	0.01	29	D	Negl.
Weekday Morning Peak Hour									
Washington Street at	Eastbound	0.00	<5	A	Negl.	0.00	<5	A	Negl.
Knollcrest Farm Lane/	Westbound	n/a ⁵	n/a	n/a	n/a	0.01	<5	A	Negl.
Proposed Site Driveway	NB L/R Exit	n/a	n/a	n/a	n/a	0.01	13	B	Negl.
	SB L/R Exit	0.01	21	C	Negl.	0.01	26	D	Negl.

¹Volume-to-capacity ratio

²Average control delay per vehicle (in seconds)

³Level of service

⁴95th percentile queue length (in feet)

⁵n/a = Not Applicable

⁶ Negl. = Negligible

As summarized in **Table 6**, the proposed development is not expected to materially impact the unsignalized Washington Street (Route 16)/Knollcrest Farm Lane intersection under Design Year conditions when compared to Baseline conditions. Specifically, the project will result in a nominal 1 new exiting vehicle trip every 5 to 10 minutes during the peak hours. Under Design Year conditions, the northbound (proposed Site Driveway) approach will operate at LOS C or better while the southbound (Knollcrest Farm Lane) approach will operate at LOS D or better during the peak hours.

Recommendations and Conclusions

The proposed 36-unit residential development is estimated to generate approximately 13 new vehicle-trips during the weekday morning peak hour and 19 new vehicle-trips during the weekday evening peak hour. MDM finds that incremental traffic associated with the proposed development is not expected to materially impact operating conditions at the study intersection. Specifically, the project will result in a nominal 1 new exiting vehicle trip every 5 to 10 minutes during the peak hours - a level that falls well within normal day-to-day traffic fluctuation along Washington Street. Safe stopping sight distance (SSD) is available for oncoming vehicles to detect, react and stop for vehicles exiting the proposed subdivision roadway onto Washington Street based on the regulatory speed limit and observed travel speeds.

MDM recommends the following site access design elements which will provide ample capacity to accommodate site-generated traffic while also enhancing safety and capacity:

- Proposed plantings (shrubs, bushes) and structures (walls, fences, etc.) should be maintained at a height of 2 feet or less above the adjacent roadway grade within the driveway "sight line triangles" with respect to Washington Street to provide unobstructed sight lines for vehicles entering and exiting the Site.
- A MUTCD compliant "STOP" sign (R1-1) and STOP line pavement marking are recommended on the driveway approach to Washington Street. The sign and pavement marking shall be compliant with the Manual on Uniform Traffic Control Devices (MUTCD).
- Driveway width, alignment and curb radii will be designed to accommodate delivery and emergency apparatus. This includes a minimum driveway width of 22-feet at Washington Street with curbs of 30-foot radius.