

MEMORANDUM

TO: Mr. Lars Unhjem
Villebridge
1150 Great Plain Avenue, # 920056
Needham, MA 02492

FROM: Mr. Jeffrey S. Dirk, P.E. *, PTOE, FITE
Managing Partner and
Mr. Daniel C. LaCivita
Transportation Engineer
Vanasse & Associates, Inc.
35 New England Business Center Drive
Suite 140
Andover, MA 01810-1066
(978) 269-6830
jdirk@rdva.com



**Professional Engineer in CT, MA, ME, NH, RI and VA*

DATE: October 27, 2023

RE: 9301

SUBJECT: Corridor Improvement Study
North Main Street/South Main Street (Route 114)/Boston Street (Route 62)
Middleton, Massachusetts

Vanasse & Associates, Inc. (VAI) has prepared a Corridor Improvement Study for the North Main Street/South Main Street (Route 114) and Boston Street (Route 62) corridors in Middleton, Massachusetts, to identify potential improvement strategies that are intended to improve traffic flow, enhance safety and promote mobility through accommodating alternative modes of transportation to single-occupancy vehicles (SOVs). This study has been prepared in accordance with the scope of work developed in consultation with the Town of Middleton and includes the following:

- An evaluation of existing traffic volumes, motor vehicle crash data and operating conditions (levels of service, motorist delays and vehicle queuing) at five (5) intersections along Route 114 between and including the Fuller Meadow Elementary School driveway and Essex Street/Foster Street and three (3) intersections along Route 62 between and including Route 114 and River Street;
- An assessment of future traffic volumes and operating conditions at the study intersections with the completion of identified specific development projects and general background traffic growth; and
- A review of potential improvement strategies for the segment of Route 114 between and including Boston Street and Central Street/Lake Street.

The following details our assessment of improvement strategies for the South Main Street/North Main Street and Boston Street corridors.

STUDY AREA

The study area that was evaluated as a part of this assessment consisted of South Main Street/North Main Street (Route 114) between and including the Fuller Meadow Elementary School driveway and Forest Street/Essex Street, and Boston Street (Route 62) between and including Route 114 and River Street.



Within this area, the following specific intersections were included in this assessment which are also depicted geographically on Figure 1:

1. Route 114 (North Main Street) at Forest Street and Essex Street
2. Route 114 (North Main Street and South Main Street) at Central Street and Lake Street
3. Route 114 (South Main Street) at Maple Street (Route 62)
4. Route 114 (South Main Street) at Boston Street (Route 62) and the Middleton Town Hall Driveways
5. Route 114 (South Main Street) at the Fuller Elementary School Driveway
6. Route 62 (Boston Street) at Elm Street (Route 62)
7. Route 62 (Boston Street) at Flint Street
8. Route 62 (Boston Street) at River Street

EXISTING CONDITIONS

A comprehensive field inventory of existing conditions within the study area was conducted in May and June 2022. The field investigation consisted of an inventory of existing roadway geometrics; pedestrian and bicycle facilities; public transportation services; traffic volumes; and operating characteristics; as well as posted speed limits and land use information within the study area. In addition to the filed inventories, a detailed inventory of the traffic signal equipment at the signalized study area intersections along Route 114 was also completed. The traffic signal inventories are attached and were used to inform the traffic operations analysis (discussion follows).

The following describes the study area roadways and intersections.

Roadways

North Main Street/South Main Street (Route 114)

- Urban principal arterial roadway that traverses the study area in a general north-south direction and provides four lanes (2 lanes per direction) between Boston Street (Route 62) and Central Street/Lake Street, and two lanes (1 lane per direction) to the north of Central Street/Lake Street and to the south of Boston Street;
- Under MassDOT jurisdiction south of Boston Street, between Pleasant Street and Maple Street, and north of Central Street/Lake Street;
- Provides one to two 13-foot wide travel lanes that are separated by a double-yellow centerline with 2-foot wide marked shoulders and additional travel lanes at major intersections;
- The posted speed limit is 30 miles per hour (mph) within the study area;
- Sidewalks are provided along one or both sides of the roadway within the study area;
- Illumination is provided by way of streetlights mounted on wood poles;
- Land use within the study area consists of the Project site, Memorial Hall (Middleton Town Offices), and residential and commercial properties.



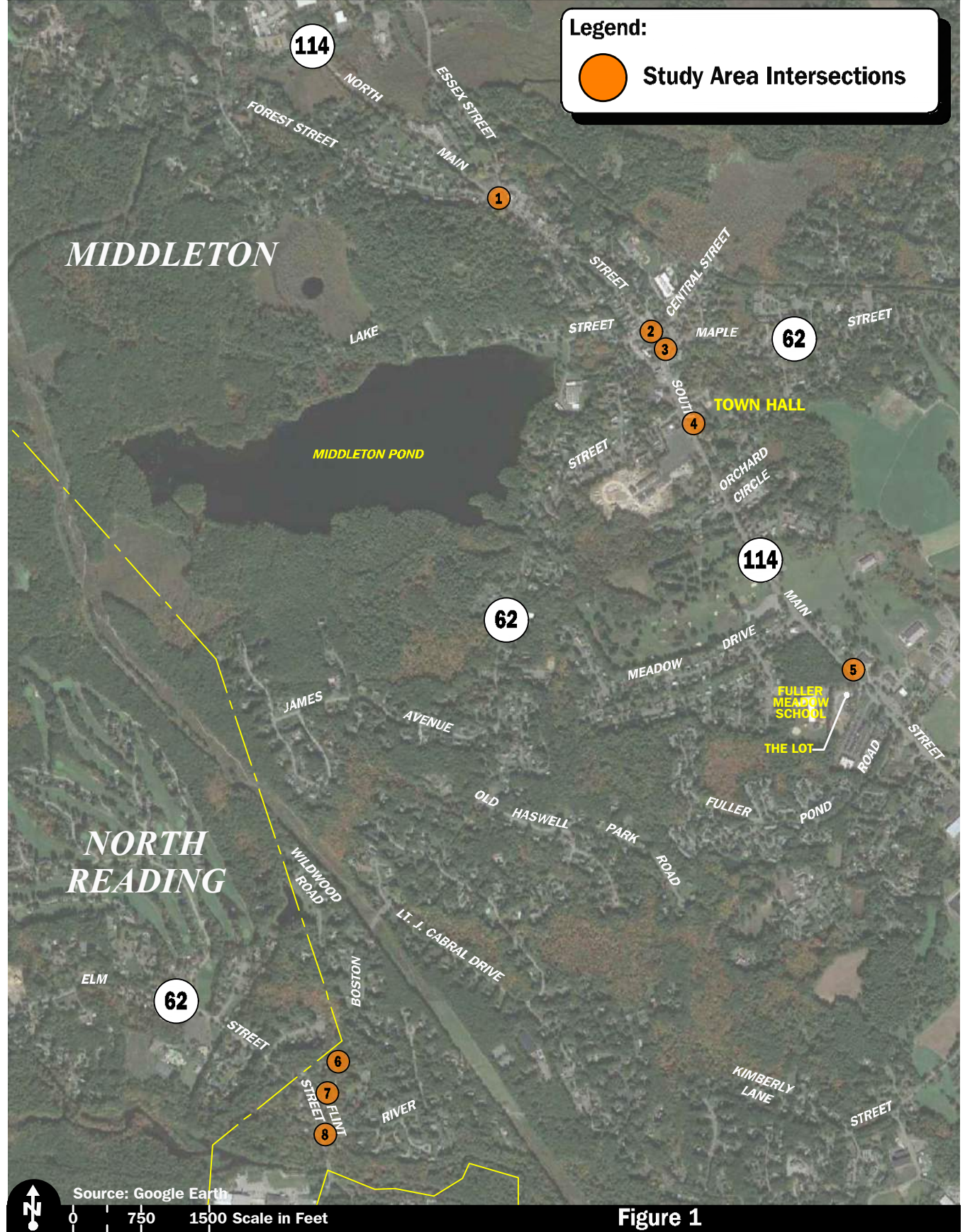


Figure 1

Study Area Map



Boston Street (Route 62)

- Two-lane urban minor arterial roadway under Town jurisdiction;
- Traverses the study area in a general northeast-southwest direction;
- Provides two 11- to 12-foot wide travel lanes that are separated by a double-yellow centerline with 1-foot wide marked shoulders and additional travel lanes provided at major intersections;
- The posted speed limit varies from 25 mph to 40 mph within the study area;
- A sidewalk is provided along the north side of the roadway between Route 114 and James Road and along the south side to Wildwood Road;
- Illumination is provided by way of streetlights mounted on wood poles;
- Land use within the study area consists of the Project site, St. Agnes Parish and residential properties.

Intersections

Table 1 and Figure 2 summarize existing lane use, traffic control, and pedestrian and bicycle accommodations at the study area intersections as observed in June and July 2022.

Table 1
STUDY AREA INTERSECTION DESCRIPTION

Intersection	Traffic Control Type ^a	No. of Travel Lanes Provided	Shoulder Provided? (Yes/No/Width)	Pedestrian Accommodations? (Yes/No/Description)	Bicycle Accommodations? (Yes/No/Description)
North Main St./ Essex St./ Forest St.	TS	1 left-turn lane and 1 through lane, with right-turns exiting prior to the intersection by way of a channelized right-turn lane on the North Main St. northbound approach; 1 left-turn/through lane and 1 through/right-turn lane on the North Main St. southbound approach; 1 general-purpose travel lane on the Essex St. and Forest St. approaches.	Yes; 1 to 4 feet on all legs.	Yes; sidewalks are provided along both sides of North Main St. south of the intersection, the east side of North Main Street north of the intersection for approximately 230 feet, both sides of Essex St. and the south side of Forest St. for approximately 100 ft; crosswalks are provided for crossing Essex Street and the North Main St. south leg; pedestrian traffic signal equipment and phasing (exclusive) provided as a part of the traffic signal system.	Yes; shared traveled-way ^b

See notes at end of table.



Table 1 (Continued)
STUDY AREA INTERSECTION DESCRIPTION

Intersection	Traffic Control Type^a	No. of Travel Lanes Provided	Shoulder Provided? (Yes/No/Width)	Pedestrian Accommodations? (Yes/No/Description)	Bicycle Accommodations? (Yes/No/Description)
South Main St./ North Main St./ Central St./ Lake St.	TS	1 left-turn/through lane and 1 through/right-turn lane on North and South Main St. approaches; 1 general-purpose travel lane on Central St. and Lake St. approaches; marked on-street parking along the west side of North Main St. north of the intersection.	Yes; 1 foot on South Main St.; 1 to 2 feet on Central St.; 2 feet along the east side of North Main St.	Yes; sidewalks are provided along both sides of North and South Main St., along the north side of Central St. and along the south side for approximately 70 feet, and the north side of Lake St. for approximately 80 feet; crosswalks are provided for crossing all legs of the intersection; pedestrian traffic signal equipment and phasing (exclusive) provided as a part of the traffic signal system.	Yes; shared traveled-way
South Main St./ Maple St.	TS	1 through lane and 1 through/right-turn lane on South Main St. northbound approach; 1 left-turn/through lane and 1 through lane on South Main St. southbound approach; 1 left-turn lane and 1 right-turn lane on Maple St. approach.	Yes; 1 to 2 feet on all legs.	Yes; sidewalks are provided along both sides of the intersecting roadways; crosswalks are provided for crossing South Main St. south leg and Maple St.; pedestrian traffic signal equipment and phasing (exclusive) provided as a part of the traffic signal system.	Yes; shared traveled-way
South Main St./ Boston St./ Town Hall Dwys	TS	1 left-turn/through lane and 1 through/right-turn lane on South Main St. approaches; 1 left-turn lane and 1 through/right-turn lane on Boston St. approach; 1 general-purpose travel lane on the Town Hall driveway approach.	Yes; 2 feet on the South Main St. and 1 foot on Boston St.	Yes; sidewalks are provided along both sides of South Main St. and the north side of Boston St.; crosswalks are provided for crossing the South Main St. and Boston St. legs; the sidewalk along the east side of South Main St. is flush across the Town Hall Dwys; pedestrian traffic signal equipment and phasing (exclusive) are provided as a part of the traffic signal system.	Yes; shared traveled-way
South Main St./ Fuller Meadow School Dwy.	U	1 left-turn lane and 1 through/right-turn lane on South Main St. northbound; center turn lane and 1 through/right-turn lane on South Main St. southbound; 1 general purpose lane on Fuller Meadow School Dwy.	Yes; 3 to 4 feet on the South Main St.	Yes; sidewalk along the west side of South Main St. and along the north side of the Fuller Meadow School Dwy.; crosswalk provided across the Fuller Meadow School Dwy.	Yes; shared traveled-way

See notes at end of table.



Table 1 (Continued)
STUDY AREA INTERSECTION DESCRIPTION

Intersection	Traffic Control Type ^a	No. of Travel Lanes Provided	Shoulder Provided? (Yes/No/Width)	Pedestrian Accommodations? (Yes/No/Description)	Bicycle Accommodations? (Yes/No/Description)
Boston St./ Elm St.	S	1 general-purpose travel lane on all approaches.	Yes; 1 to 3 feet on all approaches.	No	Yes; shared traveled-way
Boston St./ Flint St.	S	1 general-purpose travel lane on all approaches; Flint St. is one-way toward Boston St.	Yes, 1 to 2 feet on Boston St.	No	Yes; shared traveled-way
Boston St./ River St.	S	1 general-purpose travel lane on all approaches; truck restriction signs installed for River St.	Yes, 2 to 3 feet on Boston St. and 1 foot on River St.	No	Yes; shared traveled-way

TS = traffic signal control; S = STOP-sign control.

^bCombined shoulder and travel lane width equal to or exceeding 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, turning movement counts (TMCs), and vehicle classification counts were completed in May 2022 and September 2023. The ATR counts were conducted on May 19th through May 21st, 2022 (Thursday through Saturday, inclusive) on South Main Street south of Boston Street, on Boston Street west of South Main Street, and on North Main Street north of Lake Street in order to record weekday traffic conditions over an extended period, with peak-period TMCs performed at the study intersections during the weekday morning (7:00 to 9:00 AM) and evening (3:00 to 7:00 PM or 2:00 to 7:00 PM) peak-periods on Thursday, May 19, 2022 and on Thursday, September 28, 2023 (South Main Street/Fuller Meadow Elementary School Driveway), and during the Saturday midday peak-period (11:00 AM to 2:00 PM) on May 21, 2022 and on September 30, 2023 (South Main Street/Fuller Meadow Elementary School Driveway). These time periods were selected for analysis purposes as they are representative of the peak traffic volume hours for the study area roadway network.

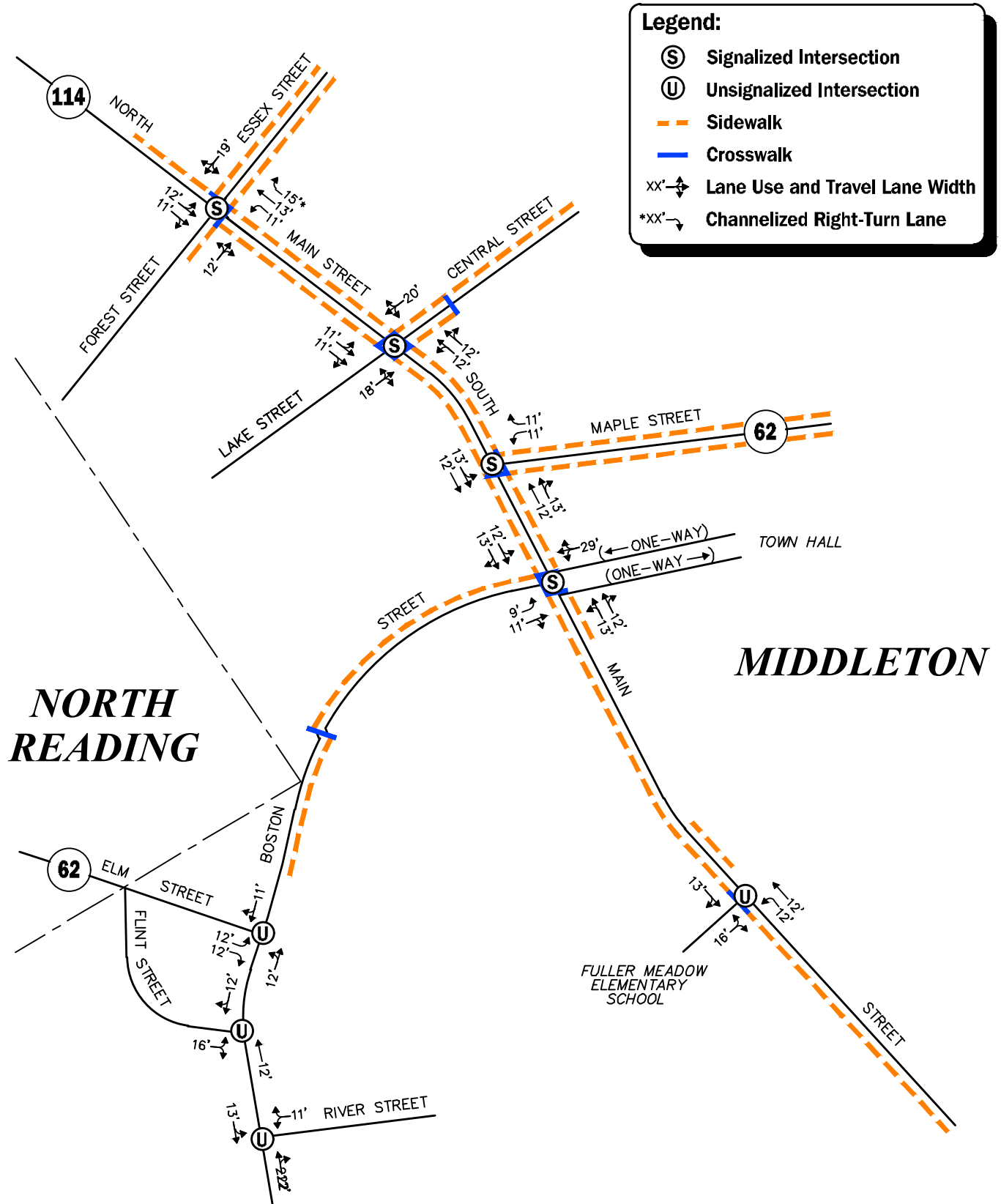
Traffic-Volume Adjustments

In order to evaluate the potential for seasonal fluctuation of traffic volumes within the study area, MassDOT weekday seasonal factors for Urban Group 3 (Other Principal Arterial) and Groups 4-7 (minor arterials, major and minor collectors and local roads and streets), which include roadways with the same functional classification as the study area roadways, were reviewed.¹ Based on a review of this data, it was determined that traffic volumes for the month of May are approximately 7.0 to 12.0 percent *higher* than those under average-month conditions with those during the month of September approximately 8.7 percent *higher* than those under average-month conditions. In order to provide a conservative assessment of traffic volume conditions within the study area, no adjustment was made to the raw traffic count data as the data is representative of *above* average-month conditions.

In order to account for the impact on traffic volumes and trip patterns resulting from the COVID-19 pandemic, traffic-volume data collected at MassDOT Continuous Count Station No. 5080 located on I-95

¹MassDOT statewide Traffic Data Collection; 2019 Weekday Seasonal Factors, Groups U4-7.





Not To Scale



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Figure 2

**Existing Intersection Lane Use,
Travel Lane Width, and
Pedestrian Facilities**

in Peabody in May 2022 was compared to data collected at the same count station in May 2019.² Based on this pre- and post-COVID-19 traffic-volume comparison, the traffic-volume data that was collected as part of this assessment was found to be approximately 8.8 percent *below* the conditions that existed prior to the COVID-19 pandemic. As stated previously, May traffic volumes are approximately 7.0 to 12.0 percent *higher* than those under average-month conditions. A review of the monthly traffic count data for Count Station No. 5080 indicates that May traffic volumes at that location are approximately 5.3 percent *higher* than average month conditions. As such, the May traffic volumes were adjusted upward by the difference between the COVID adjustment (8.8 percent) and the seasonal adjustment (5.3 percent) based on the count station data in order to be representative of traffic volume conditions that existed prior to the COVID-19 pandemic under average-month conditions. We note that MassDOT no longer requires pandemic-related adjustment of traffic counts performed after March 2022, except in locations where the predominant land use consists of offices or similar uses³ and, as such a pandemic-related adjustment was not applied to the September 2023 traffic count data.

In order to account for the changes in traffic volumes between the year the counts were taken (2022) to the current year (2023), the May 2022 traffic volumes were adjusted upward using the annual background traffic growth rate (discussion follows) in order to be representative of traffic volume conditions that exist in 2023.

The 2023 Existing traffic volumes are summarized in Table 2, with the weekday morning, weekday evening and Saturday midday peak-hour traffic volumes graphically depicted on Figures 3, 4, and 5, respectively. Note that the peak-hour traffic volumes that are presented in Table 2 were obtained from the aforementioned figures.

Table 2
2023 EXISTING TRAFFIC VOLUMES

Location/Peak Hour	AWT ^a	Saturday ^b	VPH ^c	K Factor ^d	Directional Distribution ^e
<i>South Main Street, south of Boston Street:</i>	24,345	23,740	--	--	--
Weekday Morning (7:30 – 8:30 AM)	--	--	1,834	7.5	51.7% SB
Weekday Evening (4:45 – 5:45 PM)	--	--	1,934	7.9	51.7% NB
Saturday Midday (12:15PM – 1:15 PM)	--	--	1,907	8.0	50.3% SB
<i>Boston Street, west of South Main Street:</i>	8,400	8,370	--	--	--
Weekday Morning (7:30 – 8:30 AM)	--	--	650	7.7	52.5% WB
Weekday Evening (4:45 – 5:45 PM)	--	--	775	9.2	56.7% EB
Saturday Midday (12:15PM – 1:15 PM)	--	--	649	7.8	56.2% EB
<i>North Main Street, north of Lake Street:</i>	22,265	20,495	--	--	--
Weekday Morning (7:30 – 8:30 AM)	--	--	2,247	10.1	52.6% SB
Weekday Evening (4:45 – 5:45 PM)	--	--	2,366	10.6	52.6% NB
Saturday Midday (12:15PM – 1:15 PM)	--	--	2,002	9.8	51.6% SB

^aAverage weekday traffic in vehicles per day.

^bAverage Saturday traffic in vehicles per day.

^cVehicles per hour.

^dPercent of daily traffic occurring during the peak hour.

^ePercent traveling in peak direction.

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

²MassDOT Traffic Volumes for the Commonwealth of Massachusetts; 2022.

³25% Design Submission Guidelines; MassDOT Highway Division, Traffic and Safety Engineering; Revised May 31, 2022.





2023 Existing Weekday Morning Peak-Hour Traffic Volumes



2023 Existing Weekday Evening Peak-Hour Traffic Volumes



2023 Existing Saturday Midday Peak-Hour Traffic Volumes

As can be seen in Table 2, South Main Street south of Boston Street was found to accommodate approximately 24,345 vehicles on an average weekday and approximately 23,740 vehicles on a Saturday (both two-way, 24-hour volumes), with approximately 1,834 vehicles per hour (vph) during the weekday morning peak-hour, 1,934 vph during the weekday evening peak-hour and 1,907 vph during the Saturday midday peak-hour.

Boston Street west of South Main Street was found to accommodate approximately 8,400 vehicles on an average weekday and approximately 8,370 vehicles on a Saturday, with approximately 650 vph during the weekday morning peak-hour, 775 vph during the weekday evening peak-hour and 649 vph during the Saturday midday peak-hour.

North Main Street north of Lake Street was found to accommodate approximately 22,265 vehicles on an average weekday and approximately 20,495 vehicles on a Saturday, with approximately 2,247 vph during the weekday morning peak-hour, 2,366 vph during the weekday evening peak-hour and 2,002 vph during the Saturday midday peak-hour.

Pedestrian and Bicycle Facilities

A comprehensive field inventory of pedestrian and bicycle facilities within the study area was undertaken in June 2022. The field inventory consisted of a review of the location of sidewalks and pedestrian crossing locations along the study roadways and at the study area intersections, as well as the location of existing and planned future bicycle facilities.

As detailed on Figure 2, with the exception of Lake Street, sidewalks are generally provided along one or both sides of the study area roadways, with marked crosswalks provided for crossing one or more legs of the study area intersections along North and South Main Street, and pedestrian traffic signal equipment and phasing provided as a part of the traffic systems at the signalized study area intersections.

Formal bicycle facilities are not currently provided within the study area; however, the study area roadways generally provide sufficient width (combined travel lane and shoulder) to support bicycle travel in a shared traveled-way configuration.⁴

Public Transportation

Regularly scheduled public transportation services are not currently provided within the Town of Middleton. The Massachusetts Bay Transportation Authority (MBTA) operates The Ride paratransit services for eligible persons within the Town who cannot use fixed-route transit all or some of the time due to a physical, cognitive, or mental disability in accordance with Americans with Disabilities Act (ADA) requirements. In addition, the Town of Middleton Council on Aging (COA) provides transportation services to eligible seniors for errands and medical appointments by appointment.

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



Spot Speed Measurements

Vehicle travel speed measurements were performed on North Main Street, South Main Street and on Boston Street in conjunction with the ATR counts. Table 3 summarizes the vehicle travel speed measurements.

Table 3
VEHICLE TRAVEL SPEED MEASUREMENTS

	South Main Street		Boston Street		North Main Street	
	Northbound	Southbound	Eastbound	Westbound	Northbound	Southbound
Mean Travel Speed (mph)	32	36	27	30	33	33
85 th Percentile Speed (mph)	37	42	33	34	39	40
Posted Speed Limit (mph)	30	30	25	35	30	35

mph = miles per hour.

As can be seen in Table 3, the mean vehicle travel speed along South Main Street south of Boston Street was found to be 32 mph in the northbound direction and 36 mph southbound. The measured 85th percentile vehicle travel speed, or the speed at which 85 percent of the observed vehicles traveled at or below, was found to be 37 mph in the northbound direction and 42 mph southbound, which is 7 to 12 mph *above* the posted speed limit in the Project site vicinity (30 mph).

The mean vehicle travel speed along Boston Street west of South Main Street was found to be 27 mph in the eastbound direction and 30 mph westbound, with the measured 85th percentile vehicle travel speed found to be 33 mph in the eastbound direction and 34 mph westbound. We note that the speed limit transitions in the vicinity of the Project site to 25 mph in the eastbound direction approaching South Main Street and is 35 mph in the westbound direction (consistent with the posted speed limit on Maple Street, which is also Route 62).

The mean vehicle travel speed along North Main Street north of Lake Street was found to be 33 mph in both the north and southbound directions, with the measured 85th percentile vehicle travel speed found to be 39 mph in the northbound direction and 40 mph southbound, which is 5 to 9 mph *above* the posted speed limit in the vicinity of the Project site (30/35 mph).

Motor Vehicle Crash Data

Motor vehicle crash information for the study area intersections was provided by the MassDOT Highway Division Safety Management/Traffic Operations Unit for the most recent five-year period available (2016 through 2020, 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 4.



Table 4
MOTOR VEHICLE CRASH DATA SUMMARY^a

	North Main St./ Essex St./ Forest St.	North Main St./ South Main St./ Central St./ Lake St.	South Main St./ Maple St.	South Main St./ Boston St./ Town Hall Dwys	South Main St./ Fuller Meadow Middle School/ The Lot	Elm St./ Boston St.	Boston St./ River St.
Traffic Control Type: ^b	S	S	S	S	U	U	U
<i>Year:</i>							
2016	5	6	15	2	0	0	3
2017	0	4	13	8	0	1	4
2018	3	7	17	7	1	3	3
2019	3	2	16	7	1	2	2
<u>2020</u>	<u>3</u>	<u>6</u>	<u>4</u>	<u>0</u>	<u>0</u>	<u>4</u>	<u>1</u>
Total	14	25	65	24	2	10	13
Average	2.8	5.0	13.0	4.8	0.4	2.0	2.6
Rate ^c	0.28	0.49	1.06	0.47	0.05	0.41	0.49
MassDOT Crash Rate: ^d	0.78/0.73	0.78/0.73	0.78/0.73	0.78/0.73	0.57/0.57	0.57/0.57	0.57/0.57
Significant? ^e	No	No	Yes	No	No	No	No
<i>Type:</i>							
Angle	6	7	21	7	0	6	7
Rear-End	5	9	29	8	1	2	1
Head-On	1	3	1	0	0	2	0
Sideswipe	1	5	14	5	1	0	2
Fixed Object	0	1	0	0	0	0	0
Pedestrian/Bicycle	0	0	0	0	0	0	0
<u>Unknown/Other</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>4</u>	<u>0</u>	<u>0</u>	<u>3</u>
Total	14	25	65	24	2	10	13
<i>Conditions:</i>							
Clear	9	15	51	20	1	7	10
Cloudy	3	5	6	3	1	3	0
Rain	2	4	7	1	0	0	1
<u>Snow/Ice</u>	<u>0</u>	<u>1</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>2</u>
Total	14	25	65	24	2	10	13
<i>Lighting:</i>							
Daylight	9	18	40	19	2	8	11
Dawn/Dusk	1	2	3	2	0	0	0
Dark (Road Lit)	3	5	21	3	0	2	2
<u>Dark (Road Unlit)</u>	<u>1</u>	<u>0</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Total	14	25	65	24	2	10	13
<i>Day of Week:</i>							
Monday through Friday	11	17	54	19	2	9	7
Saturday	3	7	6	3	0	0	2
<u>Sunday</u>	<u>0</u>	<u>1</u>	<u>5</u>	<u>2</u>	<u>0</u>	<u>1</u>	<u>4</u>
Total	14	25	65	24	2	10	13
<i>Severity:</i>							
Property Damage Only	13	19	57	20	2	4	7
Personal Injury	1	6	8	4	0	5	6
Fatality	0	0	0	0	0	0	0
<u>Not Reported</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>0</u>
Total	14	25	65	24	2	10	13

^aSource: MassDOT Safety Management/Traffic Operations Unit records, 2016 through 2020.

^bTraffic Control Type: S = Signalized; U = unsignalized.

^cCrash rate per million vehicles entering the intersection.

^dStatewide/District crash rate.

^eThe intersection crash rate is significant if it is found to exceed the MassDOT crash rate for the MassDOT Highway Division District in which the Project is located (District 4)



As can be seen in Table 4, with the exception of the South Main Street/Maple Street intersection, the study area intersections were found to have experienced an average of 5.0 or fewer reported motor vehicle crashes per year over the five-year review period and were found to have motor vehicle crash rates below the MassDOT statewide and District averages for similar intersections for the MassDOT Highway Division District in which the intersections are located (District 4). The majority of the crashes were reported to have occurred on a weekday; under clear conditions; during daylight; and involved angle or rear-end type collisions that resulted in property damage only. No (0) motor vehicle crashes were reported to have occurred at the Boston Street/Flint Street intersection over the five-year review period.

The South Main Street/Maple Street intersection was found to have experienced a total of 65 reported motor vehicle crashes over the five-year review period, or an average of 13.0 crashes per year, the majority of which occurred on a weekday; during daylight; under clear weather conditions; and involved angle or rear-end type collisions that resulted in property damage only. The intersection was found to have a motor vehicle crash rate that is above both the MassDOT statewide and District average crash rates for similar intersections for the MassDOT Highway Division District in which the intersection is located.

A review of the MassDOT statewide High Crash Location List indicates that the South Main Street/Maple Street intersection has been identified as a “Top 5% Intersection Crash Cluster” location for the 2018-2020 reporting period and Highway Safety Improvement Program (HSIP) eligible. MassDOT defines a HSIP eligible cluster as: “...one in which the total number of ‘equivalent property damage only’ crashes is within the top 5% in the region.” The Equivalent Property Damage Only (EPDO) index is a method of combining the number of crashes with the severity of crashes based on a weighted scale, where a property damage only crash is worth 1 point and injury and fatal crashes are worth 21 points. Designation as a HSIP location allows for MassDOT to prioritize funding for safety-related improvements in a specific region of the state.

The Applicant for the multifamily residential development that is proposed to be located at 10 Boston Street has committed to advancing the following improvements at the South Main Street/Maple Street intersection: i) facilitating the completion of a Road Safety Audit (RSA) at the intersection in order to identify improvement strategies; and ii) designing and implementing an optimal traffic signal timing and phasing plan, with a particular emphasis of the “yellow” and “all-red” clearance intervals and the pedestrian phase times.

The detailed MassDOT Crash Rate Worksheet and High Crash Location mapping are attached.

FUTURE CONDITIONS

Traffic volumes in the study area were projected to the year 2030, which reflects a seven-year planning horizon from the existing conditions baseline and is consistent with MassDOT’s *Transportation Impact Assessment (TIA) Guidelines*. The following describes the methodology used to develop the 2030 Future condition horizon year traffic volumes.

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 Town of Middleton Planning Department 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 review in conjunction with this assessment:

- ***Multifamily Residential Community, 20 Elm Street, North Reading, Massachusetts.*** This project will entail the construction of a 200-unit multifamily residential community to be located at 20 Elm Street in North Reading.
- ***Age-Restricted Residential Development, 59 South Main Street, Middleton, Massachusetts.*** This project will entail the construction of a 45 unit age-restricted multifamily residential development to be located at 59 South Main Street in Middleton.
- ***Middleton Town Complex, 105 South Main Street, Middleton, Massachusetts.*** This project will consist of the relocation of the Middleton Fire Station, Police Station and Town Hall to a single complex to be located at 105 South Main Street in Middleton.
- ***Aroma Joe's, 210-220 South Main Street, Middleton, Massachusetts.*** This project will convert a portion of an existing commercial building located at 210-220 South Main Street in Middleton, to accommodate an Aroma Joe's coffee shop with a drive-through window.
- ***Chase Bank, 247 South Main Street, Middleton, Massachusetts.*** This project will entail the construction of a Chase Bank with a drive-up ATM to be located at 247 South Main Street in Middleton.
- ***Multifamily Residential Development, 10 Boston Street, Middleton, Massachusetts.*** This project will entail the construction of a 60-unit multifamily residential development to be located at 10 Boston Street and portions of 49 South Main Street and 18 Boston Street in Middleton.
- ***Commercial Development, 49 South Main Street, Middleton, Massachusetts.*** This project will entail the construction of two (2) commercial buildings to be located at 49 South Main Street in Middleton that are envisioned to include a 5,000± sf bank with drive-up teller facility and an 8,000± sf building that will include a coffee-shop, restaurant or pharmacy with drive-through window. For the purpose of this study, the 8,000± sf building was assumed to be occupied by a coffee shop.



Traffic volumes associated with the aforementioned specific development projects by others were obtained from the traffic study conducted for the projects.^{5,6,7,8,9} 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 permanent count stations located in Middleton and surrounding towns were reviewed in order to determine general traffic growth trends in the area. This data indicates that traffic volumes have fluctuated over the past several years (2009 to 2019), with the average traffic growth rate found to be approximately 1.31 percent. In order to provide a prudent planning condition and to be consistent with the growth rate used in recently completed transportation assessments that have been performed within the study area, a higher 1.5 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 Middleton Highway Division were consulted in order to determine if there were any planned future roadway improvement projects expected to be completed by 2030 within the study area. Based on these discussions, the following roadway improvement project was identified within the study area:

- ***Route 114 Resurfacing and Related Work, Middleton, Massachusetts.*** This project is being undertaken by the Town of Middleton and will entail the resurfacing of sections of Route 114. The project is expected to be funded through the 2023 Transportation Improvement Program (TIP). No changes are planned at the study area intersections as a result of this project that would impact future traffic volumes or operating conditions.

In addition, the Applicant for the multifamily residential development that is proposed at 10 Boston Street has committed to implementing the following improvements within the study area in conjunction with the project and subject to receipt of all necessary rights, permits and approvals:

- ***South Main Street at Boston Street and Town Hall Driveways*** - Design and implement an optimal traffic signal timing and phasing plan.
- ***South Main Street at Maple Street*** - Facilitate the completion of a Road Safety Audit (RSA) and Design and implement an optimal traffic signal timing and phasing plan, with a particular emphasis of the “yellow” and “all-red” clearance intervals and the pedestrian phase times.
- ***North Main Street and South Main Street at Lake Street and Central Street*** - design and implement an optimal traffic signal timing and phasing plan.

⁵*Transportation Impact Assessment*, Proposed Multifamily Residential Community, North Reading, Massachusetts; VAI; July 2019.

⁶*Memorandum*, Trip Generation Estimate Proposed Age-Restricted Residential Development, Middleton, Massachusetts; MDM Transportation Consultants, Inc.; August 15, 2019.

⁷*Initial Traffic Assessment*, Middleton Town Complex, Middleton, Massachusetts, Pare Corporation; October 2019.

⁸*Transportation Impact Assessment*, Proposed Aroma Joe’s, Middleton, Massachusetts; VAI; January 2022.

⁹*Transportation Impact Assessment*, Proposed Multifamily Residential Development, Middleton, Massachusetts; VAI; August 2023.



No other roadway improvement projects aside from routine maintenance activities were identified to be planned within the study area at this time.

Future Horizon Year Traffic Volumes

The 2030 Future horizon year peak-hour traffic-volumes were developed by: i) applying the 1.5 percent per year compounded annual background traffic growth rate to the 2023 Existing peak-hour traffic volumes; and ii) adding the peak-hour traffic volumes associated with the identified specific development projects. The resulting 2030 Future weekday morning, weekday evening and Saturday midday peak-hour traffic volumes are shown on Figures 6, 7 and 8, respectively.

TRAFFIC OPERATIONS ANALYSIS

In order to assess operating conditions on the roadway network, a detailed traffic operations analysis (motorist delays, vehicle queuing, and level-of-service) was performed for the study 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 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 *2000 Highway Capacity Manual*¹⁰ for signalized intersections and the *Highway Capacity Manual 6th Edition* (HCM)¹¹ for unsignalized intersections, was used to complete the level-of-service and vehicle queue analyses.

Analysis Results

Level-of-service and vehicle queue analysis were conducted for 2023 Existing and 2030 Future conditions for the intersections within the study area. The results of the intersection capacity and vehicle queue analyses are summarized in Tables 5 and 6, with the detailed analysis results attached.

The following is a summary of the level-of-service and vehicle queue analyses for intersections within the study area. For context, we note that an LOS of “D” or better is generally defined as “acceptable” operating conditions.

Signalized Intersections (Table 5)

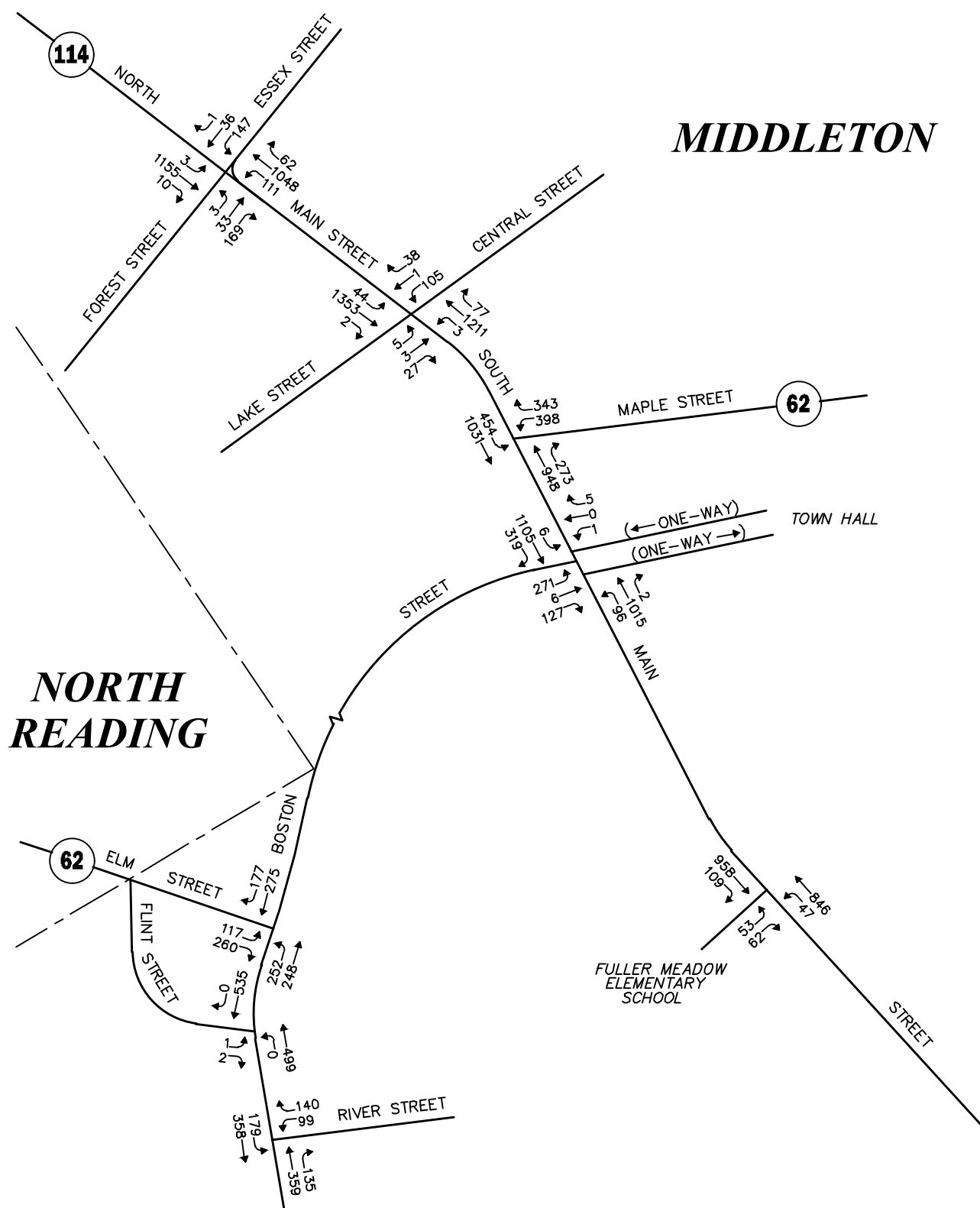
❖ *North Main Street at Essex Street and Forest Street*

Under 2023 Existing conditions, this signalized intersection was shown to be operating at an overall LOS B during all three analysis periods. Vehicle queues for through movements on the North Main

¹⁰*Highway Capacity Manual*; Transportation Research Board; Washington, DC; 2000.

¹¹*Highway Capacity Manual*, Transportation Research Board; Washington, DC; 2016.



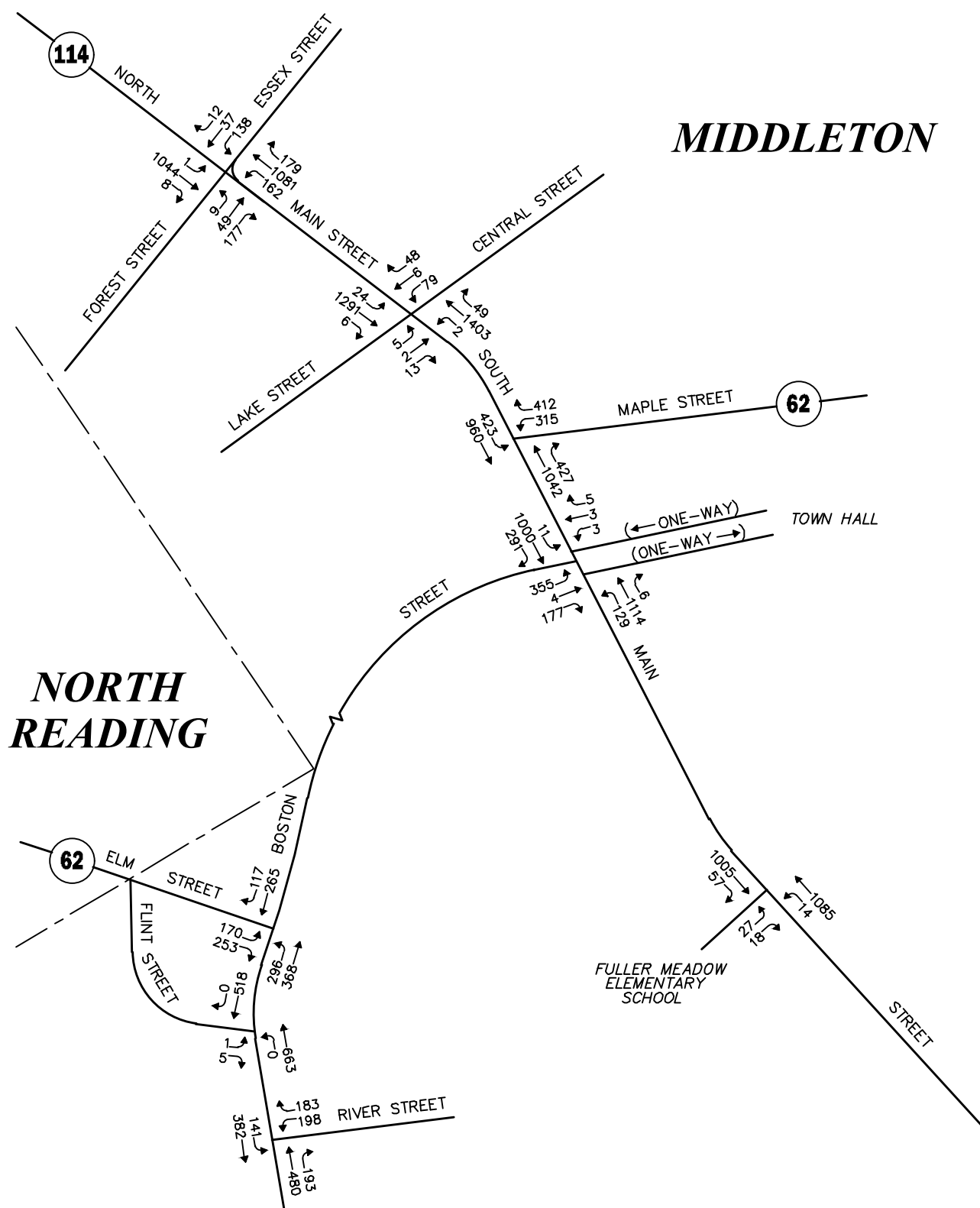


Not To Scale



Figure 6

**2030 Future Year
Weekday Morning
Peak-Hour Traffic Volumes**

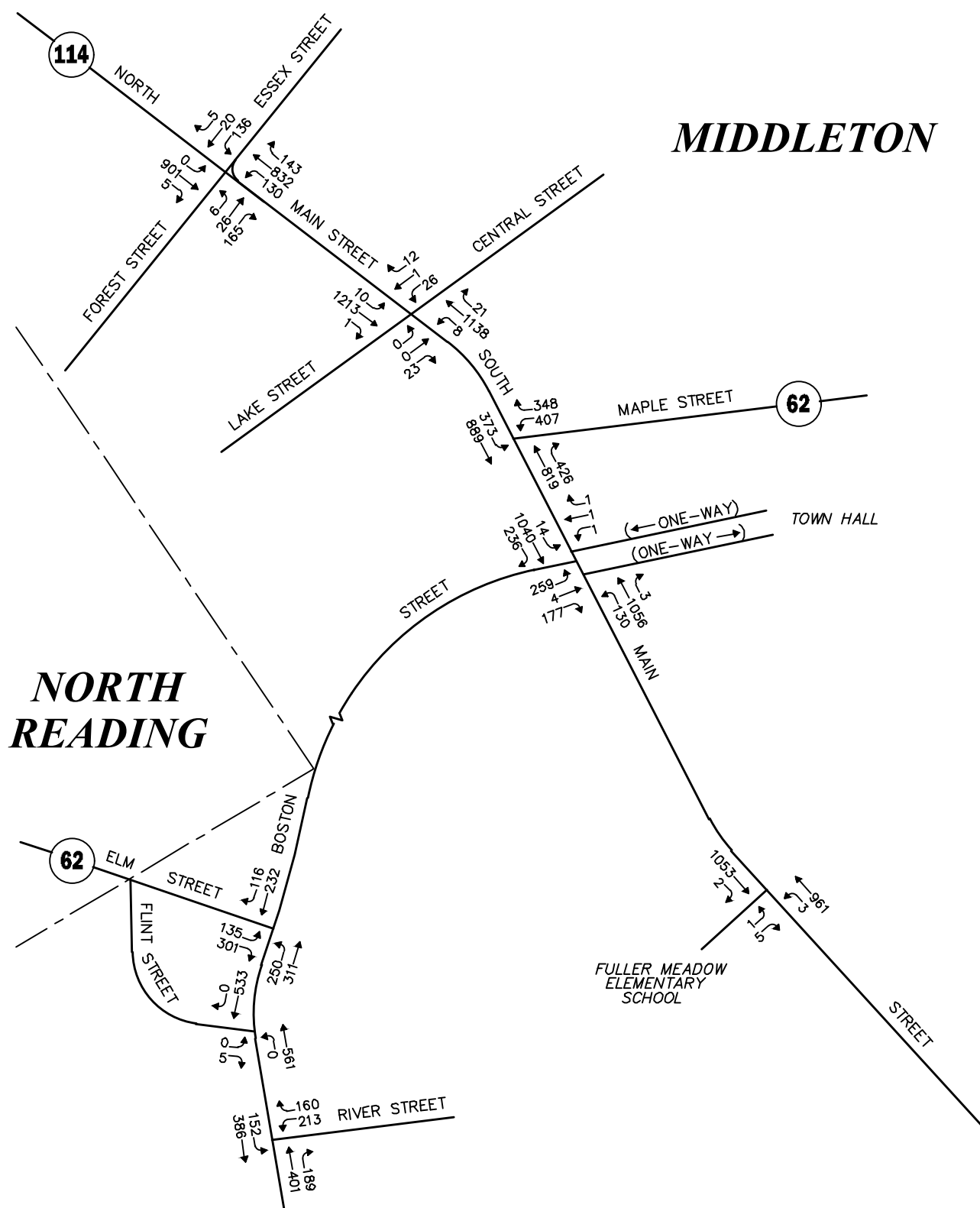


Not To Scale



Figure 7

2030 Future Year
Weekday Evening
Peak-Hour Traffic Volumes



Not To Scale



Figure 8

**2030 Future Year
Saturday Midday
Peak-Hour Traffic Volumes**

Street northbound approach were reported to extend up to 21 vehicles (weekday evening peak-hour).

Under 2030 Future horizon year conditions, overall operating conditions were shown to change from LOS B to LOS C during the weekday morning and evening peak hours, and to remain operating at from LOS B during the Saturday midday peak-hour. All movements from Forest Street were identified to operate at capacity (LOS E) during the weekday morning and evening peak hours with vehicle queues of up to 8 vehicles.

❖ ***North Main Street at South Main Street at Central Street and Lake Street***

Under 2023 Existing conditions, this signalized intersection was shown to be operating at an overall LOS C during the weekday morning peak-hour and at LOS B during the weekday evening and Saturday midday peak hours. It was noted that all movements from Central Street were identified to be operating over capacity (LOS F) during the weekday morning peak-hour and at capacity (LOS E) during the weekday evening peak-hour with vehicle queues of up to 8 vehicles.

Under 2030 Future horizon year conditions, overall operating conditions were shown to change from LOS C to LOS D during the weekday morning peak-hour, from LOS B to LOS C during the weekday evening peak-hour and to remain at LOS B during the Saturday midday peak-hour. All movements from Central Street were identified to continue to operate over capacity (LOS F) during the weekday morning peak-hour and at capacity (LOS E) during the weekday evening peak-hour with vehicle queues of up to 10 vehicles.

❖ ***South Main Street at Maple Street***

Under 2023 Existing conditions, this signalized intersection was shown to operate over capacity (LOS F) during all three analysis periods with extended vehicle queuing reported (up to 39 vehicles) on the South Main Street northbound approach. In addition to the South Main Street northbound approach, left-turn movements from Maple Street were shown to be operating at capacity (LOS E) during the weekday morning and weekday evening peak hours, and over capacity during the Saturday midday peak-hour, with vehicle queues of up to 20 vehicles.

Under 2030 Future horizon year conditions, overall operating conditions were shown to remain at LOS F during the peak hours, with the South Main Street northbound approach and left-turn movements from Maple Street identified to be operating over capacity with vehicle queues of up to 38 vehicles on South Main Street northbound and up to 26 vehicles in the Maple Street left-turn lane.

❖ ***South Main Street at Boston Street and the Town Hall Driveways***

Under 2023 Existing conditions, this signalized intersection was shown to be operating at an overall LOS B during the weekday morning peak-hour, at LOS C during the weekday evening peak-hour and at LOS B during the Saturday midday peak-hour. It was noted that left-turn movements from the Boston Street approach were identified to be operating at their design capacity (LOS E) during the weekday morning and Saturday midday peak hours with vehicle queues of up to 14 vehicles (weekday evening peak-hour).

Under 2030 Future horizon year conditions, overall operating conditions were shown to change from LOS B to LOS D during the weekday morning peak-hour, from LOS C to LOS F during the weekday evening peak-hour and from LOS B to LOS C during the Saturday midday peak-hour.



Left-turn movements from Boston Street were shown to continue to operate at LOS E during the weekday morning and Saturday midday peak hours with vehicle queues of up to 15 vehicles (weekday evening peak-hour), with all movements from the South Main Street northbound approach was shown to operate over capacity (LOS F) during the weekday evening peak-hour with vehicle queues of up to 40 vehicles.

Unsignalized Intersections (Table 6)

❖ South Main Street at the Fuller Meadow Elementary School Driveway

Under 2023 Existing conditions, all movements exiting the Fuller Meadow Elementary School driveway were shown to operate over capacity (LOS F) during the weekday morning and evening peak hours, and at LOS C during the Saturday midday peak-hour, with vehicle queues of up to 28 vehicles (weekday morning peak-hour). All movements approaching the intersection along South Main Street were shown to operate at LOS A during all three peak hours with negligible vehicle queuing.

Under 2030 Future horizon year conditions, all movements exiting the Fuller Meadow Elementary School driveway were shown to continue to operate over capacity during the weekday morning and evening peak-hours, and to change from LOS C to LOS E during the Saturday midday peak hour. Vehicle queues on the school driveway approach were shown to increase to 33 vehicles during the weekday morning peak-hour. All movements approaching the intersection along South Main Street were shown to continue to operate at LOS A during all three peak hours with vehicle queuing of up to one (1) vehicle.

❖ Boston Street at Elm Street

Under 2023 Existing conditions, left-turn movements from Elm Street were shown to operate over capacity (LOS F) during the weekday morning and evening peak hours, and at capacity (LOS E) during the Saturday midday peak-hour, with vehicle queues of up to 8 vehicles (weekday evening peak-hour). All movements approaching the intersection along Boston Street were shown to operate at LOS A during all three peak hours with vehicle queues of up to one (1) vehicle.

Under 2030 Future horizon year conditions, left-turn movements from Elm Street were shown to continue to operate over capacity during the weekday morning and evening peak hours, and to change from LOS E to LOS F during the Saturday midday peak-hour, with vehicle queues of up to 17 vehicles (weekday evening peak-hour). All movements approaching the intersection along Boston Street were shown to operate at LOS A during all three peak hours with vehicle queues of up to two (2) vehicles.

❖ Boston Street at Flint Street

Under 2023 Existing and 2030 Future year conditions, all movements from Flint Street were shown to operate at LOS C during the weekday morning peak-hour and at LOS B during the weekday evening and Saturday midday peak hours, with negligible vehicle queuing. All movements approaching the intersection along Boston Street were shown to operate at LOS A during all three peak hours, also with negligible vehicle queuing.



❖ **Boston Street at River Street**

Under 2023 Existing conditions, all movements exiting River Street were shown to operate over capacity (LOS F) during all three analysis periods, with vehicle queues of up to 19 vehicles during the weekday evening and Saturday midday peak hours. All movements approaching the intersection along Boston Street were shown to operate at LOS A during all three peak hours with vehicle queues of up to one (1) vehicle.

Under 2030 Future horizon year conditions, all movements exiting River Street were shown to continue to operate over capacity during all three analysis periods, with vehicle queues increasing to up to 34 vehicles during the weekday evening and Saturday midday peak hours. All movements approaching the intersection along Boston Street were shown to continue to operate at LOS A during all three peak hours with vehicle queues of up to one (1) vehicle.



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

Signalized Intersection/Peak-hour/Movement	2023 Existing				2030 Horizon Year			
	V/C ^a	Delay ^b	LOS ^c	Queue ^d 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th
<i>North Main Street at Forest Street and Essex Street</i>								
<i>Weekday Morning:</i>								
Essex Street EB LT/TH/RT	0.19	17.8	B	1/2	0.22	18.0	B	1/2
Forest Street WB LT/TH/RT	0.71	29.2	C	3/5	0.93	59.9	E	3/7
North Main Street NB LT	0.35	7.8	A	1/1	0.45	9.9	A	1/2
North Main Street NB TH	0.82	14.2	B	10/20	0.96	29.5	C	14/26
North Main Street NB RT	0.03	4.8	A	0/0	0.04	4.8	A	0/1
North Main Street SB LT/TH/RT	0.67	14.2	B	6/9	0.90	24.2	C	9/14
Overall	--	15.2	B	--	--	27.3	C	--
<i>Weekday Evening:</i>								
Essex Street EB LT/TH/RT	0.36	18.3	B	2/3	0.44	19.0	B	2/3
Forest Street WB LT/TH/RT	0.74	31.6	C	3/6	0.99	79.1	E	3/8
North Main Street NB LT	0.45	8.1	A	1/2	0.59	11.8	B	1/3
North Main Street NB TH	0.85	15.7	B	10/21	1.00	37.3	D	15/27
North Main Street NB RT	0.12	5.2	A	1/1	0.15	5.3	A	1/2
North Main Street SB LT/TH/RT	0.63	14.1	B	5/8	0.87	21.9	C	7/12
Overall	--	15.5	B	--	--	29.6	C	--
<i>Saturday Midday:</i>								
Essex Street EB LT/TH/RT	0.19	14.9	B	1/2	0.22	17.4	B	1/2
Forest Street WB LT/TH/RT	0.49	17.4	B	2/4	0.74	31.7	C	2/6
North Main Street NB LT	0.35	7.4	A	1/2	0.42	8.1	A	1/2
North Main Street NB TH	0.67	10.0	B	6/10	0.75	11.5	B	8/14
North Main Street NB RT	0.09	5.6	A	0/1	0.11	5.2	A	1/1
North Main Street SB LT/TH/RT	0.56	13.4	B	4/6	0.62	13.9	B	6/8
Overall	--	11.9	B	--	--	13.8	B	--

See notes at end of Table.



Table 5 (Continued)
SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

Signalized Intersection/Peak-hour/Movement	2023 Existing				2030 Horizon Year			
	V/C ^a	Delay ^b	LOS ^c	Queue ^d 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th
North Main Street and South Main Street at Lake Street and Central Street								
<i>Weekday Morning:</i>								
Lake Street EB LT/TH/RT	0.06	47.2	D	1/1	0.07	47.3	D	1/1
Central Street WB LT/TH/RT	1.07	136.3	F	6/8	1.28	212.1	F	8/10
South Main Street NB LT/TH/RT	0.44	12.8	B	2/7	0.52	19.3	B	2/11
North Main Street SB LT/TH/RT	0.76	22.2	C	16/20	0.93	33.6	C	22/30
Overall	--	28.2	C	--	--	42.1	D	--
<i>Weekday Evening:</i>								
Lake Street EB LT/TH/RT	0.06	47.1	D	1/1	0.07	47.2	D	1/1
Central Street WB LT/TH/RT	0.69	60.2	E	5/6	0.80	70.7	E	6/7
South Main Street NB LT/TH/RT	0.48	13.2	B	3/8	0.56	19.6	B	4/12
North Main Street SB LT/TH/RT	0.66	19.1	B	13/16	0.80	23.3	C	18/22
Overall	--	19.4	B	--	--	24.8	C	--
<i>Saturday Midday:</i>								
Lake Street EB LT/TH/RT	0.02	46.8	D	0/0	0.02	46.8	D	0/0
Central Street WB LT/TH/RT	0.15	47.9	D	1/2	0.17	48.1	D	1/2
South Main Street NB LT/TH/RT	0.39	7.0	A	3/4	0.47	11.3	B	3/8
North Main Street SB LT/TH/RT	0.60	17.7	B	12/15	0.71	20.3	C	16/19
Overall	--	13.7	B	--	--	17.0	B	--

See notes at end of Table.



Table 5 (Continued)
SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

Signalized Intersection/Peak-hour/Movement	2023 Existing				2030 Horizon Year			
	V/C ^a	Delay ^b	LOS ^c	Queue ^d 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th
South Main Street at Maple Street								
<i>Weekday Morning:</i>								
Maple Street WB LT	0.92	76.3	E	11/18	1.16	<u>146.9</u>	F	17/25
Maple Street WB RT	0.22	40.6	D	0/3	0.29	<u>41.5</u>	D	1/4
South Main Street NB TH/RT	1.61	<u>326.4</u>	F	23/31	1.97	<u>495.1</u>	F	38/38
South Main Street SB LT	--	--	--	--	--	--	--	--
South Main Street SB LT/TH	0.72	4.0	A	1/3	0.85	11.1	B	4/4
Overall	--	<u>135.1</u>	F	--	--	<u>212.5</u>	F	--
<i>Weekday Evening:</i>								
Maple Street WB LT	0.79	56.7	E	9/13	0.99	<u>93.8</u>	F	12/19
Maple Street WB RT	0.28	41.4	D	0/3	0.31	<u>41.8</u>	D	0/3
South Main Street NB TH/RT	1.76	<u>399.2</u>	F	33/39	2.12	<u>544.2</u>	F	30/43
South Main Street SB LT	--	--	--	--	--	--	--	--
South Main Street SB LT/TH	0.65	1.5	A	0/1	0.76	5.1	A	0/4
Overall	--	<u>172.8</u>	F	--	--	<u>239.2</u>	F	--
<i>Saturday Midday:</i>								
Maple Street WB LT	1.08	<u>117.9</u>	F	15/20	1.33	<u>214.8</u>	F	21/26
Maple Street WB RT	0.25	41.0	D	0/2	0.46	<u>43.7</u>	D	2/5
South Main Street NB TH/RT	1.46	<u>257.9</u>	F	25/31	1.80	<u>408.5</u>	F	29/34
South Main Street SB LT	--	--	--	--	--	--	--	--
South Main Street SB LT/TH	0.62	0.9	A	0/0	0.73	2.8	A	0/0
Overall	--	<u>115.8</u>	F	--	--	<u>188.8</u>	F	--

See notes at end of Table.



Table 5 (Continued)
SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

Signalized Intersection/Peak-hour/Movement	2023 Existing				2030 Horizon Year			
	V/C ^a	Delay ^b	LOS ^c	Queue ^d 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th
<i>South Main Street at Boston Street and the Town Hall Driveways</i>								
<i>Weekday Morning:</i>								
Boston Street EB LT	0.82	57.3	E	8/11	0.84	55.5	E	10/12
Boston Street EB TH/RT	0.07	34.2	C	0/2	0.11	31.1	C	0/2
Town Hall Driveways WB LT/TH/RT	0.01	33.5	C	0/0	0.01	29.9	C	0/0
South Main Street NB LT	--	--	--	--	--	--	--	--
South Main Street NB LT/TH/RT	0.58	12.7	B	9/14	1.02	54.5	D	23/31
South Main Street SB LT/TH/RT	0.55	14.7	B	15/18	0.72	21.1	C	19/23
Overall	--	19.1	B	--	--	37.8	D	--
<i>Weekday Evening:</i>								
Boston Street EB LT	0.85	52.5	D	11/14	0.79	39.8	D	12/15
Boston Street EB TH/RT	0.10	28.0	C	0/2	0.14	22.6	C	0/2
Town Hall Driveways WB LT/TH/RT	0.02	27.2	C	0/1	0.02	21.4	C	0/1
South Main Street NB LT	--	--	--	--	--	--	--	--
South Main Street NB LT/TH/RT	0.80	24.8	C	15/21	1.79	<u>264.3</u>	F	33/40
South Main Street SB LT/TH/RT	0.57	21.2	C	15/19	0.80	21.6	C	7/10
Overall	--	27.2	C	--	--	123.0	F	--
<i>Saturday Midday:</i>								
Boston Street EB LT	0.80	57.1	E	8/11	0.83	56.6	E	9/12
Boston Street EB TH/RT	0.10	35.9	D	0/2	0.14	33.9	C	0/2
Town Hall Driveways WB LT/TH/RT	0.01	35.0	D	0/0	0.01	32.5	C	0/0
South Main Street NB LT	--	--	--	--	--	--	--	--
South Main Street NB LT/TH/RT	0.59	11.5	B	8/14	0.94	33.3	C	18/29
South Main Street SB LT/TH/RT	0.48	6.1	A	7/9	0.61	9.8	A	10/15
Overall	--	15.3	B	--	--	25.3	C	--

^aVolume-to-capacity ratio.

^bControl (signal) delay per vehicle in seconds.

^cLevel of service.

^dQueue length in vehicles.

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



Table 6
UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

Unsignalized Intersection/Peak-hour/Movement	2023 Existing				2030 Horizon Year			
	Demand ^a	Delay ^b	LOS ^c	Queue ^d 95 th	Demand	Delay	LOS	Queue 95 th
<i>South Main Street at Fuller Meadow Elementary School</i>								
<i>Weekday Morning:</i>								
Fuller Meadow Elementary School EB LT/RT	115	<u>689.6</u>	F	28	115	<u>1343.8</u>	F	33
South Main Street NB TH	739	0.7	A	0	893	0.6	A	1
South Main Street SB TH	902	0.0	A	0	1,067	0.0	A	0
<i>Weekday Evening:</i>								
Fuller Meadow Elementary School EB LT/RT	45	<u>315.9</u>	F	10	45	<u>758.6</u>	F	13
South Main Street NB TH	929	0.2	A	0	1,099	0.1	A	0
South Main Street SB TH	905	0.0	A	0	1,062	0.0	A	0
<i>Saturday MIDDAY:</i>								
Fuller Meadow Elementary School EB LT/RT	6	24.5	C	0	6	34.0	E	1
South Main Street NB TH	801	0.0	A	0	964	0.0	A	0
South Main Street SB TH	884	0.0	A	0	1,055	0.0	A	0
<i>Boston Street at Elm Street</i>								
<i>Weekday Morning:</i>								
Elm Street EB LT	84	<u>63.3</u>	F	4	117	<u>330.9</u>	F	11
Elm Street EB RT	209	13.6	B	2	260	17.4	C	3
Boston Street NB LT/TH	413	4.9	A	1	500	5.1	A	2
Boston Street SB TH/RT	368	0.0	A	0	452	0.0	A	0
<i>Weekday Evening:</i>								
Elm Street EB LT	138	<u>142.8</u>	F	8	170	<u>683.1</u>	F	17
Elm Street EB RT	211	11.9	B	2	253	13.9	B	2
Boston Street NB LT/TH	543	3.9	A	1	664	4.3	A	2
Boston Street SB TH/RT	299	0.0	A	0	382	0.0	A	0
<i>Saturday MIDDAY:</i>								
Elm Street EB LT	107	41.6	E	3	135	<u>167.7</u>	F	9
Elm Street EB RT	253	12.5	B	2	301	15.1	C	3
Boston Street NB LT/TH	458	3.8	A	1	561	4.1	A	1
Boston Street SB TH/RT	273	0.0	A	0	348	0.0	A	0

See notes at end of table.



Table 6
UNSIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

Unsignalized Intersection/Peak-hour/Movement	2023 Existing				2030 Horizon Year			
	Demand ^a	Delay ^b	LOS ^c	Queue ^d 95 th	Demand	Delay	LOS	Queue 95 th
<i>Boston Street at Flint Street</i>								
<i>Weekday Morning:</i>								
Flint Street EB LT/RT	3	15.0	C	0	3	17.9	C	0
Boston Street NB TH	412	0.0	A	0	499	0.0	A	0
Boston Street SB TH	431	0.0	A	0	535	0.0	A	0
<i>Weekday Evening:</i>								
Flint Street EB LT/RT	5	13.1	B	0	6	14.7	B	0
Boston Street NB TH	542	0.0	A	0	663	0.0	A	0
Boston Street SB TH	423	0.0	A	0	518	0.0	A	0
<i>Saturday Midday:</i>								
Flint Street EB LT/RT	4	11.3	B	0	5	12.4	B	0
Boston Street NB TH	458	0.0	A	0	561	0.0	A	0
Boston Street SB TH	435	0.0	A	0	533	0.0	A	0
<i>Boston Street at River Street</i>								
<i>Weekday Morning:</i>								
River Street WB LT/RT	202	<u>55.3</u>	F	7	239	<u>233.3</u>	F	17
Boston Street NB TH	420	0.0	A	0	494	0.0	A	0
Boston Street SB TH	433	2.9	A	1	537	3.2	A	1
<i>Weekday Evening:</i>								
River Street WB LT/RT	324	<u>225.9</u>	F	19	381	<u>650.8</u>	F	34
Boston Street NB TH	569	0.0	A	0	673	0.0	A	0
Boston Street SB TH	427	2.5	A	1	523	2.8	A	1
<i>Saturday Midday:</i>								
River Street WB LT/RT	319	<u>197.1</u>	F	19	373	<u>562.1</u>	F	34
Boston Street NB TH	499	0.0	A	0	590	0.0	A	0
Boston Street SB TH	439	2.5	A	1	538	2.7	A	1

^aVolume-to-capacity ratio.

^bControl (signal) delay per vehicle in seconds.

^cLevel of service.

^dQueue length in vehicles.

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



CORRIDOR IMPROVEMENT EVALUATION

As identified in the previous sections, the South Main Street/Maple Street intersection was identified to be operating at or over capacity under 2023 Existing conditions, with the South Main Street/Boston Street/Town Hall Driveways intersection identified to operate over capacity during the weekday evening peak-hour under 2030 Future horizon year conditions. In addition, the South Main Street/Maple Street intersection was identified to have a motor vehicle crash rate that exceeds the MassDOT average crash rates for similar intersections and the intersection has been identified as a “Top 5% Intersection Crash Cluster” location for the 2018-2020 reporting period and HSIP eligible. Given the proximity of the North Main Street/South Main Street/Lake Street intersection to the South Main Street/Maple Street intersection, these two intersections are controlled by the same traffic signal controller and operationally function as a single interconnected traffic signal. As such, recommendations for improvements at the South Main Street/Maple Street intersection also need to consider impacts at the North Main Street/South Main Street/Lake Street intersection.

A review of potential improvement measures was undertaken for the North Main Street/South Main Street corridor within the Middleton Town Center area, inclusive of the North Main Street/South Main Street/Lake Street, South Main Street/Maple Street and South Main Street/Boston Street/Town Hall Driveways intersections, that are intended to improve traffic operations, enhance safety and promote mobility through improving pedestrian and bicycle accommodations in the context of a Complete Streets design approach. Two improvement strategies were evaluated that include a Long-Term Corridor Improvement Project for the Route 114 corridor that would result in the establishment of on-road, buffered bicycle lanes and sidewalks along both sides of the roadway, with capacity enhancements by way of the development of left-turn lane accommodations at critical intersections, and a Critical Infrastructure Improvement Plan that would allow for the advancement of specific improvements that would achieve the operational and safety improvement goals and improve pedestrian accommodations while planning for the potential future long-term corridor improvements.

The intent of the Critical Infrastructure Improvement Plan is to define specific improvements that could be advanced in the near-term within then available public right-of-way and with the cooperation of the property owners along the west side of South Main Street at Boston Street.

The following summarizes the improvement strategies that have been identified for the North Main Street/South Main Street corridor within the Middleton Town Center area.

➤ Long-Term Corridor Improvement Project

○ *North Main Street/South Main Street Corridor Improvements:*

- a. Provide 5.5-foot wide (minimum) Americans with Disabilities Act (ADA) compliant sidewalks along both sides of North Main Street/South Main Street with accompanying ADA compliant wheelchair ramps for all pedestrian crossings.
- b. Provide 5-foot wide buffered bicycle lanes along both sides of North Main Street/South Main Street that are separated (buffered) from the adjacent travel lane by 3-feet.
- c. Maintain two (2) through travel lanes per direction that are 11-feet in width with additional turn lanes provided where necessary at major intersections (discussion follows).



- ***Intersection Improvements:***

- *North Main Street and South Main Street at Central Street and Lake Street*

- Install an Adaptive Signal Control Technologies (ASCT) system to include vehicle detection and monitoring

- *South Main Street at Maple Street*

- a. Widen South Main Street to provide a southbound left-turn lane;
 - b. Widen Maple Street to provide a second left-turn lane;
 - c. Reconstruct the traffic signal system to accommodate the roadway widening; and
 - d. Install an ASCT system to include vehicle detection and monitoring; and

- *South Main Street at Boston Street and the Middleton Town Hall Driveways*

- a. Widen South Main Street to provide a northbound left-turn lane;
 - b. Widen Boston Street to provide a second left-turn lane and to accommodate a bicycle lane transition from South Main Street along the north side;
 - c. Provide a 10-foot wide shared-use path along the south side of Boston Street to accommodate eastbound bicycle travel approaching South Main Street;
 - d. Reconstruct the traffic signal system to accommodate the roadway widening;
 - e. Install an ASCT system to include vehicle detection and monitoring; and
 - f. Replace the pedestrian signal indications with Audible Pedestrian Signal (APS) devices with countdown-type displays and accompanying ADA compliant pushbuttons and signs.

The suggested long-term improvements at the South Main Street/Boston Street/Middleton Town Hall Driveways intersection are depicted on Figure 9, which has been prepared to define an easement area along Boston Street and South Main Street at the intersection that would allow for: i) advancement of the suggested long-term improvements; ii) provide context for the planned redevelopment of 49 South Main Street; and iii) accommodate the multifamily residential development proposal that is currently before the Zoning Board of Appeals at 10 Boston Street (reflected on Figure 9).

Table 7 summarizes the improvement in traffic operations that can be attained with the implementation of the long-term corridor improvement project. As can be seen in Table 7, overall operating conditions at the intersections within the Middleton Town Center area were shown to improve to LOS D or better. The Central Street approach to the North Main Street/South Main Street/Central Street/Lake Street intersection was shown to continue to operate over capacity (LOS F) during both the weekday morning and evening peak hours. These conditions are, in part, due to the need to balance operating conditions at the intersection with those at the South Main Street/Maple Street intersection since both intersections are operated by the same traffic signal controller. With the installation of the ASCT system, actual operating conditions are expected to be better than predicted by the analysis model as the ASCT system will look for efficiencies and seek to balance and improve traffic operations based on real-time measurements of vehicle arrival and departure data.



Table 7
IMPROVED SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

Signalized Intersection/Peak-hour/Movement	2030 with Long-Term Corridor Improvements				2030 with Critical Infrastructure Improvements			
	V/C	Delay	LOS	Queue 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th
<i>North Main Street and South Main Street at Lake Street and Central Street</i>								
<i>Weekday Morning:</i>								
Lake Street EB LT/TH/RT	0.11	50.5	D	1/1	0.09	49.3	D	1/1
Central Street WB LT/TH/RT	2.17	<u>536.0</u>	F	10/12	1.77	<u>426.0</u>	F	10/12
South Main Street NB LT/TH/RT	0.49	1.8	A	2/2	0.50	7.3	A	2/5
North Main Street SB LT/TH/RT	0.76	13.8	B	15/18	0.89	26.5	C	20/25
Overall	--	51.5	D	--	--	51.0	D	--
<i>Weekday Evening:</i>								
Lake Street EB LT/TH/RT	0.11	52.1	D	1/1	0.12	53.2	D	1/1
Central Street WB LT/TH/RT	1.45	<u>295.5</u>	F	8/9	1.63	<u>374.9</u>	F	8/10
South Main Street NB LT/TH/RT	0.52	2.0	A	3/3	0.51	5.7	A	3/5
North Main Street SB LT/TH/RT	0.63	8.9	A	10/13	0.74	17.8	B	15/19
Overall	--	24.3	C	--	--	35.0	D	--
<i>Saturday Midday:</i>								
Lake Street EB LT/TH/RT	0.02	48.7	D	0/0	0.02	51.5	D	0/0
Central Street WB LT/TH/RT	0.23	50.5	D	1/2	0.32	54.1	D	1/3
South Main Street NB LT/TH/RT	0.45	2.6	A	3/3	0.44	2.8	A	3/3
North Main Street SB LT/TH/RT	0.61	11.8	B	12/14	0.67	16.5	B	14/17
Overall	--	8.7	A	-	--	11.2	B	--

See notes at end of Table.



Table 7 (Continued)
IMPROVED SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

Signalized Intersection/Peak-hour/Movement	2030 with Long-Term Corridor Improvements				2030 with Critical Infrastructure Improvements			
	V/C	Delay	LOS	Queue 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th
South Main Street at Maple Street								
<i>Weekday Morning:</i>								
Maple Street WB LT	0.91	72.5	E	7/11	1.11	<u>127.2</u>	F	15/23
Maple Street WB RT	0.24	46.4	D	0/4	0.25	38.5	D	0/4
South Main Street NB TH/RT	1.04	79.7	E	22/26	1.38	<u>222.5</u>	F	27/31
South Main Street SB LT	0.88	41.6	D	10/17	--	--	--	--
South Main Street SB LT/TH	0.38	0.9	A	1/1	0.91	17.9	B	4/5
Overall	--	48.3	D	--	--	109.6	F	--
<i>Weekday Evening:</i>								
Maple Street WB LT	0.89	71.4	E	6/9	0.89	64.0	E	11/17
Maple Street WB RT	0.31	48.8	D	0/3	0.31	37.8	D	0/3
South Main Street NB TH/RT	1.05	76.9	E	20/29	1.41	<u>232.4</u>	F	28/38
South Main Street SB LT	0.79	33.5	C	7/13	--	--	--	--
South Main Street SB LT/TH	0.34	0.6	A	1/1	0.83	10.0	B	1/4
Overall	--	48.4	D	--	--	109.8	F	--
<i>Saturday Midday:</i>								
Maple Street WB LT	0.94	73.9	E	8/12	1.19	<u>152.4</u>	F	19/24
Maple Street WB RT	0.28	45.1	D	0/2	0.38	38.6	D	2/4
South Main Street NB TH/RT	1.03	73.6	E	22/23	1.22	<u>153.3</u>	F	27/30
South Main Street SB LT	0.73	27.8	C	4/10	--	--	--	--
South Main Street SB LT/TH	0.34	0.2	A	0/0	0.79	6.1	A	0/1
Overall	--	46.0	D	--	--	85.0	F	--

See notes at end of Table.



Table 7 (Continued)
IMPROVED SIGNALIZED INTERSECTION LEVEL-OF-SERVICE AND VEHICLE QUEUE SUMMARY

Signalized Intersection/Peak-hour/Movement	2030 with Long-Term Corridor Improvements				2030 with Critical Infrastructure Improvements			
	V/C	Delay	LOS	Queue 50 th /95 th	V/C	Delay	LOS	Queue 50 th /95 th
<i>South Main Street at Boston Street and the Town Hall</i>								
<i>Driveways</i>								
<i>Weekday Morning:</i>								
Boston Street EB LT	0.68	49.1	D	4/6	0.67	47.8	D	5/6
Boston Street EB TH/RT	0.12	40.0	D	0/2	0.12	39.5	D	0/2
Town Hall Driveways WB LT/TH/RT	0.01	39.0	D	0/0	0.01	38.4	D	0/0
South Main Street NB LT	0.42	13.0	B	1/2	0.43	13.5	B	1/2
South Main Street NB LT/TH/RT	0.44	6.6	A	6/9	0.44	6.9	A	7/9
South Main Street SB LT/TH/RT	0.71	12.6	B	4/7	0.71	11.9	B	10/14
Overall	--	15.5	B	--	--	15.2	B	--
<i>Weekday Evening:</i>								
Boston Street EB LT	0.69	44.4	D	6/8	0.69	44.4	D	6/8
Boston Street EB TH/RT	0.15	35.4	D	0/2	0.15	35.4	D	0/2
Town Hall Driveways WB LT/TH/RT	0.03	34.2	C	0/1	0.03	34.2	C	0/1
South Main Street NB LT	0.51	17.1	B	2/4	0.51	16.7	B	2/4
South Main Street NB LT/TH/RT	0.51	9.8	A	9/12	0.51	9.8	A	9/12
South Main Street SB LT/TH/RT	0.74	16.9	B	6/7	0.73	17.4	B	10/14
Overall	--	18.9	B	--	--	19.1	B	--
<i>Saturday MIDDAY:</i>								
Boston Street EB LT	0.67	49.7	D	5/6	0.67	50.3	D	5/6
Boston Street EB TH/RT	0.15	41.8	D	0/3	0.15	42.0	D	0/3
Town Hall Driveways WB LT/TH/RT	0.02	40.6	D	0/1	0.02	40.8	D	0/1
South Main Street NB LT	0.43	10.2	B	1/2	0.41	9.2	A	1/2
South Main Street NB LT/TH/RT	0.41	5.4	A	6/8	0.41	5.3	A	5/8
South Main Street SB LT/TH/RT	0.62	8.3	A	6/14	0.61	10.0	B	6/6
Overall	--	13.6	B	--	--	14.3	B	--

^aVolume-to-capacity ratio.

^bControl (signal) delay per vehicle in seconds.

^cLevel of service.

^dQueue length in vehicles.

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



➤ **Critical Infrastructure Improvement Project**

○ ***South Main Street Corridor Improvements:***

- a. Provide 5.5-foot wide (minimum) ADA compliant sidewalks along both sides of South Main Street at and approaching Boston Street with accompanying ADA compliant wheelchair ramps for all pedestrian crossings.
- b. Provide a 10-foot wide shared-use path along the frontage of 49 South Main Street (South Main Street and Boston Street (partial)).
- c. Maintain two (2) through travel lanes per direction that are 11-feet in width with a left-turn lane provided on the northbound approach to Boston Street (discussion follows).

○ ***Intersection Improvements:***

- *North Main Street and South Main Street at Central Street and Lake Street*
Install an ASCT system to include vehicle detection and monitoring.
- *South Main Street at Maple Street*
Install an ASCT system to include vehicle detection and monitoring.
- *South Main Street at Boston Street and the Middleton Town Hall Driveways*
 - a. Widen South Main Street to provide a northbound left-turn lane;
 - b. Provide a 10-foot wide shared-use path along the south side of Boston Street to accommodate bicycle travel approaching South Main Street;
 - c. Reconstruct the traffic signal system to accommodate the roadway widening;
 - d. Install an ASCT system to include vehicle detection and monitoring; and
 - e. Replace the pedestrian signal indications with APS devices with countdown-type displays and accompanying ADA compliant pushbuttons and signs.

The suggested Critical Infrastructure Improvements at the South Main Street/Boston Street/Middleton Town Hall Driveways intersection are depicted on Figure 10, which includes the same easement area that was established along Boston Street and South Main Street shown on Figure 9.

Table 7 also summarizes the improvement in traffic operations that can be attained with the implementation of the critical infrastructure improvements. As can be seen in Table 7, a similar level of operational improvement is afforded at the South Main Street/Boston Street/Middleton Town Hall Driveways intersection as that provided by the Long-Term Corridor Improvement Project, with overall intersection operations improving to LOS B during the analysis periods and no movement reported to be operating below LOS D. The replacement of the traffic signal systems at the North Main Street/South Main Street/Central Street/Lake Street and South Main Street/Maple Street intersections with the ASCT system will reduce overall motorists delays at both intersections; however, overall operating conditions will continue to be over capacity absent the capacity improvements that are associated with the Long-Term Corridor Improvement Project.



SUMMARY

VAI has prepared a Corridor Improvement Study for the North Main Street/South Main Street (Route 114) and Boston Street (Route 62) corridors in Middleton, Massachusetts, to identify potential improvement strategies that are intended to improve traffic flow, enhance safety and promote mobility. As a result of this study, suggested improvements have been developed for the North Main Street/South Main Street corridor within the Middleton Town Center area that include a Long-Term Corridor Improvement Project and a Critical Infrastructure Improvement Plan that would allow for the advancement of specific improvements in the near-term within then available public right-of-way and with the cooperation of the property owners along the west side of South Main Street at Boston Street. Both improvement programs will result in a reduction in overall motorist delay within the Middleton Town Center area and enhance safety for all roadway users.

Attachments



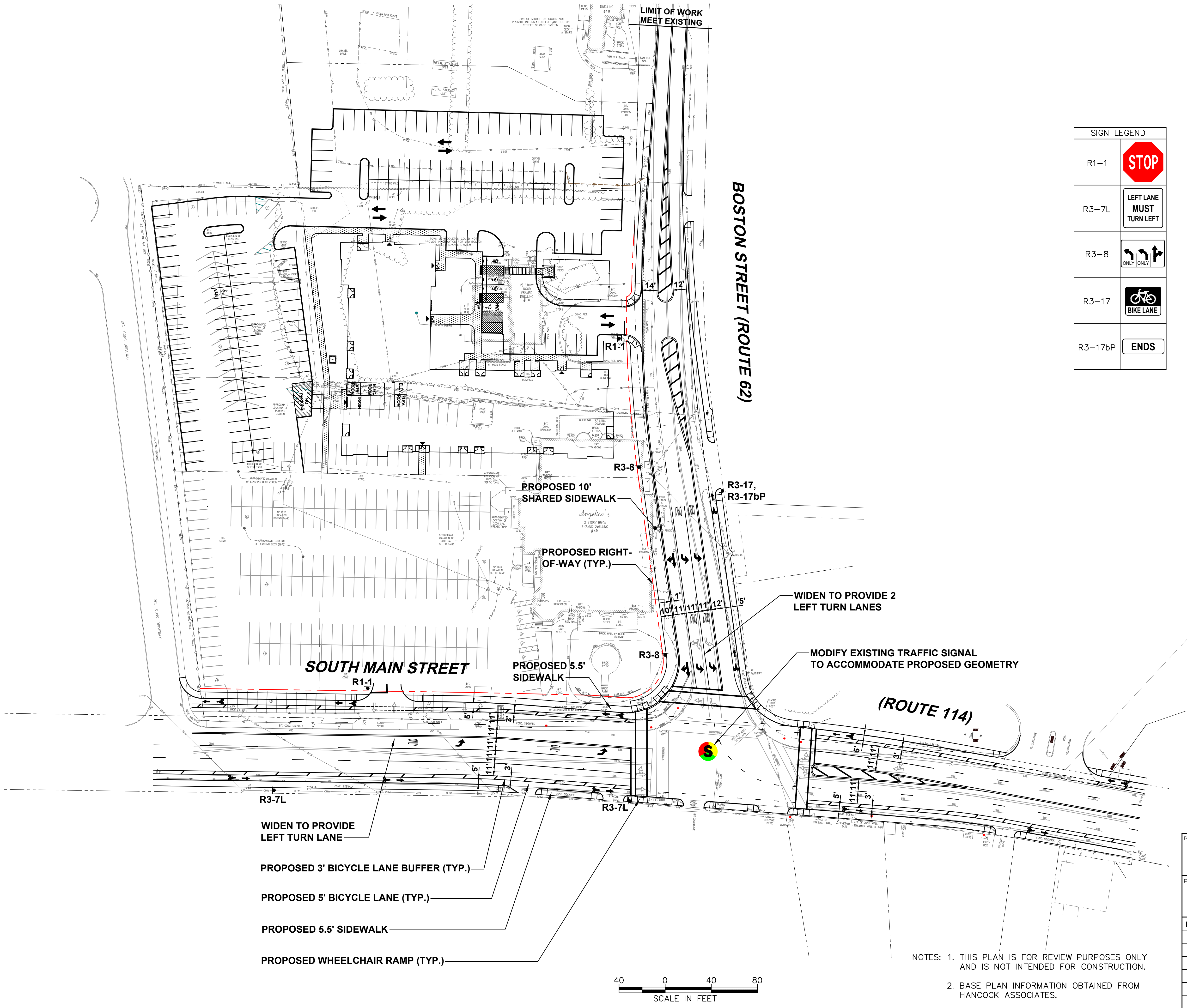



FIGURE 9
LONG-TERM CORRIDOR
IMPROVEMENT PROJECT
CONCEPTUAL IMPROVEMENT PLAN

PROJECT:
PROPOSED MULTIFAMILY RESIDENTIAL DEVELOPMENT
MIDDLETON, MASSACHUSETTS

PROPOSER:
VILLEBRIDGE
NEEDHAM, MASSACHUSETTS

NO.	REVISIONS	DATE	 Transportation Engineers & Planners 35 New England Business Center Drive - Suite 140 - Andover, MA 01810 www.rdvia.com 978-474-8800	
			DESIGNED BY: JSD	DATE: 10/16/2023
			DRAWN BY: JTG	SCALE: 1" = 40'
			CHECKED BY: JSD	SHEET 1 OF 1

NOTES: 1. THIS PLAN IS FOR REVIEW PURPOSES ONLY
AND IS NOT INTENDED FOR CONSTRUCTION.
2. BASE PLAN INFORMATION OBTAINED FROM
HANCOCK ASSOCIATES.

