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Traffic Impact Study

Prepared For

Canal Street Residential Development

Located on

Canal Street
Millbury, Massachusetts

July 2021

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1
INTRODUCTION

Elite Home Builders, hereafter referred to as the applicant, is proposing the development of a parcel of land totaling 2.77 acres to construct a three-story apartment building complex. The proposed development is located on the north side of Canal Street, between Howe Avenue and Elm Street intersections. The applicant is proposing to evaluate the impact of this development site on area roadway traffic and consider any improvements that may be necessary in order to make this development feasible and acceptable. This traffic study is prepared to make this evaluation. The purpose of this traffic study is to develop an understanding of existing traffic operations and concerns, forecast future site generated traffic, assess the adequacy of the existing roadway system to accommodate the proposed development into the future, and to identify and recommend appropriate mitigation strategies, should any be deemed necessary.

Project description

The applicant proposes to develop a 2.77-acre parcel of land and construct a 74,000+- square-foot (sf) building to house a total of 59 apartment units (45 one-bedroom and 14 two-bedroom). This residential building will be a three-story structure with open lawn area and outdoor amenities, as well as a dog park. A total of 110 parking spaces will be provided, including six handicap parking spaces, one van accessible parking space, and 18 garages.

The site will be accessed via a boulevard style driveway directly from Canal Street across from Church Street. This driveway will be serving the entire site including the handicapped parking spaces near the entrances to the building. This driveway which will be located across from Church Street is approximately 200’ from the Howe Avenue intersection and 350’ from the Elm Street intersection. As stated earlier, the proposed driveway will be a boulevard style with a 10’ divider median island separating ingress and egress movements, each 18’ wide. The proposed 110 parking spaces will be accessed by this driveway. The proposed site is located in Business-1 (B-1) zoning district and is currently vacant as its approximate location is shown in the aerial photograph in Figure 1.

Figure 1 - Proposed Multi Family Development Site

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EXISTING CONDITIONS

Evaluation of the transportation impacts associated with the proposed multifamily residential development project requires a thorough understanding of the existing transportation system in the immediate vicinity of the site. Evaluating existing roadway network operating conditions necessitates an examination of existing roadway traffic volumes, geometric features, and local community traffic-related issues. Each of these elements is described below.

Study Area Roadway Network

The study area for this traffic impact report has been defined to include the evaluation of the following intersections located within 1,000' of the proposed site as they were identified in consultation with the Millbury Planning Director.

- Canal Street at Elm Street
- Canal Street at Howe Avenue
- Canal Street at Church Street
- Canal Street at Main Street
- Elm Street at Main Street and South Main Street

Canal Street (Route 122A) is a two-way roadway with one travel lane in each direction. The roadway has a grade of approximately 3% and its width is about 36' near the proposed driveway. It provides a 16' lane and a 2-foot shoulder on each side. There are sidewalks on both sides along its length. On-street parking is not allowed on either side of the street. Canal Street intersects Elm Street to the southeast forming a three-legged "Y" intersection, and with Church Street across from the proposed access driveway, Howe Avenue and Main Street to the northwest. It is a numbered suburban arterial roadway with a mixture of residential and commercial land uses. It traverses in northwesterly and southeasterly directions and provides access to Main Street and the center of Millbury to the northwest and connects with Elm Street forming a "Y" intersection, and Grafton Street and Providence Street at its southeasterly terminus. Daily traffic volume in both directions for Canal Street at a point northwest of Church Street and in the vicinity of the proposed development was obtained from the *massDOT* website. The Annual Average Daily Traffic (AADT) on Canal Street from permanent counting station #RPA05-186-2134 was 8,222 vehicles per day in 2018, 8,189 in 2019, and 6,756 in 2020 at a point southeast of the Howe Avenue intersection. As evident here, the 2020 volumes are significantly lower than those of the previous two years. Once the volumes are adjusted in accordance with the *massDOT* Engineering Directive E-20-005, the 2021 daily volume is projected based on the 2019 volume (last year before the COVID-19 pandemic) at a rate of 0.02 or 2% per year or multiplied by 1.04 to reflect a two-year increase. The projected 2021 volume for this location is 8,517 vehicles per day. The *massDOT* procedure is further described below in the Traffic Volumes section of this report.

Finally, there are no speed limit signs posted on Canal Street. Therefore, the prima facia speed

limit of 30 miles per hour (mph) applies to this area. This is consistent with the historic speed survey data last conducted by the *massDOT* whereas the 85th percentile speed was recorded at 32 mph and the pace speed was logged at a 20-30 mph interval.

Elm Street traverses in the northeasterly and southwesterly directions. Its pavement width is 40'. Elm Street intersects with Canal Street at its northeasterly terminus at approximately 80 degrees forming a "Y" intersection. It also intersects with Main Street at nearly 90 degrees. Sidewalks and on-street parking are provided on both sides of the street. Its pavement provides for a 12' travel lane and an eight-foot parking lane in each direction. The land use is primarily commercial with a few multifamily properties near the Canal Street intersection.

Again, there are no speed limit signs posted on Elm Street. Therefore, the prima facia speed limit of 30 mph applies to this area.

Main Street is a two-way roadway with one travel lane in each direction. It traverses in the northerly and southerly directions. The roadway width is approximately 40' near the Canal Street intersection. It provides a 12' lane and an eight-foot parking lane on each side. There are sidewalks on both sides along its length. Main Street intersects Canal Street forming a three-legged "T" intersection, and with Hamilton Street, Orchard Street, and Martin Street to the north. Main Street is posted with 30 mph speed limit signs near the Hamilton Street intersection.

Howe Avenue is also a two-way roadway with one travel lane in each direction. It traverses in the northerly and southerly directions and provides sidewalks on its west side. Its pavement width is 32 feet with one 16' travel lane in each direction. No on-street parking is designated. The land use is mostly residential on the west side and commercial/industrial on the east side of the street. Its southerly section is posted with 35 mph speed limit signs while its northly section close to Millbury Avenue is posted with 40 mph speed limit signs.

Church Street is a one-way street in the northeasterly direction, and it connects to Main Street at its southwesterly end and to Canal Street at its northeasterly terminus. It is approximately 700' long and it has a pavement width of 18'-20'. It provides a sidewalk on the northwesterly side. Its land use is primarily residential.

Intersection of Canal and Elm Street is a three-legged intersection with a one-lane approach for Elm Street. Its Canal Street southeast bound approach has two lanes where the left lane is dedicated to left-turn traffic only. Its dedicated lane is 125' in length. The Canal Street westbound approach has one lane, and it splits into two lanes at a triangular traffic island with a yield sign to control right turn maneuvers. The traffic at this intersection is controlled by a traffic actuated traffic signal system. Crosswalks are provided for each leg of the intersection with pedestrian pushbuttons at each crossing. McLaughlin's Service Station, located on the south side of the intersection across from Canal Street, is also provided with signal indications for those vehicles leaving through two of their service bays.

Intersection of Canal Street and Howe Avenue is a three-legged intersection with one travel lane for the Howe Avenue approach and two travel lanes for the Canal Street approaches. The northwesterly Canal Street approach consists of a dedicated right-turn lane which is

approximately 60' long and a through lane, while the southeasterly Canal Street approach has a dedicated left-turn lane which is 90' long and a through lane. This intersection is controlled by a traffic actuated traffic signal system. It provides crosswalks across Howe Avenue and the northwesterly side of Canal Street with pedestrian signals.

Intersection of Canal Street and Main Street is also a three-legged intersection where its westbound approach forms two lanes for about 50'. The right lane is for right-turn only. The southbound approach of Main Street also has two lanes, one dedicated for left-turn maneuvers which is 150' long. Finally, the northbound approach has only one general purpose lane. This intersection is also equipped with a traffic actuated traffic signal system with pedestrian signals for crosswalks across Elm Street and the southerly side of Main Street.

Intersection of Elm Street and Main Street is a four-legged intersection where all approaches have two travel lanes. The northbound, southbound, and westbound approaches have a dedicated right-turn lane and a shared through and left-turn lane. The eastbound approach consists of a dedicated left-turn lane and a shared through and right-turn lane. All dedicated lanes are approximately 70' in length. This intersection is also equipped with a traffic actuated traffic signal system with pedestrian signals at each crosswalk.

Traffic Volumes

Due to the reductions in traffic volumes caused by the COVID-19 pandemic, taking new traffic counts in 2021 may undercount the baseline for which future years are based. Therefore, the peak hour traffic counts were compared with the *massDOT* historic traffic data and guidelines. Table 1 below shows the historic *massDOT* Average Daily Traffic Volumes for the affected streets.

Table 1 – *massDOT* ADTs

Roadway	massDOT Count Station ID	ADT
Canal Street (Rt 122A)	RPA05-186-2134	8,189
Elm Street	236115	9,969
Main Street	240694	12,085
Howe Avenue	240685	7,246

The new peak hour turning movement counts (TMCs) were collected on Thursday, February 25, 2021, during two-hour periods between the hours of 7-9 AM and 4-6 PM commuter peak periods, and Saturday, February 27, 2021, between 11:00 AM and 1:00 PM in order to identify the critical peak hour. This standard practice is designed to help determine the traffic impacts of the proposed multifamily residential development on nearby roadways and intersections under worst case scenario.

As mentioned herein above, the COVID-19 pandemic has caused a drop in vehicular traffic over the last year. In April 2020, *massDOT* published the Guidance on Traffic Count Data and how

to estimate existing and future traffic counts taken after March 13, 2020. The procedure to adjust the TMC to pre-COVID conditions requires the use of historical data, seasonally adjust the historical data, and then forecast the historical data to the existing year.

There is one (1) count station (ID #RPA05-186-2134) in the study area which is located on Route 122A (Canal Street) between Howe Avenue and Elm Street. The data was collected in July 2011. *massDOT* provides seasonal adjustment factors from 2014 to 2019, and for this count station, the seasonal adjustment factor of 2014 was used. Based on the *massDOT* Traffic Volume and Classification, Canal Street is included in group U4-U7 for the Growth Factor and Seasonal Factor. Based on group U4-U7 and as per Stantec recommendation, the yearly growth rate for this group is 0.02, or 2% per year. The count station volumes were compared against the TMCs at the same location to develop a factor to adjust the current TMCs to pre-COVID conditions. Table 2 shows the adjusted count station volumes, the TMCs at the same location as the count station, and the adjustment factor to be used.

As stated in the original WSP report, the *massDOT* volumes are lower than the collected TMCs, which resulted in an average adjustment factor of less than one (1). Therefore, an adjustment factor of 1.0 was used, and the collected TMCs were not further reduced. The Year 2021 traffic volumes for the AM, PM, and Saturday peak periods are shown below in Figure 2.

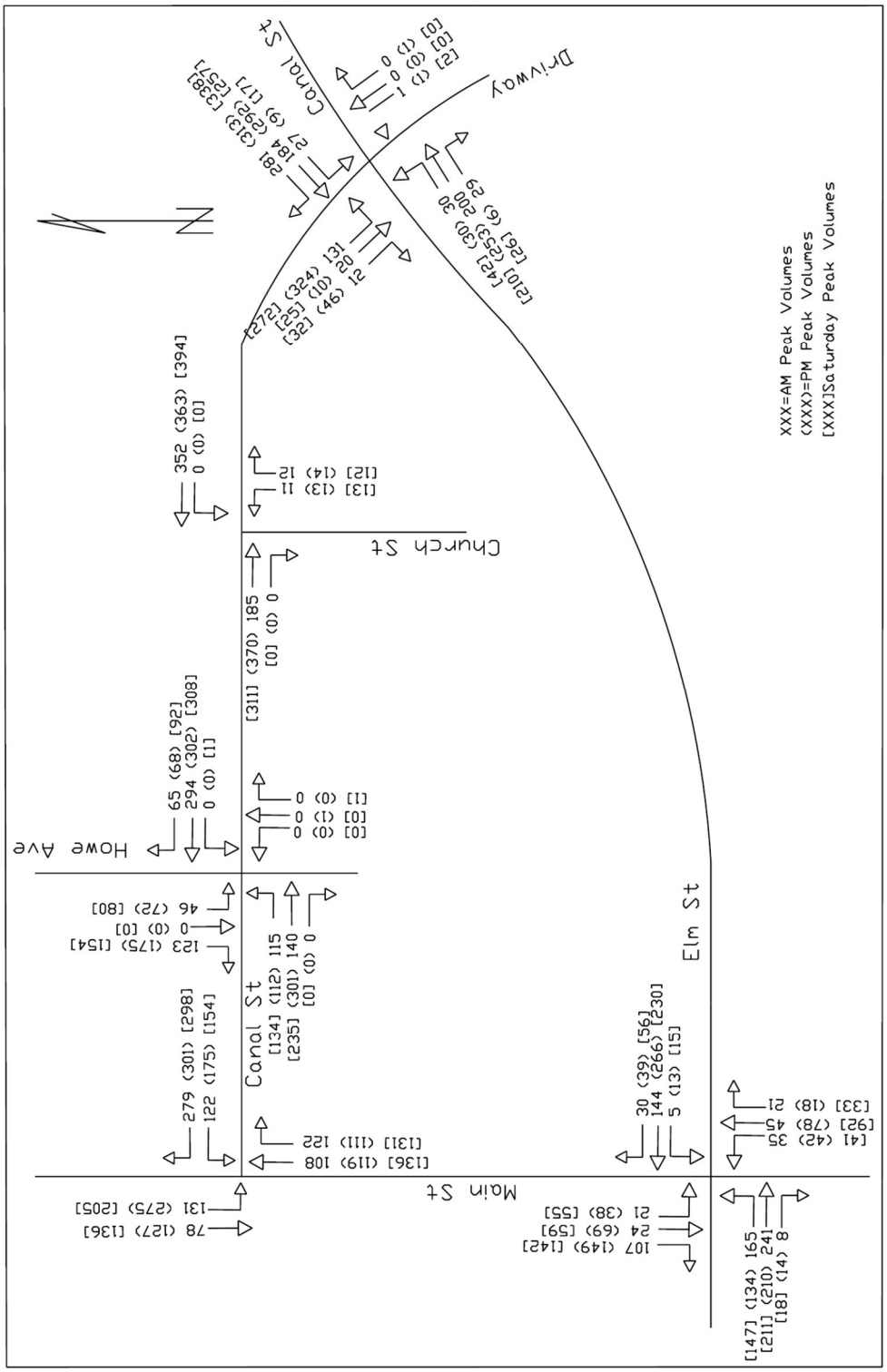
Table 2 - Adjustment Factor

Source	AM Peak	PM Peak
massDOT Canal St Rt 122A	352	492
Collected TMCs for Canal St	544	741
Peak Hour Adjustment Factor	0.65	0.66
Adjustment Factor Used	1	1

Additionally, the *massDOT* Highway Division provides statewide traffic data collection that includes weekday seasonal factors. To evaluate the potential for seasonal fluctuation of traffic volumes on roadways near the proposed site, weekday seasonal factors were obtained from the *massDOT* Statewide Traffic Data Collection. The review of the *massDOT* seasonal adjustment factors shows that the roadways having characteristics similar to Canal Street (U4-U7) have a 1.0 adjustment factor for the February traffic counts, thus not requiring further adjustment. A copy of the *massDOT* seasonal adjustment factors is included in the Technical Appendix section of this report.

Typically, the PM peak period has the higher volumes, and is considered the critical peak. As is the case here, higher traffic volumes also occur during the PM peak period at these intersections. Percentage of truck traffic at the above-mentioned *massDOT* permanent counting station #RPA05-186-2134 along Canal Street near the proposed site was last recorded by *massDOT* at approximately 1.4%. This value is considered below average of 2% for roadways having similar characteristics. The following Figure 2 depicts the base line TMCs with the above-mentioned adjustments to reflect the year 2021 (baseline).

Figure 2
Existing Baseline Turning Movement Counts



Safety Concerns

Sight Distances: Sight distance is defined in the *massDOT* Project Development and Design Guide as the length of roadway ahead that is visible to the road users. In most cases, specific sight distance measures apply to motor vehicles and bicyclists. There are two aspects of sight distance that apply to this case. They are:

- Stopping sight distance
- Intersection sight distance

The sight distances are related to the design speed (posted speed) of the roadway and are based on the standards of the American Association of State Highway and Transportation Officials (AASHTO) document titled ***A Policy on Geometric Design of Highways and Streets,*** also referred to as the **Green Book**.

Stopping Sight Distance is further described in the *massDOT* Project Development and Design Guide as the distance necessary for a vehicle traveling at the design speed (posted speed) before reaching a stationary object in its path. The sight distance at every point along a roadway should be at least the stopping sight distance.

The sight distances for vehicles leaving the site via the access driveway to the right (northwest) and left (southeast) were measured in the field. The measured distances are those from a point 5' back of a stop bar (approximately 15' from the street line) and 3.5' above grade to represent drivers' eye height to an object 3.5' above roadway grade. The field review of Canal Street showed that the available sight line for the traffic coming out of the proposed driveway is approximately 350'+ to the right (northwest) all the way through the Howe Avenue intersection and approximately 380' to the left (southeast) and through the Elm Street intersection. As stated earlier, the prima facia speed limit of 30 mph applies to Canal Street.

Based on Basic Design Controls for roadway design, the Stopping Sight Distance is calculated using the formula d=(V*V)/(30*f), plus the time required for perception and reaction by a driver (2.5 seconds). V is approach speed in mph, and f=0.28-0.35. The stopping sight distances are calculated and are provided in Exhibit 3-8 of the 2006 *massDOT* Project Development and Design Guide. A copy of this exhibit is presented in the Technical Appendix section of this report. Due to the 3% grade of the road, the required stopping sight distance for 30 mph on Canal Street is 205' to the northwest (right) and 184' to the southeast (left). The following photographs illustrate the available sight distances visually for both directions on Canal Street at the proposed driveway.

Intersection Sight Distance is explained by the *massDOT* Project Development and Design Guide as a sight distance at an intersection to allow drivers to perceive the presence of potentially conflicting vehicles. This should occur in sufficient time for a motorist to stop or adjust their speed, as appropriate, to avoid colliding in the intersection. Intersection sight distance also allows drivers of stopped vehicles with a sufficient view of the intersecting roadway to decide when to enter or cross the intersecting roadway. The AASHTO **Green Book** provides procedures to determine desirable intersection sight distances at intersections for various cases, one of which is Intersection Sight Triangle. Exhibit 3-11 of the *massDOT* Project Development

and Design Guide demonstrates the sight distances desired based on Intersection Sight Triangle methodology. A copy of this exhibit is also included in the Technical Appendix of this report. As shown in this exhibit, for the posted speed limit of 30 mph on Canal Street, 335' should be provided for vehicles turning left from the proposed driveway, and 290' should be provided for vehicles turning right from the site driveway.

As demonstrated herein above, available sight distances are greater than the desired values for intersection sight distances. Therefore, proper intersection sight distances can be provided in either direction.

A utility pole located on the north side of Canal Street just west of the proposed driveway may create a blind spot for a very short distance and a fraction of a second. However, it should be noted that the line of sight is clear and visible beyond the utility pole, and therefore, it is not the source of any safety concerns.

The sight distances were examined both horizontally and vertically. The following Figure 3 is a Google Earth aerial photo that shows the profile of Canal Street in respect to the proposed driveway in both directions.

Again, as demonstrated herein above, available sight distances are greater than both the desired and required values. Therefore, proper sight distances will be provided in both directions.

From proposed Canal Street Driveway looking to the right (northwest)

From proposed Canal Street Driveway looking to the left (southeast)

Figure 3 – Canal Street Profile

Accidents: The latest accident data compiled by the *massDOT* were obtained and reviewed for a five-year period of 2015-2019. This review summarizes the total number of accidents that occurred at each of these five intersections during this five-year period, and is listed in Table 3, below. It is noted that no accidents were reported for the intersection of Canal Street with Church Street during the five-year period of 2015-2019, while a total of nine accidents were reported for the intersection of Canal Street and Elm Street, seven accidents occurred at the intersection of Canal Street and Howe Avenue, two accidents were reported for the intersection of Canal Street and Main Street, and finally, eight accidents were reported for the intersection of Elm Street and Main Street during this period.

Of all the 26 accidents reported at these intersections, two occurred during morning peak hours and six accidents were reported during afternoon peak hours. There were no fatalities reported at any of these intersections, and only six accidents involved non-fatal injuries. The breakdown of all accidents at all five intersections is also presented below in Table 3.

Using the turning movement counts compiled during traffic surveys of these five intersections, accident rates were calculated in accidents per million vehicles entering each intersection. Utilizing the *massDOT* prescribed methodology, the accident rates for these intersections were calculated at much lower than the *massDOT*'s latest available rate of 0.89 for signalized intersections and 0.61 for unsignalized intersections on roadways in District 3 of the *massDOT*, in which the town of Millbury is located. A summary of the accident analysis is also included in the following Table 3. A copy of the accident rate calculation sheets is included in the Technical Appendix section of this report. Also included in the Technical Appendix section of this report is a copy of the *massDOT* Average Crash Rates for signalized and unsignalized intersections throughout the Commonwealth of Massachusetts.

This accident analysis indicates there are no safety deficiencies associated with either of these intersections.

Table 3 - Vehicle Crash Summary (2018-2020)

	Canal St Elm St	Canal St Main St	Canal St Howe Ave	Elm St Main St	Canal St Church St
Intersection	Signalized	Signalized	Signalized	Signalized	Unsignalized
Calculated Crash Rate	0.35	0.09	0.34	0.37	0
massDOT Av Rate	0.89	0.89	0.89	0.89	0.61
Year					
2015	3	1	2	2	0
2016	2	0	2	1	0
2017	3	0	1	2	0
2018	0	0	2	2	0
2019	1	1	0	1	0
Collision Type					
Angle	4	1	5	1	0
Rear-end	5	1	0	4	0
Sideswipe	0	0	1	1	0
Single Vehicle	0	0	0	0	0
Severity					
Fatal Injury	0	0	0	0	0
Non-Fatal Injury	4	0	1	1	0
Property Damage	5	2	6	7	0
Time of Day					
7:00 AM to 9:00 AM	0	0	1	1	0
4:00 PM to 6:00 PM	3	0	2	1	0
Other Times	6	2	4	6	0
Pavement Conditions					
Dry	6	2	5	6	0
Wet	1	0	1	2	0
Snow	1	0	1	0	0

Source: massDOT Crash Portal 2017-2019

Existing Conditions Summary

Canal Street can be characterized as a two-way roadway with one travel lane in each direction along its length in the vicinity of the proposed multifamily residential development site. Canal Street at its intersections with Main Street and Elm Street has a dedicated left-turn lane in the northwesterly and southeasterly directions. The roadway width is 36’ except at its intersection with Main Street where it widens to 40’ to accommodate a dedicated left-turn lane. Canal Street connects to Main Street at its northwesterly end and it intersects with Providence Street and Grafton Street at its southeast terminus.

The current land use designation for the proposed multifamily residential development site is Business–1 (B-1) and the site is currently undeveloped.

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FUTURE CONDITIONS

Where possible, traffic volumes in the study area are projected to post-development levels. Projected traffic volumes include the existing traffic data obtained from the turning movement counts adjusted and normalized into the year 2021 to account for the COVID-19 pandemic and to represent the baseline, projected into the future 2026-year peak hours to reflect increases due to future area projects, and added to the new traffic expected to be generated by the proposed multifamily residential development site.

Site-Generated Traffic

The magnitude of traffic volumes that will be generated by the proposed multifamily residential development site was projected by using the *Trip Generation Manual* published by the Institute of Transportation Engineers (ITE) and its computer software.

Based on the ITE *Trip Generation Manual*, the rates at which the proposed land use generates traffic vary depending upon the time of day. These rates were used to calculate the number of trips expected to be generated by the proposed multifamily residential development during an average weekday morning, afternoon, and Saturday peak traffic periods. To obtain the most accurate forecast and to be consistent with the requirements of the *massDOT* procedures, when available, the values in the fitted curves in the *Trip Generation Manual* were used to forecast trips to and from the proposed site for daily, AM, PM, and Saturday peak hours. The ITE trip tabulations outputs are presented in the Technical Appendix section ofthis report. The resulting trips and their directional distribution for this site are shown in the following Table 4.

TABLE 4
ITE Trip Generation for Clinics
59 Units Multi-Family - Mid-Rise Housing LU Code 221

Daily	%In	%Out	AM Pk	%In	%Out	PM Pk	%In	%Out	Sat Pk	%In	%Out
5.44	50%	50%	0.36	24%	76%	0.44	59%	41%	0.44	47%	53%
321	160	161	21	5	16	27*	16*	11*	32*	15*	17*

* *Fitted Curve values were used as they were greater than Average values*

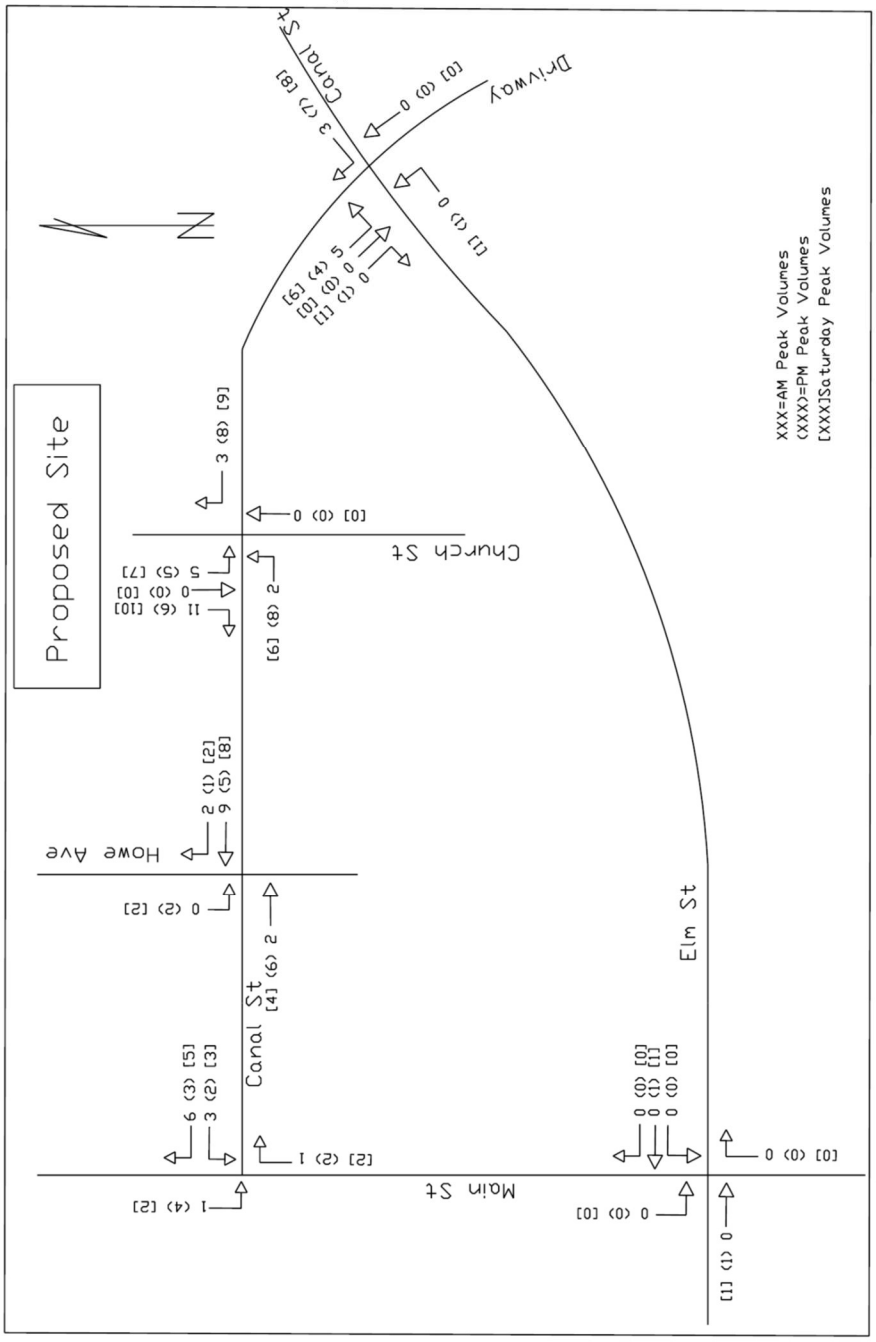
As can be seen in Table 4 above, the total number of new trips expected to be generated by the proposed multifamily residential development results in the highest traffic during Saturday peak period. In standard traffic engineering practice, the critical peak period trips are usually used to evaluate the worst-case scenario. However, since the Canal Street traffic volumes are greatest during PM peak hour, the PM peak is considered to be the critical peak. To assess the worst case scenario, all three peak traffic periods were evaluated for all five intersections.

Trip Distribution and Assignment

Because such factors as population density, land use, availability of major highways in the area, and other demographics that make up the traffic patterns within a community, the directional distribution of the projected site-generated trips to and from the proposed multifamily residential development site was based on the existing traffic patterns within the immediate vicinity of the site and based on the knowledge of the local traffic patterns. The turning movement traffic counts for the five intersections near the proposed site are good indicators of the traffic patterns in this area.

Using this information, the projected new site-generated trips from Table 4 are proportionally assigned to each approach of these intersections. As shown in Table 4 above, during AM peak period, a sum of five vehicles would be arriving at the proposed development site and 16 vehicles would be departing from the site in both directions along Canal Street via the proposed driveway. During PM peak period, a total of 16 vehicles are expected to arrive at and 11 vehicles would depart from the proposed site via the proposed driveway. During Saturday peak period, a total of 15 vehicles are expected to enter and 17 vehicles would be exiting the site. Finally, a total of 160 vehicles will be arriving at and 161 vehicles will be leaving the proposed site during a 24-hour period on an average weekday. The following Figure 4 shows the above-mentioned distribution of trips associated with the proposed site along Canal Street and other intersections within the study area.

Figure 4 - Trip Generation and Distribution



[1] *Trip Generation, 10th Edition,* Institute of Transportation Engineers; Washington, DC

Site Access, Circulation and Parking

Site access and internal traffic circulation was evaluated as part of assessing the proposed multifamily residential development site. Access to the proposed site will be achieved through a proposed driveway located directly on Canal Street across from Church Street forming a four-legged intersection. The proposed driveway will provide full access to all parking spaces and garages. This driveway is intended to accommodate all traffic to and from the proposed development. The access driveway is designed as a boulevard style having an entrance and exit 18' each separated by a 10' median island. The entrance from Canal Street is designed with a 20' radius to safely accommodate Millbury Fire Department apparatus. A detail of the Turning Performance Analysis is included on the site plan.

The magnitude of parking spaces that will be required by the proposed multifamily residential development was projected by using the *Parking Generation*[1] document also published by the ITE.

Based on the ITE Parking Generation document, the rates at which Low/Mid-Rise Apartments (land use 221) generate demand for parking vary depending upon the location of the project. The demand for off-street parking is greatest for facilities located in suburban areas primarily due to the lack of public transportation and long distances from daily conveniences. Based on the ITE *Parking Generation* document, a copy of which is included in the Technical Appendix of this report, the 85th percentile or peak period parking demand rate for multifamily residential developments located in suburban areas is 1.46 parking spaces per dwelling unit. As stated earlier, a total of 110 parking spaces are proposed for this site. Thus, the proposed parking supply is calculated at 1.86 spaces per unit. Although the proposed number of parking spaces is 16.7% lower than that required by the town of Millbury zoning regulations, it is 27.5% greater than that in the ITE *Parking Generation* document.

Therefore, based on the above assessment, it is concluded that sufficient parking spaces are proposed.

[1] *Parking Generation,* Institute of Transportation Engineers; Washington, DC

4
TRAFFIC OPERATIONS

Measuring existing traffic volumes and projecting future traffic volumes quantify traffic flow within the study area. To assess the quality of traffic flow, intersection capacity analyses were performed to measure existing baseline conditions and for projected future design year (2026) conditions with and without the implementation of the proposed multifamily residential development project. Intersection capacity analyses provide an indication of how well roadway facilities and their components serve the traffic demands placed upon them. This section includes potential on-site and off-site mitigation improvements should any be deemed necessary to minimize the impact of the proposed multifamily residential development on the surrounding roadways.

Traffic operations measures

Level of Service (LOS) is the term used to demonstrate the different operating conditions which occur on a given roadway segment or at an intersection under different traffic volume conditions. LOS is a qualitative measure of the effect of several other factors including roadway geometry, speed, travel delay, signal timing, freedom to maneuver and safety. The criteria used to analyze the intersections in proximity of the proposed development site are based on the Highway Capacity Manual and its computer software, Synchro.

The LOS concept is an indicator of the operational qualities of a roadway or an intersection. Six LOSs are defined for each type of facility. They are given letter designations from "A" to "F". LOS "A" represents the best operating conditions, while LOS "F" represents the worst. Typically, LOS "D" is considered acceptable during peak hour conditions, but LOS "E" may also be acceptable under some circumstances.

The LOS designation is reported differently for signalized and unsignalized intersections. For signalized intersections, the analysis considers the operation of all traffic entering the intersection, and a LOS designation can be calculated for overall conditions at the intersection. For an unsignalized intersection, however, the analysis assumes that through traffic on major roadways is not affected by traffic on side streets (streets with lower volumes and/or ones under stop sign control). Therefore, a LOS designation is typically calculated for the controlled movements (minor street approaches and major street left-turn movements). As described in the following paragraphs, capacity or LOS analyses were considered for year 2021 existing, year 2026 future no build, and year 2026 future build conditions for morning, evening, and Saturday peak hour periods at the above-mentioned intersections, including the proposed driveway.

Existing Conditions

Intersection capacity analyses were performed for all five intersections during morning, evening, and Saturday peak traffic periods. These intersections are the only locations in the vicinity of the proposed multifamily residential development site that were identified by the Planning Director and may be affected by the traffic expected to be generated by the proposed development. Four of the intersections are signalized and one intersection is unsignalized. For analyses of the signalized intersections, the intersection timing and sequence data were obtained from Central Mass Signal LLC, the maintenance contractor for the town of Millbury. This information was used in the analyses, and a copy of it is included in the technical Appendix section of this report.

The analysis concluded that LOS "B" or better is calculated for all approaches of these intersections during AM, PM and Saturday peak periods. A summary of the intersection analyses results for existing conditions is shown below in Table 5.

Future Conditions

Capacity analyses for the future year peak hour traffic operations were performed for the year 2026 volumes during all three peak periods with and without the proposed multifamily residential development project in place. A summary of the intersection analyses results for both future no-build and future build conditions is also shown below in Table 5.

As noted earlier in this report, based on the *massDOT* Traffic Volume and Classification data, Canal Street is included in group U4-U7 for the Growth Factor and Seasonal Factor. Based on roadways in group U4-U7 and as pointed out by the Stantec review, the yearly growth rate for this group is 0.02, or 2% per year. Therefore, the baseline volumes were increased by that rate over five years, or 10% to reflect future no-build conditions. Figure 5 shows the volumes for the future no-build conditions for all five intersections within the study area. The projected future no-build year (2026) traffic should account for any future developments in the general area of the proposed site.

Build traffic volumes were determined by projecting site-generated traffic volumes and distributing those volumes over the intersections within the study area roadway network, and finally, adding them to the future no-build conditions volumes. The following Figure 6 shows future build conditions traffic volumes for all five intersections, including the proposed driveway off Canal Street.

Figure 5 – Turning Movement Counts, Future No Build Conditions

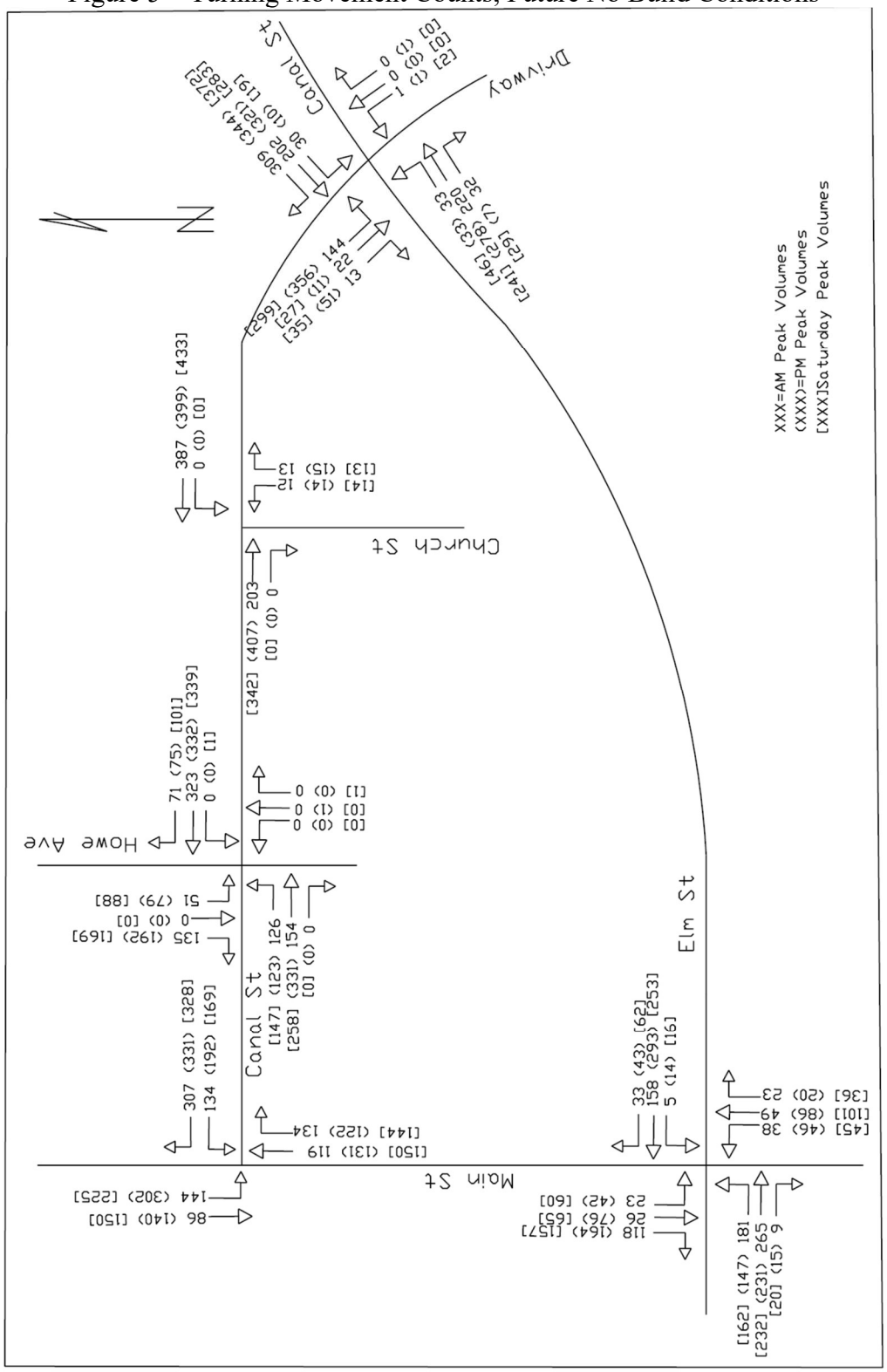
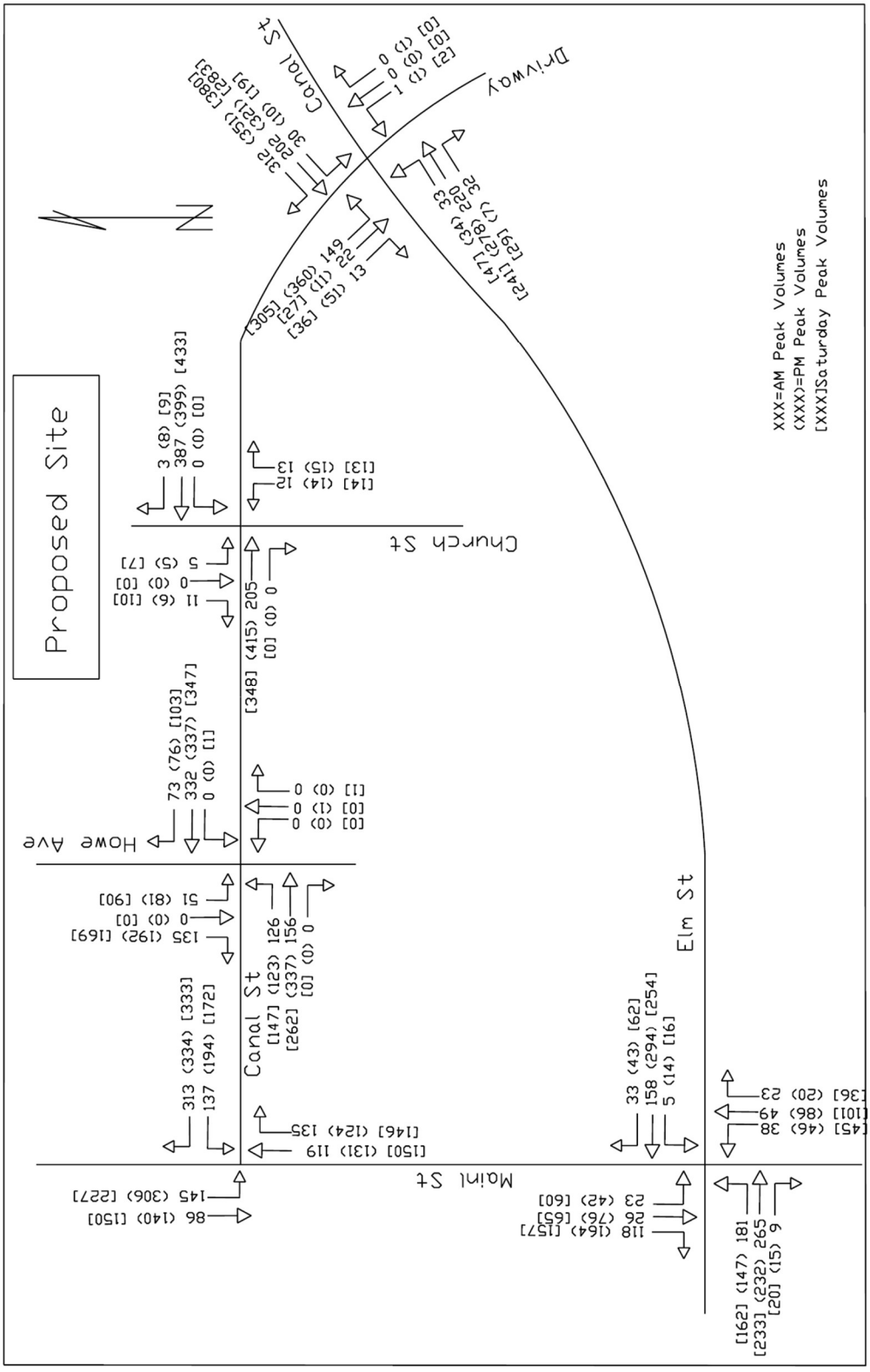


Figure 6 – Turning Movement Counts, Future Build Conditions



The intersection LOSs for the year 2026 no-build conditions were calculated for the approaches of these intersections and are expected to remain at "B" or better during all three peak periods except the northbound approach of Church Street that will be operating at LOS "C" during PM peak period signifying no significant increase in vehicular delays.

To assess the potential traffic impact of the proposed development on these intersections, all traffic from the site was distributed along Canal Street, Elm Street, Main Street and their intersections. This should result in the assessment of all five intersections under worst-case scenario. The above Figures 2, 5 and 6 show the volumes at all intersections for the AM, PM and Saturday peak hours under existing, future no-build, and future build conditions.

The intersection analysis for the year 2026 build conditions were performed for the approaches of all five intersections including the proposed site driveway off Canal Street directly across from Church Street. The analysis revealed that under future build conditions, all five intersections will be operating the same as the future no-build with LOS "B" or better. However, the Church Street approach and the proposed driveway approach are expected to continue to operate at LOS "B" during AM peak period and LOS "C" during PM and Saturday peak periods.

Again, the above-mentioned LOS "B" or better for all intersections except the Church Street approach which will be operating at LOS "C" during future no-build and build conditions are indicative of little or no impact associated with the development of the proposed multifamily residential project.

A summary of intersection analyses for all five locations, including the proposed new driveway which makes up the fourth leg of the Church Street intersection, is provided below in Table 5.

Finally, the computer printout of the above-mentioned analysis is included in the Technical Appendix of this report.

Table 5
Level Of Service Analysis Results Summary

	Int of Canal St and Elm St											
AM Peak	Existing 2021				No Build 2026				Build 2026			
Approach	EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB
Approach Delay	7	2.9	7	7.5	7.2	3	7	7.6	7.3	3.1	7	7.6
v/c	0.5	0.38	0.01	0.25	0.51	0.41	0.01	0.27	0.51	0.41	0.01	0.28
Approach LOS	A	A	A	A	A	A	A	A	A	A	A	A
Int Av Sig Delay	5				5.1	A			5.1			
Int LOS	A								A			

PM Peak	Existing 2021				No Build 2026				Build 2026			
Approach	EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB
Approach Delay	10.7	5.3	6	7.8	11.5	5.7	6.5	8.8	11.7	5.7	6.5	8.9
v/c	0.53	0.54	0	0.46	0.58	0.58	0.01	0.64	0.59	0.59	0.01	0.64
Approach LOS	B	A	A	A	B	A	A	A	B	A	A	A
Int Av Sig Delay	7.2				7.9				7.9			
Int LOS	A				A				A			

Sat Peak	Existing 2021				No Build 2026				Build 2026			
Approach	EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB
Approach Delay	9.4	4.2	7	7.8	10.2	4.4	8	8.6	10.3	4.4	8	8.7
v/c	0.54	0.46	0.01	0.44	0.59	0.49	0.01	0.44	0.59	0.49	0.01	0.45
Approach LOS	A	A	A	A	B	A	A	A	B	A	A	A
Int Av Sig Delay	6.4				7				7			
Int LOS	A				A				A			

	Int of Elm St and Main St											
AM Peak	Existing 2021				No Build 2026				Build 2026			
Approach	EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB
Approach Delay	5.3	11.1	11.4	6.2	5.4	11.2	11.5	6.2	5.4	11.2	11.5	6.2
v/c	0.3	0.34	0.14	0.18	0.33	0.36	0.15	0.2	0.33	0.36	0.15	0.2
Approach LOS	A	B	B	A	A	B	B	A	A	B	B	A
Int Av Sig Delay	7.4				7.5				7.5			
Int LOS	A				A				A			

PM Peak	Existing 2021				No Build 2026				Build 2026			
Approach	EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB
Approach Delay	5.2	12	14.5	8.5	5.4	12.3	15	8.7	5.4	12.3	15.1	8.8
v/c	0.28	0.54	0.22	0.23	0.33	0.56	0.36	0.32	0.33	0.56	0.36	0.32
Approach LOS	A	B	B	A	A	B	B	A	A	B	B	A
Int Av Sig Delay	9.3				9.6				9.6			
Int LOS	A				A				A			

Sat Peak	Existing 2021				No Build 2026				Build 2026			
Approach	EB	WB	NB	SB	EB	WB	NB	SB	EB	WB	NB	SB
Approach Delay	5.5	11.3	12.8	8.8	5.6	11.4	13.8	10.2	5.6	11.4	13.8	10.2
v/c	0.3	0.48	0.27	0.29	0.34	0.51	0.33	0.36	0.34	0.51	0.33	0.36
Approach LOS	A	B	B	A	A	B	B	B	A	B	B	B
Int Av Sig Delay	8.9				9.4				9.4			
Int LOS	A				A				A			

Table 5 Continued

	Int of Canal St & Howe Ave								
AM Peak	Existing 2021			No Build 2026			Build 2026		
Approach	EB	WB	SB	EB	WB	SB	EB	WB	SB
Approach Delay	4.7	12	6.7	4.9	12.3	7.6	4.9	12.3	7.8
v/c	0.24	0.52	0.39	0.28	0.54	0.42	0.29	0.55	0.42
Approach LOS	A	B	A	A	B	A	A	B	A
Int Av Sig Delay	8.5			8.9			8.9		
Int LOS	A			A			A		

PM Peak	Existing 2021			No Build 2026			Build 2026		
Approach	EB	WB	SB	EB	WB	SB	EB	WB	SB
Approach Delay	10.3	14.3	12.5	11.1	15.3	13.8	11.2	15.4	14.1
v/c	0.33	0.54	0.49	0.4	0.51	0.56	0.4	0.52	0.57
Approach LOS	B	B	B	B	B	B	B	B	B
Int Av Sig Delay	12.3			13.3			13.4		
Int LOS	B			B			B		

Sat Peak	Existing 2021			No Build 2026			Build 2026		
Approach	EB	WB	SB	EB	WB	SB	EB	WB	SB
Approach Delay	11.2	15.9	13.8	12.3	17.4	15.3	12.4	17.6	15.7
v/c	0.42	0.44	0.57	0.45	0.47	0.6	0.45	0.48	0.6
Approach LOS	B	B	B	B	B	B	B	B	B
Int Av Sig Delay	13.8			15.1			15.3		
Int LOS	B			B			B		

	Int of Canal St & Church St									
AM Peak	Existing 2021			No Build 2026			Build 2026			
Approach	EB	WB	NB	EB	WB	NB	EB	WB	NB	SB
Control Delay	0	0	11.3	0	0	11.7	0.1	0	12.6	12.4
v/c	0.13	0.23	.o4	0.14	0.26	0.05	0	0	0.05	0.03
App LOS			B			B			B	B
Int Av Delay	0.4			0.5			0.8			
ICU LOS	A			A			A			

PM Peak	Existing 2021			No Build 2026			Build 2026			
Approach	EB	WB	NB	EB	WB	NB	EB	WB	NB	SB
Control Delay	0	0	14	0	0	15	0.2	0	17.2	16.4
v/c	0.25	0.26	0.07	0.28	0.28	0.09	0.01	0	0.11	0.04
App LOS			B			C			C	C
Int Av Delay	0.5			0.5			0.9			
ICU LOS	A			A			A			

Sat Peak	Existing 2021			No Build 2026			Build 2026			
Approach	EB	WB	NB	EB	WB	NB	EB	WB	NB	SB
Control Delay	0	0	13.2	0	0	14	0.2	0	15.9	15
v/c	0.21	0.26	0.06	0.23	0.28	0.07	0.01	0	0.08	0.05
App LOS			B			B			C	C
Int Av Delay	0.4			0.5			0.9			
ICU LOS	A			A			A			

Table 5Continued

	Int of Canal St & Main St								
AM Peak	Existing 2021			No Build 2026			Build 2026		
Approach	WB	NB	SB	WB	NB	SB	WB	NB	SB
Approach Delay	9	11.5	12.2	9	11.5	12.3	9	11.4	12.3
v/c	0.47	0.32	0.28	0.5	0.35	0.32	0.5	0.35	0.32
Approach LOS	A	B	B	A	B	B	A	B	B
Int Av Sig Delay	10.5			10.5			10.5		
Int LOS	B			B			B		

PM Peak	Existing 2021			No Build 2026			Build 2026		
Approach	WB	NB	SB	WB	NB	SB	WB	NB	SB
Approach Delay	11	13.1	14.1	11	13.1	14.4	11	13	14.5
v/c	0.51	0.32	0.56	0.54	0.35	0.63	0.55	0.36	0.64
Approach LOS	B	B	B	B	B	B	B	B	B
Int Av Sig Delay	12.5			12.6			12.6		
Int LOS	B			B			B		

Sat Peak	Existing 2021			No Build 2026			Build 2026		
Approach	WB	NB	SB	WB	NB	SB	WB	NB	SB
Approach Delay	10.6	13.4	14.4	10.7	13.5	14.6	10.7	13.4	14.6
v/c	0.51	0.36	,42	0.54	0.39	0.49	0.55	0.39	0.49
Approach LOS	B	B	B	B	B	B	B	B	B
Int Av Sig Delay	12.5			12.6			12.6		
Int LOS	B			B			B		

5
FINDINGS

This traffic study has been conducted to evaluate the potential traffic impacts associated with the proposed multifamily residential development site located on the north side of Canal Street in the town of Millbury, Massachusetts. This study includes the evaluation of five intersections in proximity of the proposed site which are likely to be impacted by the proposed development project. Evaluation of the area to identify capacity constraints was performed for existing, future no-build, and future build conditions. Future analyses have determined that the site-generated traffic volumes are not substantial, and they can easily be accommodated with the existing roadways and the proposed new driveway off Canal Street. These analyses demonstrated that with the additional traffic volumes associated with the proposed multifamily residential development, the intersection LOS will stay the same as the existing and the future no build conditions and would be "B", or better except for the intersection of Canal and Church Streets where the LOS will remain "C", the same as future no-build conditions. The analysis concluded that the intersection of Canal Street, Church Street and the proposed access driveway will be operating at LOS "B" during AM peak period and LOS "C" during PM and Saturday peak periods.

As stated earlier, the percentage of truck traffic at permanent counting station #RPA05-186-2134 along Canal Street was recorded by the *massDOT* at 1.4%. This value is considered below average of 2% for roadways having similar characteristics.

Conclusion & Recommendations

It is concluded that the intersections within the study area have experienced low accident rates, and therefore, no safety issues can be related to these intersections.

There are ample sight distances to safely allow motorists to enter and exit the site via the proposed driveway.

The volumes of traffic associated with the proposed multifamily residential development are not considered significant, and therefore, the area roadways within close vicinity of the proposed site have enough capacity to safely serve the anticipated additional traffic. The level of service evaluation presented herein above is an indicator of the quality of traffic flow through the area. This evaluation indicates that little or no impact is expected from the proposed development and the LOS will not fall below "B" for four signalized intersections and below "C" at an unsignalized intersection that were studied. As shown in the photographs, vegetation along the north side of Canal Street may impede visibility to motorists leaving the site. Therefore, the applicant should make efforts to remove any existing vegetation and to keep any landscaping along the frontage of the proposed site to a minimum to provide ideal sight distances. Therefore, to maintain optimum safety and efficiency, the following improvements are recommended.

- The site frontage on the north side of Canal Street, particularly to the west side of its

intersection with the proposed driveway should be cleared of all existing vegetation to further improve the sight distance to the northwest.

- Any landscaping along the frontage of the proposed site on Canal Street should be limited to vegetation varieties that do not grow taller than 2.5' to ensure best sight lines are provided.
- The utility pole located just west of the driveway may need to be monitored after the site is completely developed and fully occupied in order to determine whether it should be relocated to remedy a small blind spot and to improve the line of sight to the northwest.