TRANSPORTATION IMPACT AND ACCESS STUDY

The Dunstan Residences West Newton Redevelopment

Newton, Massachusetts

PREPARED FOR

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Introduction

VHB, on behalf of Mark Development (The Proponent) has prepared a detailed Transportation Impact and Access Study for the proposed Dunstan Residences Re-development project. The project is comprised of three mixed use buildings ranging from three to six stories on two blocks. Cumulatively, the three buildings offer approximately 302 apartments and approximately 5,821 sf of retail space. Parking is provided in two subterranean garages that provide a total of 326 spaces. All of the apartments are within a 10-15-minute walk of both commuter rail and local and express bus stops, which will diminish automobile dependency for the residents.

The Project is located on an approximately three +-acre site adjacent to Dunstan Street, Kempton Place, and Washington Street in Newton, Massachusetts (The Site). The Site is currently home to various existing residential, retail, auto service, and office buildings.

To support the additional traffic generated by the Project, the Proponent is proposing signal timing modifications at a handful of intersections. In addition, various traffic demand management (TDM) initiatives are being proposed including pedestrian and bicycle accommodations on Washington Street along the site frontage and an Rapid Reflectorized Flashing Beacon (RRFB)/crosswalk along Washington Street to the east of the site.

The Traffic Impact and Access Study below quantifies existing and future traffic conditions with and without the Project. Based on the analysis of the future traffic

conditions, the major impacts of the Project are expected to be mitigated by the proposed improvements.

Project Description

The Dunstan Residences will transform an uneven stretch of Washington Street in West Newton into an attractive urban boulevard and bring an unprecedented vitality to West Newton Square. The project is comprised of three mixed use buildings ranging from three to six stories on two blocks. All of the buildings have ground floors that are primarily comprised of retail and residential common space. The smallest building has 79 apartments and the largest has 132 apartments. Cumulatively, the three buildings offer approximately 302 apartments ranging from studios to three bedrooms. The project provides a total of approximately 5,821 sf of retail space, which will accommodate a variety of local and regional retailers. Parking is provided in two subterranean garages that provide a total of 326 spaces. The total area of the project, excluding parking, is 283,295 sf. All of the apartments are within a 10-minute walk of both commuter rail and local and express bus stops, which will diminish automobile dependency for the residents.

The two smaller buildings are paired to form an interior courtyard and define the block along Washington Street. These form a strong street wall along the north side of Washington Street which helps define the corridor and sets the edge for generous sidewalks along the retail stores that occupy the ground floors of these buildings. The sidewalks are characterized by street trees, streetlights, and comfortable benches to encourage strolling and shopping. Parallel parking spaces line the street and protect pedestrians from the moving traffic beyond. The wide lanes of Washington Street could also be narrowed to accommodate dedicated bicycle lanes if the City desires. The medium sized building is on a lot further down Kempton Place. It will front on Kempton Place as well as a new publicly accessible green space facing the Cheesecake Brook.

The interior courtyard between the two larger buildings is publicly accessible thanks to a passageway that provides an inviting connection from the bustle of Washington Street to the tranquility of the green courtyard within. This courtyard is animated by the activity of the retail stores and common spaces that surround it, making it a comfortable place for both residents and the public to enjoy. As this courtyard connects to Washington Street by the pedestrian passageway to the south, it also connects to the new Brook Drive to the north by a cascading stair and an open passage. Brook Drive is an intimately scaled lane that connects Kempton Place to Dunstan Street and provides a pedestrian friendly boardwalk along the Cheesecake Brook. As the site falls approximately twelve feet from Washington Street to Cheesecake Brook, it provides an opportunity for the underground

parking to be accessed from the side streets and allows the northern frontage of the parking levels to be lined by unique apartment

Study Methodology

The following transportation analysis has been performed in general conformance with the Massachusetts Executive Office of Environmental Affairs (EEA)/Executive Office of Transportation (EOT) guidelines. The scope of the study was determined through consultation with the City of Newton.

VHB prepared the traffic assessment in three stages. The first stage involved an assessment of existing traffic conditions within the Project study area including an inventory of existing roadway geometry; observations of traffic flow, including daily and peak period traffic counts; a summary of existing public transit facilities in the area; and a review of vehicular crash data.

The second stage of the study established the framework for evaluating the transportation impacts of the proposed Project. Specific travel demand forecasts for the Project were assessed along with future traffic demands on the study area roadways due to projected background traffic growth and other proposed area developments that may occur independent of the Project. The year 2028, a seven-year time horizon, was selected as the design year for analysis for the preparation of this traffic impact and access assessment.

The third and final stage of the study discusses possible measures to improve existing and future traffic operations in the area by offsetting the traffic-related impacts associated with the development of the proposed Project.

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Existing Conditions

Evaluation of the transportation impacts associated with the Project requires an understanding of the existing transportation conditions in the study area including; an inventory of the traffic control, roadway, driveway, and intersection geometry in the study area, the collection of daily and peak hour traffic volumes, a summary of public transit options in the area, and a review of recent crash history. Each of these elements is described in detail below.

Study Area

Based on VHB's knowledge of the area transportation network and the operational characteristics of the Project as well as input from the City of Newton, a study area was established. The study area consists of the following 30 intersections:

- 1: Washington Street at Auburn Street – *signalized*
- 2: Washington Street at Prospect Street – *signalized*
- 3: Washington Street at Perkins Street – s*ignalized*
- 4: Washington Street at I-90 EB On-Ramp – *signalized*
- 5: Washington Street at I-90 WB Off-Ramp – *signalized*
- 6: Washington Street at Putnam Street – *unsignalized*
- 7: Washington Street at Elm Street – *signalized*
- 8: Washington Street at Cherry Street – *signalized*

- 9: Washington Street at Highland Street – *signalized*
- 10: Washington Street at Waltham Street / Watertown Street – *signalized*
- 11: Washington Street at Chestnut Street – *signalized*
- 12: Washington Street at Davis Court / Jacob's Auto Sales Driveway – *unsignalized*
- 13: Washington Street at Dunstan Street – *unsignalized*
- 14: Washington Street at Kempton Place – *unsignalized*
- 15: Washington Street at Cross Street – *unsignalized*
- 16: Washington Street at Lowell Avenue – *signalized*
- 17: Washington Street at Walnut Street – *signalized*
- 18: Watertown Street at Eden Avenue – *unsignalized*
- 19: Watertown Street at Davis Court – *unsignalized*
- 20: Watertown Street at Davis Avenue – *unsignalized*
- 21: Watertown Street at Dunstan Street – *unsignalized*
- 22: Watertown Street at Adella Avenue (west) – *unsignalized*
- 23: Watertown Street at Cross Street / Adella Avenue (east) – *unsignalized*
- 24: Watertown Street at Albemarle Road– *signalized*
- 25: Watertown Street at Walnut Street – *signalized*
- 26: Webster Street at Elm Street – *unsignalized*
- 27: Webster Street at Cherry Street – *signalized*
- 28: Waltham Street at Webster Street – *unsignalized*
- 29: Waltham Street at River Street – *unsignalized*
- 30: Chestnut Street at Austin Street – *unsignalized*

A map of the project location and study area intersections are shown in Figure 1 and the observed existing geometry and traffic control at each study area intersection are illustrated in Figure 2.

Roadways

All roadways within the study area are under the jurisdiction of the City of Newton, except for the on-ramp to I-90 eastbound and the off-ramp from I-90 westbound, which are under the jurisdiction of the Massachusetts Department of Transportation (MassDOT). Descriptions of the study area roadways are provided below and a map of the roadway jurisdiction in the study area is provided in Figure 3.

Figure 1 Study Area Map

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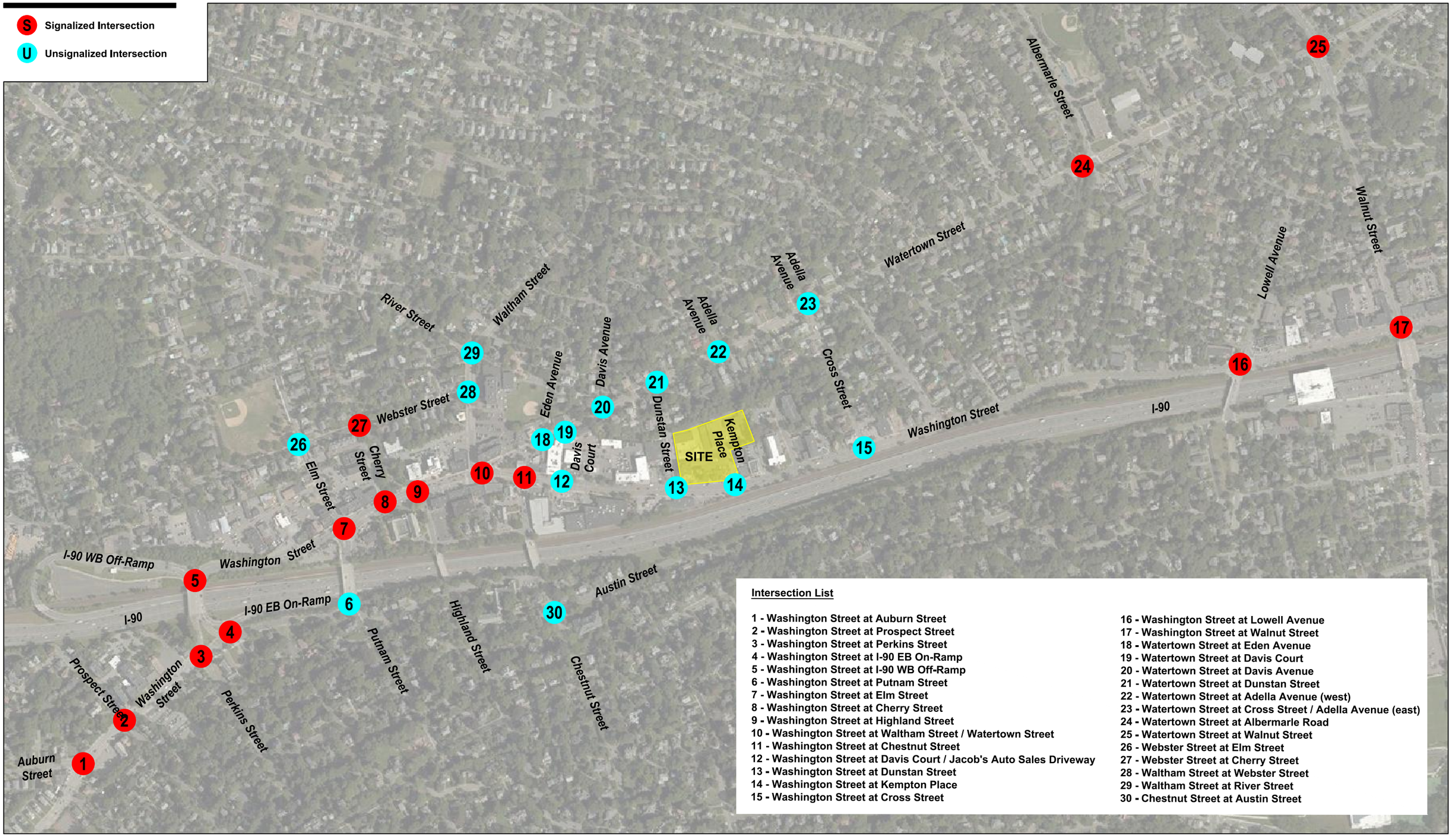

Intersection List

1 - Washington Street at Auburn Street
2 - Washington Street at Prospect Street
3 - Washington Street at Perkins Street
4 - Washington Street at I-90 EB On-Ramp
5 - Washington Street at I-90 WB Off-Ramp
6 - Washington Street at Putnam Street
7 - Washington Street at Elm Street
8 - Washington Street at Cherry Street
9 - Washington Street at Highland Street
10 - Washington Street at Waltham Street / Watertown Street
11 - Washington Street at Chestnut Street
12 - Washington Street at Davis Court / Jacob's Auto Sales Driveway
13 - Washington Street at Dunstan Street
14 - Washington Street at Kempton Place
15 - Washington Street at Cross Street
16 - Washington Street at Lowell Avenue
17 - Washington Street at Walnut Street
18 - Watertown Street at Eden Avenue
19 - Watertown Street at Davis Court
20 - Watertown Street at Davis Avenue
21 - Watertown Street at Dunstan Street
22 - Watertown Street at Adella Avenue (west)
23 - Watertown Street at Cross Street / Adella Avenue (east)
24 - Watertown Street at Albermarle Road
25 - Watertown Street at Walnut Street
26 - Webster Street at Elm Street
27 - Webster Street at Cherry Street
28 - Waltham Street at Webster Street
29 - Waltham Street at River Street
30 - Chestnut Street at Austin Street

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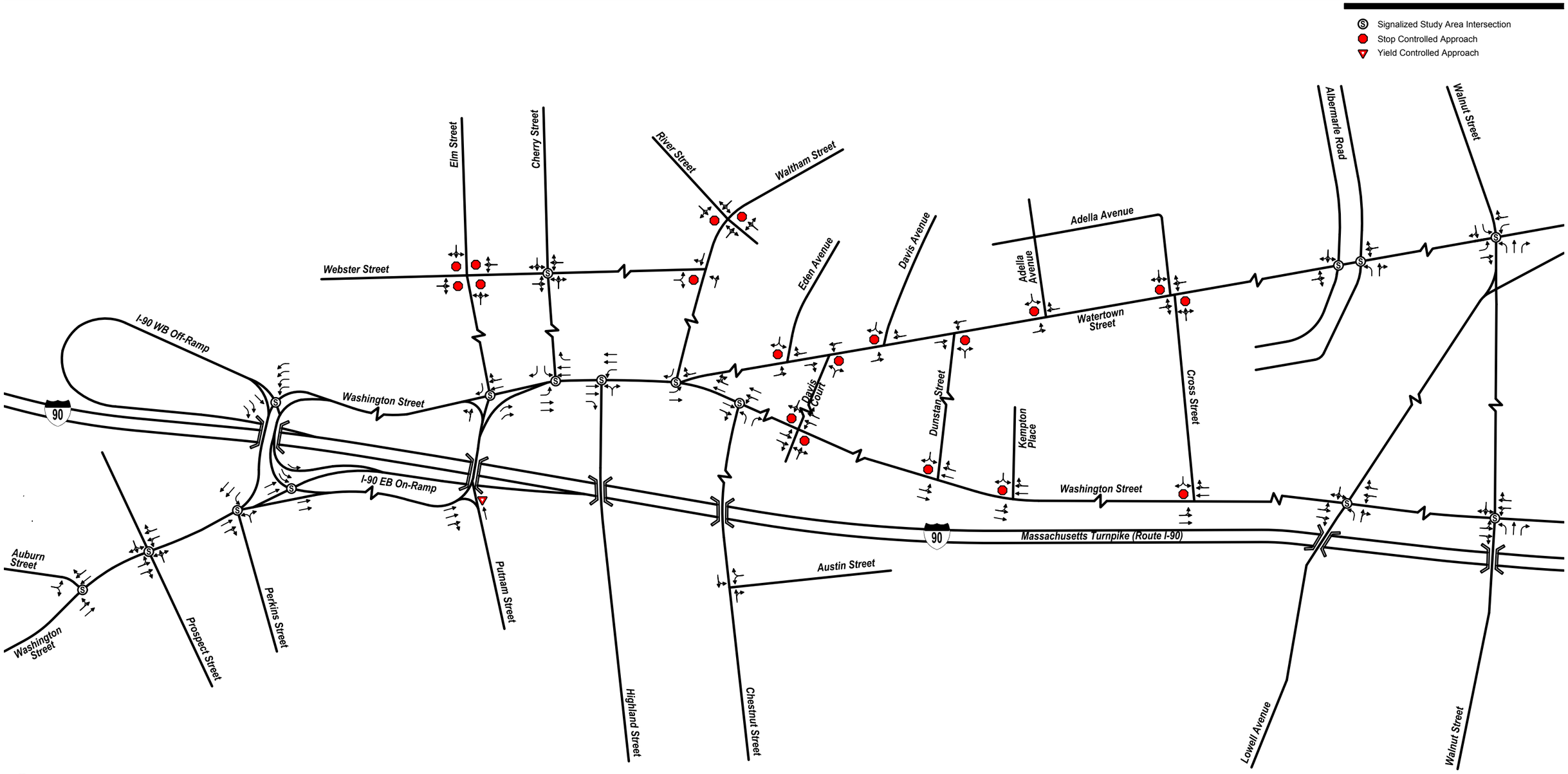
vhb Study Area Map

Figure 1

West Newton Redevelopment
Newton, Massachusetts



Not to Scale

Figure 2

Lane Geometry & Traffic Control
Study Area Intersection

West Newton Redevelopment
Newton, Massachusetts

Washington Street

Washington Street within the study area is a four-lane roadway running generally in an east-west direction. The roadway is classified as an urban principal arterial roadway west of Watertown Street and an urban minor arterial roadway east of Watertown Street. Washington Street travels from Wellesley and I-95 in the west to Newtonville, Newton Corner, and I-90 in the east. The roadway carries the designation of Route 16 from the Newton/Wellesley Town Line to the intersection of Washington Street and Watertown Street. Washington Street is under local jurisdiction, with the ramps connecting from Washington Street to I-90 under Massachusetts Department of Transportation (MassDOT) jurisdiction. Washington Street generally provides four travel lanes with additional turn lanes at some signalized intersections. The posted speed limit along Washington Street varies between 25 mph and 35 mph within the study area. Land use along Washington Street consists primarily of residential and commercial properties, with the largest congregation of commercial properties in the West Newton village center.

Watertown Street

Watertown Street (also known as Route 16) within the study area is a two-lane urban principal arterial roadway running generally in an east-west direction. Watertown Street travels from Washington Street and West Newton in the west to Nonantum and Watertown in the east. Watertown Street is under local jurisdiction and the posted speed limit along the roadway varies between 25 mph and 35 mph within the study area. Land use along Watertown Street consists primarily of residential properties, with some commercial properties on the westernmost segment of the roadway approaching West Newton village center.

Webster Street

Webster Street within the study area is a two-lane urban collector roadway running generally in an east-west direction. Webster Street travels from Lexington Street and Auburndale in the west to Waltham Street in the east. Webster Street is under local jurisdiction and the posted speed limit along the roadway is 25 mph within the study area. Land use along Webster Street consists primarily of residential properties.

Waltham Street

Waltham Street within the study area is a two-lane urban minor arterial roadway running generally in a north-south direction. Waltham Street travels from Washington Street and West Newton in the south to Waltham in the north. Waltham Street is under local jurisdiction and the posted speed limit along the roadway is 25 mph within the study area. Land use along Waltham Street consists primarily of residential properties.

Chestnut Street

Chestnut Street within the study area is a two-lane urban minor arterial roadway running generally in a north-south direction. Chestnut Street travels from Washington Street and West Newton in the north to Route 9 and Upper Falls in the south. Chestnut Street is under local jurisdiction and the posted speed limit along the roadway is 30 mph within the study area. Land use along Chestnut Street consists primarily of residential properties.

Intersection Descriptions

Detailed descriptions of each of the 30 study area intersections are included in the Appendix to this document.

Traffic Volumes

Traffic volumes for the study area roadways and intersections were collected by VHB in April 2019. This time of year was specifically chosen to capture conditions in Newton when schools were in operation and typical commuter traffic was present on the study area roadways. Automatic traffic recorder (ATR) counts were conducted for a continuous 24-hour period on a typical weekday and for a continuous 24-hour period on a typical Saturday in April 2019. The ATR counts were conducted on two study area roadways: Washington Street west of Dunstan Street and Watertown Street west of Davis Avenue. The observed ATR volumes are summarized in Table 1 and all traffic count data is included in the Appendix to this document.

Table 1 Observed Traffic Volumes

	Weekday Daily [a]	Weekday Morning Peak Hour			Weekday Evening Peak Hour			Saturday Daily	Saturday Midday Peak Hour		
Location	Vol.	Vol. [b]	K Factor [c]	Dir. Dist. [d]	Vol.	K Factor	Dir. Dist.	Vol.	Vol.	K Factor	Dir. Dist.
Washington Street				EB			EB				WB
west of Dunstan Street	12,100	1,100	9.1%	56%	1,070	8.8%	55%	8,850	775	6.4%	56%
Watertown Street				EB			WB				EB
west of Davis Avenue	8,500	625	7.3%	52%	685	8.1%	51%	8,510	580	6.8%	52%

Source: VHB; Based on automatic traffic recorder (ATR) counts conducted in April 2019.
a Average Daily Traffic (ADT) volume, expressed in vehicles per day
b Peak period traffic volumes expressed in vehicles per hour
c Represents the percent daily traffic which occurs during the peak hour
d Directional distribution of peak hour traffic
Note: Peak hours do not necessarily coincide with the peak hours of turning movement counts.

As shown in Table 1, Washington Street west of Dunstan Street carries approximately 12,141 vehicles on a typical weekday with the peak hours accounting for 9.1 percent (morning peak hour) and 8.8 percent (evening peak hour) of the weekday daily traffic flow. On a typical Saturday, Washington Street west of Dunstan Street carries approximately 8,850 vehicles with the midday peak hour accounting for 8.7 percent of the Saturday daily traffic flow. Traffic flow along Washington Street is heavier in the eastbound direction during the weekday morning and weekday evening peak hours. During the Saturday midday peak hour, traffic flow along Washington Street is heavier in the westbound direction.

Watertown Street west of Davis Avenue carries approximately 8,500 vehicles on a typical weekday with the peak hours accounting for 7.3 percent (morning peak hour) and 8.1 percent (evening peak hour) of the weekday daily traffic flow. On a typical Saturday, Watertown Street west of Davis Avenue carries approximately 6,980 vehicles with the midday peak hour accounting for 8.3 percent of the Saturday daily traffic flow. Traffic flow along Watertown Street is heavier in the eastbound direction during the weekday morning and Saturday midday peak hours. During the weekday evening peak hour, traffic flow along Watertown Street is heavier in the westbound direction.

In addition, Manual Turning Movement Counts (TMCs) were conducted concurrently with the ATR counts at each of the study area intersections during the weekday morning peak period from 7:00 AM to 9:00 AM, the weekday evening peak period from 4:00 PM to 6:00 PM, and the Saturday midday peak period from 11:00 AM to 2:00 PM. These time periods were selected so that the combined peak periods for the roadway and Project Site activity would be evaluated. Based on the TMCs, the weekday morning peak period generally occurs from 7:30 AM to 8:30 AM, the weekday evening peak period generally occurs from 5:00 PM to 6:00 PM, and the Saturday midday peak period generally occurs from 12:00 PM to 1:00 PM.

In addition, to be responsive to a city request, observations were conducted on Wednesday, September 4 from 5:00 PM to 6:00 PM and on Thursday, September 5 from 7:30 AM to 8:30 AM to determine the number of vehicles traveling northbound on Chestnut Street that make a left turn onto Washington Street then a right turn onto Watertown Street. During these observations 21 vehicles were recorded making this maneuver during the morning observation period and 18 vehicles were recorded making this maneuver during the evening observation period. The TMCs indicate that 20 vehicles make the westbound right turn from Washington Street onto Watertown Street and 25 vehicles during the weekday evening peak hour. Note that one more vehicle was observed than was counted during the weekday morning peak hour, which can be attributed to the count being conducted on a different day than the observation. Overall, the field observation results indicate that most of the vehicles that make the right turn from Washington Street onto Watertown Street during the weekday morning and evening peak hours first made the northbound left turn from Chestnut Street.

Seasonal Adjustment

As stated previously, the traffic data collected for the study area was obtained during the month of April 2019. To quantify the seasonal variation of traffic volumes in the area, historic traffic data available from MassDOT were reviewed. Specifically, 2018 monthly traffic volumes were reviewed at MassDOT permanent counting stations along I-90 and I-95 in Newton and Weston. Multiple count stations were reviewed in order to get an accurate representation of seasonal traffic volumes in the region. Based on the review, traffic volumes in April are slightly higher than average month conditions. To present a conservative analysis, the observed traffic volumes were not adjusted downward. The seasonal adjustment factors are included in the Appendix to this study.

Year 2021 Adjustment

To determine 2021 existing conditions traffic volumes, the 2019 turning movement count volumes were increased based on an ambient background traffic. Historic traffic growth was determined to be increasing at 0.5 percent per year based on previously submitted traffic studies in the area as well as historic traffic data in the area as described in this study. The 2019 turning movement counts were increased by 0.5 percent per year to provide a 2021 Existing Conditions.

The resulting 2021 Existing Conditions weekday morning, weekday evening, and Saturday midday peak hour traffic volumes are shown in Figures 4, 5, and 6, respectively.

Speeds

In addition to daily traffic volumes, vehicle speed data was also collected by the ATR counts. Table 2 summarizes the average and 85th percentile speeds (a speed that is exceeded only by 15 percent of the data points, and typically used for analysis and design purposes) on the study roadways based on the recorded ATR data.

Table 2 Existing Traffic Speed Summary

	Speeds (mph)		
Location	**Posted**	**Ave [1]**	**85th [2]**
Washington Street, west of Dunstan Street	35	EB: 34 WB: 34	EB: 39 WB: 38
Whiting Avenue, west of Mount Vernon Street	25	EB: 29 WB: 29	EB: 34 WB: 34

Based on automatic traffic recorder counts conducted on April 11 and April 27, 2019

1 Average (50th percentile) speeds.
2 85th percentile speeds.

Sullivan Tire Activity

Because the existing Sullivan Tire & Auto Service shop at 1180 Washington Street is directly across from Dunstan Street and has driveways along the eastbound side of Washington Street, field observations were conducted on Wednesday, September 11, 2019 to better understand the operation of this facility. It was observed that customers enter the parking lot using the driveway east of the Sullivan Tire building, then enter the building. An employee then drives the car out of the parking lot via the east driveway onto Washington Street, then into the garages on the west side of the building. Once the car has been serviced, the employee exits the garage via the garage on the east side of the building, sounds the horn upon exiting to Washington Street, and returns the vehicle to the customer lot. Deliveries occur in front of the garages on the west side of the building. The delivery vehicle was observed to pull in head-first in front of the garages on the west side of the building, then leave by backing onto Washington Street.

Ⓢ Signalized Study Area Intersection
neg = Negligible

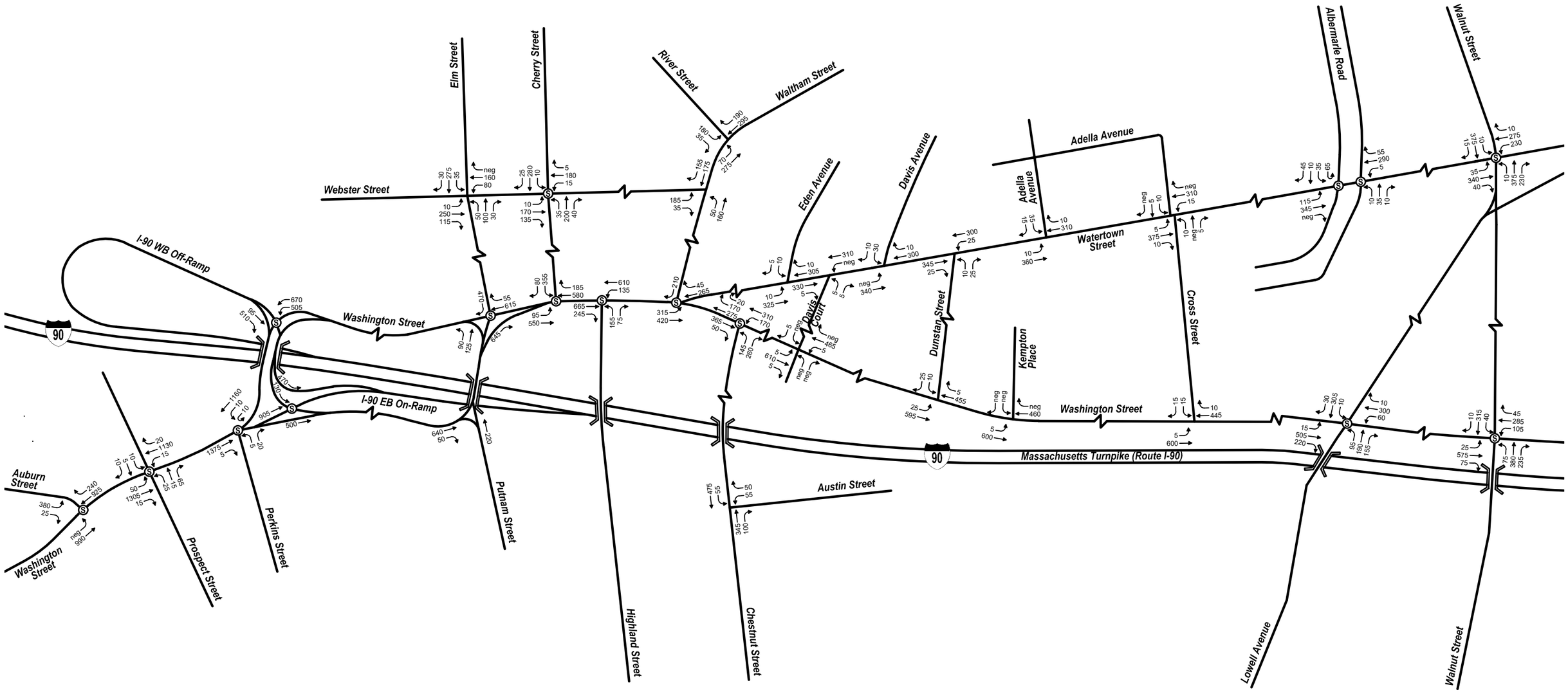


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Figure 4
2021 Existing Conditions
Weekday Morning Peak Hour Traffic Volumes

West Newton Redevelopment
Newton, Massachusetts

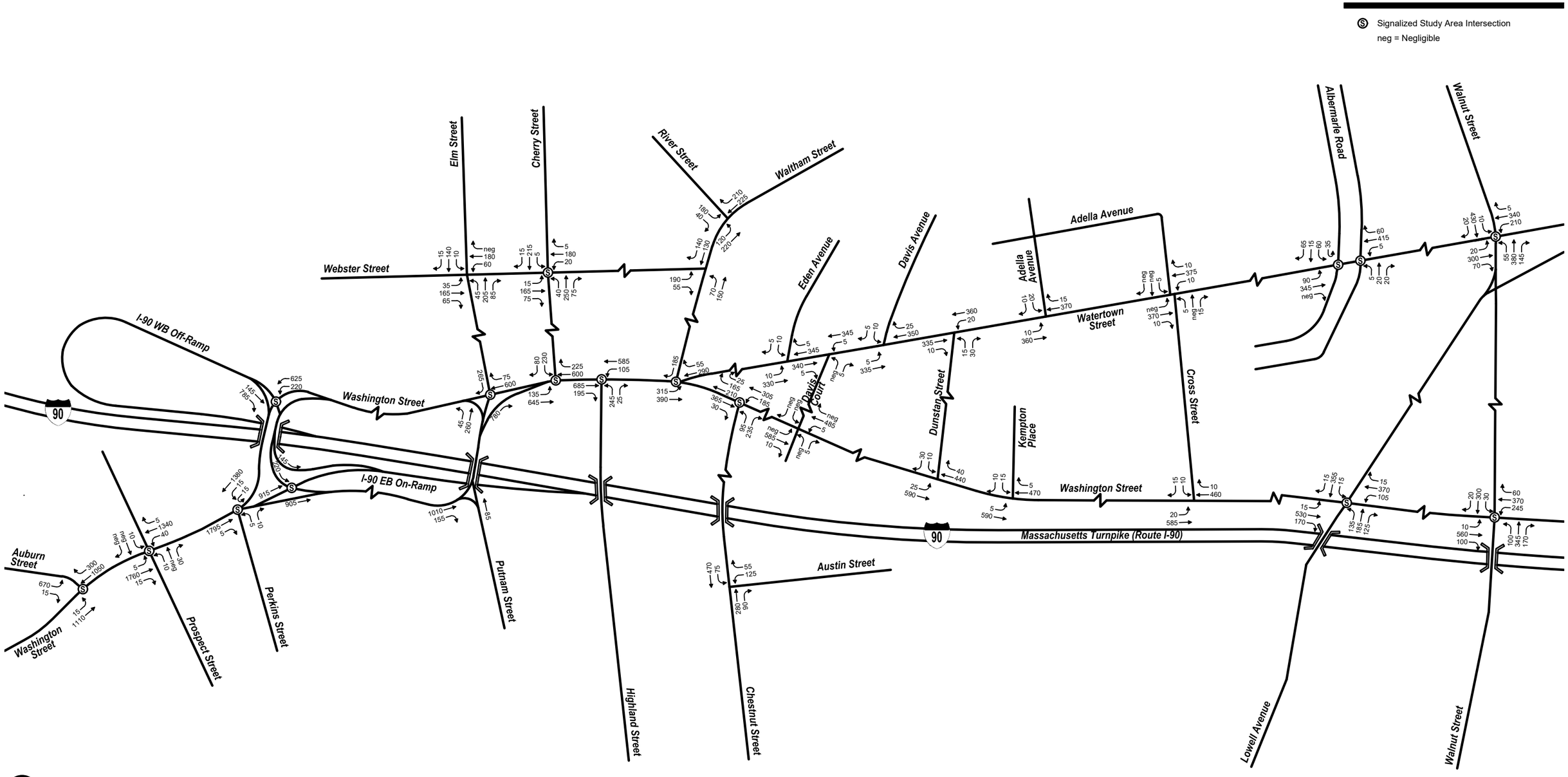

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Figure 5

2021 Existing Conditions
Weekday Evening Peak Hour Traffic Volumes

West Newton Redevelopment
Newton, Massachusetts

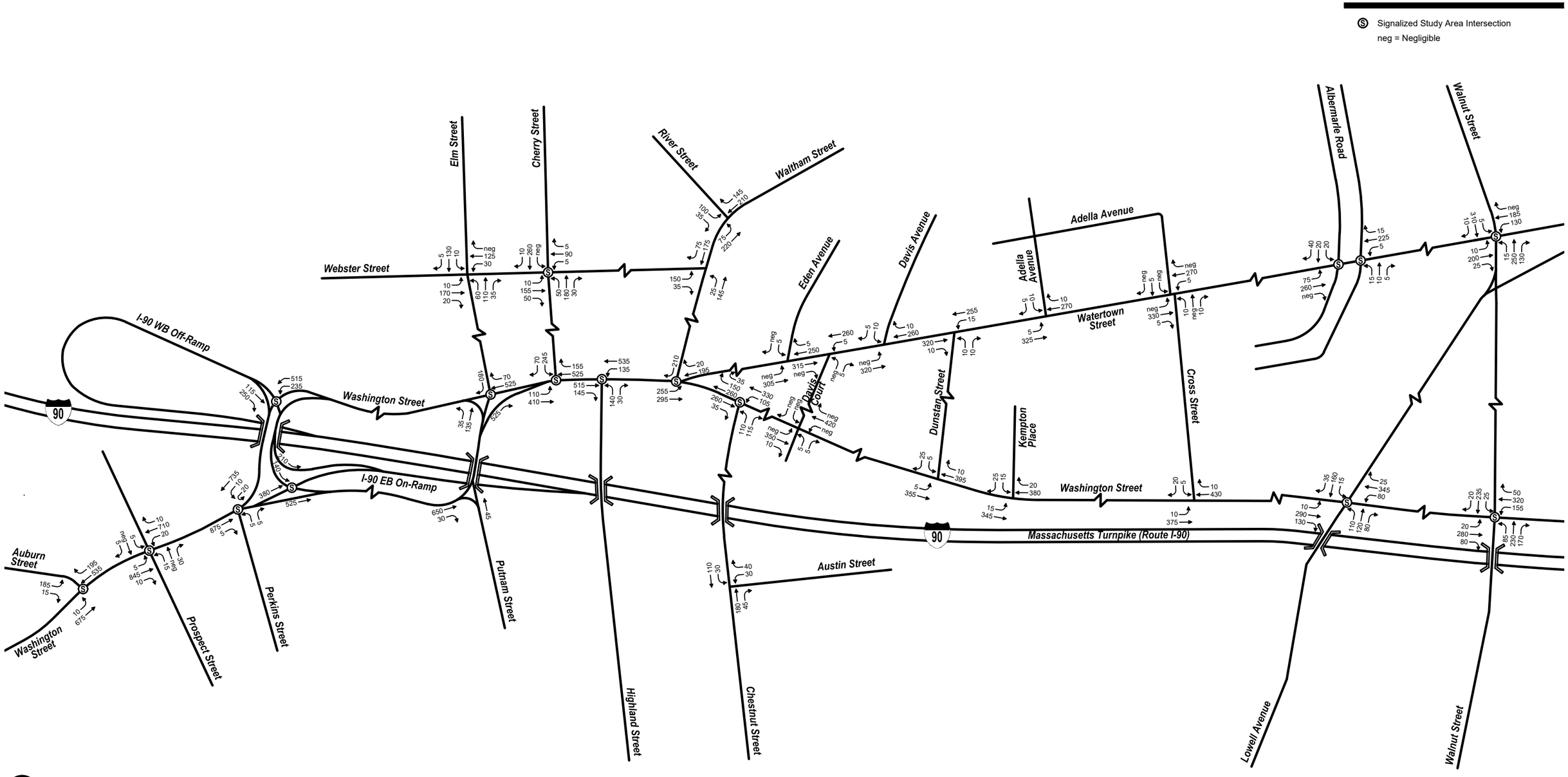

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Figure 6

2021 Existing Conditions
Saturday Midday Peak Hour Traffic Volumes

West Newton Redevelopment
Newton, Massachusetts

Pedestrian and Bicycle Facilities

Varying levels of pedestrian and bicycle facilities are provided in the study area. Sidewalks are provided on both sides of all major roadways in the study area, except for the south side of Washington Street from Kempton Place to Lowell Avenue. Crosswalks are provided at all signalized intersections (except for the intersection of Washington Street and the I-90 EB On-Ramp) and at some unsignalized intersections. West Newton has a pedestrian-friendly village center with nearly all businesses located directly at sidewalk level and with crosswalks across Washington Street located every 200-300 feet.

Bicycle facilities are currently limited in the study area, with no study area roadway having on-road or off-road bike lanes. Webster Street in the study area is marked as a shared street with sharrow pavement marking, but no dedicated bike facilities are provided within immediate proximity to the Site. In addition, there are no off-road bike and pedestrian paths within immediate proximity to the Site, with the nearest shared use path located over a mile north of the Site along the Charles River.

In 2018, the City of Newton entered into a bike-sharing agreement with Limebike, a California based bike sharing system. Limebike uses a dock-less system where bikes can be picked up and dropped off at any location in the City or in neighboring municipalities that also have contracts with Limebike. Limebike has sense pulled all of their bikes from the region and Newton is in the process of implementing a similar service with Bluebike. There are currently limited locations for blue bike including a location along Washington Street near the Armory to the east of the site.

The West Newton Square project, which was approved in 2018 by the City of Newton and is currently in final design, includes roadway, sidewalk, and streetscape improvements along Washington Street. This includes the addition of bike lanes in both directions on Washington Street between I-90 and Chestnut Street as well as the reconstruction of sidewalks and crosswalk ramps and both sides of Washington Street.

An observation of the sidewalk along the south side of Washington Street was conducted by VHB on September 11, 2019. It was found that there is currently a concrete sidewalk between Chestnut Street and the easterly limit of the Sullivan Tire & Auto Service Property at 1180 Washington Street. There is no sidewalk along the south side of Washington Street east of this property. There is also a bituminous sidewalk west of Lowell Avenue, which terminates approximately 250 feet west of Lowell Avenue. Between the Sullivan Tire & Auto Service Property and Lowell Avenue, there are bituminous landing areas for the MBTA bus stops along the south side of Washington Street.

Public Transportation

Public transportation in Newton is provided by the Massachusetts Bay Transportation Authority (MBTA). The proposed development is directly served by two MBTA bus routes; Bus Routes 553 and 554. The Framingham/Worcester Line of the commuter rail also provides additional service at West Newton Station in close proximity of the Site. Descriptions of each transit service is provided below.

- Bus Route 553 travels between Brandeis / Roberts in Waltham and Washington Street in Newton Corner. Two stops are located immediately east and west of the Site on Washington Street, with existing bus stops located west of Chestnut Street and east of Armory Street. Bus Route 553 runs six days a week, Monday through Saturday, and during peak periods has a frequency of approximately 45 minutes. One-way fares cost $1.70 per ride.
- Bus Route 554 travels between Waverly Square in Belmont and Washington Street in Newton Corner. Two stops are located immediately east and west of the Site on Washington Street, with existing bus stops located west of Chestnut Street and east of Armory Street. Bus Route 554 runs five days a week, Monday through Friday, and during peak periods has a frequency of approximately 90 minutes. One-way fares cost $1.70 per ride.
- The Framingham/Worcester Line of the MBTA Commuter Rail travels between Union Station in Worcester and Back Bay Station and South Station in Boston. The nearest stop to the Site is West Newton Station, approximately ¼ mile west of the Site on Washington Street. The nearest station entrance is an approximately five-minute walk to the west side of the Site. Service to/from West Newton Station on the Framingham/Worcester Line is provided seven days a week and during peak periods service is provided every 60-120 minutes in peak directions. On-way fare between West Newton and Boston Landing, Lansdowne, Back Bay, or South Station costs $7.00 per ride.

Figure 7 displays the existing public transportation services provided in the study area and detailed schedules can be found in the Appendix to this document.

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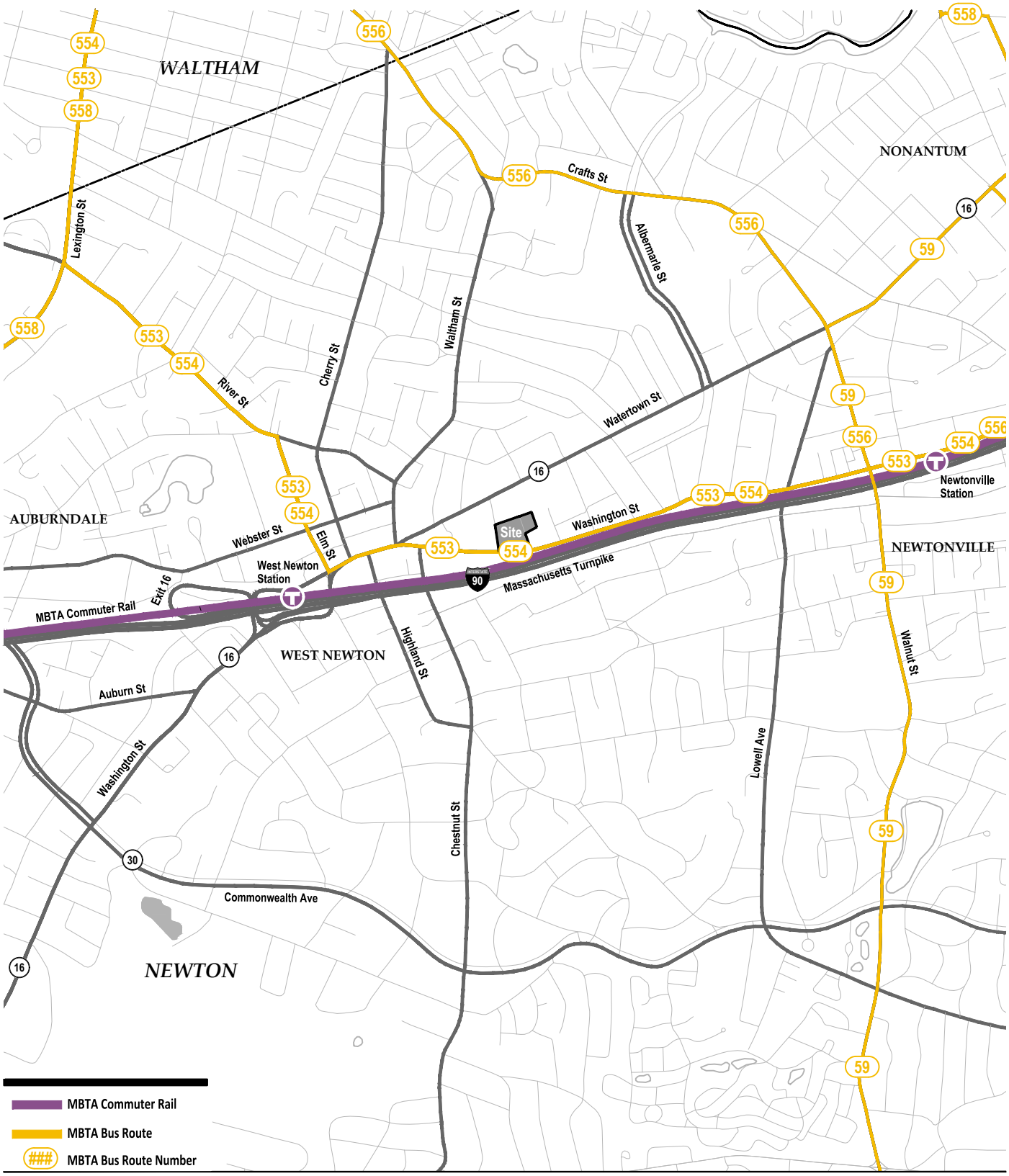

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Figure 7
Local Public Transportation Map

West Newton Redevelopment
Newton, Massachusetts

Crash History

A detailed crash analysis was conducted to identify potential vehicle accident trends and/or roadway deficiencies in the traffic study area. The most current vehicle accident data for the traffic study area intersections were obtained from MassDOT for the years 2014 to 2018. The MassDOT database is comprised of crash data from the Massachusetts Registry of Motor Vehicles (RMV) Division primarily for use in traffic studies and safety evaluations. Data files are provided for an entire city or town for an entire year, though it is possible that some crash records may be omitted either due to individual crashes not being reported, or the city crash records not being provided in a compatible format for RMV use. A summary of the study intersections vehicle accident history based on the available RMV data is presented in Table 3 and the detailed crash data is provided in the Appendix to this document.

Crash rates are calculated based on the number of accidents at an intersection and the volume of traffic traveling through that intersection on a daily basis. Rates that exceed MassDOT's average for accidents at intersections in the MassDOT district in which the town or city is located could indicate safety or geometric issues for a particular intersection. For our study area, the calculated crash rates were compared to MassDOT's District 6 average, as Newton is located in District 6. In District 6, the average crash rate is 0.71 for signalized intersections and 0.52 for unsignalized intersections. These rates imply that, on average, 0.71 accidents occurred per million vehicles entering signalized intersections throughout District 6 and 0.52 accidents occurred per million vehicles entering unsignalized intersections in District 6. It should be noted that the location for some accidents cannot be precisely determined from the database. These locations typically involve interchange intersections. Additionally, some accidents may have occurred but were either not reported or not included in the database, and therefore not considered.

Table 3 Vehicular Crash Summary (2014-2018)

	1. Washington St at Auburn St	2. Washington St at Prospect St	3. Washington St at Perkins St	4. Washington St at I-90 EB On-Ramp	5. Washington St at I-90 WB Off-Ramp	6. Washington St at Putnam St	7. Washington St at Elm St	8. Washington St at Cherry St	9. Washington St at Highland St	10. Washington St at Waltham St and Watertown St
Signalized?	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
MassDOT Average Crash Rate	0.71	0.71	0.71	0.71	0.71	0.52	0.71	0.71	0.71	0.71
Calculated Crash Rate	0.09	0.26	0.31	0.27	0.25	0.24	0.41	0.57	0.75	0.90
Exceeds Average?	No	No	No	No	No	No	No	No	Yes	Yes
Year										
2014	0	8	6	1	0	0	1	4	4	5
2015	1	2	4	4	3	1	5	2	5	3
2016	3	3	6	3	0	2	5	4	7	8
2017	0	2	3	1	4	1	2	9	4	10
2018	2	2	1	3	2	2	4	3	8	4
Total	6	17	20	12	9	6	17	22	28	30
Collision Type										
Angle	1	5	3	8	2	2	5	3	11	5
Head-on	0	2	0	0	0	0	0	1	0	0
Rear-end	5	8	8	2	1	0	3	4	6	9
Rear-to-rear	0	0	0	0	0	0	0	0	0	0
Sideswipe, opposite direction	0	0	1	0	0	0	2	0	1	1
Sideswipe, same direction	0	1	7	1	2	1	4	10	6	5
Single Vehicle Crash	0	1	1	1	4	3	2	4	4	7
Unknown/Not Reported	0	0	0	0	0	0	1	0	0	3
Severity										
Fatal Injury	0	0	0	0	0	0	0	0	0	1
Non-Fatal Injury	2	4	1	2	2	1	2	4	4	8
Property Damage Only	4	13	19	10	5	5	14	17	21	18
Unknown/Not Reported	0	0	0	0	2	0	1	1	3	3
Time of day										
Weekday ,7:00 AM - 9:00 AM	2	2	1	1	0	0	2	0	3	0
Weekday, 4:00 – 6:00 PM	1	2	3	1	0	1	2	0	5	1
Saturday 11:00 AM – 2:00 PM	0	0	1	0	0	0	0	0	1	1
Weekday, other time	3	11	12	5	6	5	13	20	12	23
Weekend, other time	0	2	3	5	3	0	0	2	7	5
Pavement Conditions										
Dry	3	12	17	11	8	5	9	13	22	25
Wet	2	4	3	0	0	0	6	6	4	4
Snow	0	1	0	1	0	0	2	0	0	1
Sand, Mud, Dirt, Oil, Gravel	1	0	0	0	0	0	0	1	0	0
Ice / Slush	0	0	0	0	0	1	0	1	2	0
Unknown/Not Reported	0	0	0	0	1	0	0	1	0	0
Non-Motorist (Bike, Pedestrian)	0	0	0	0	0	0	1	3	2	6

Source: Crash data was obtained from MassDOT Crash Portal, accessed in March 2021.

Table 3 Vehicular Crash Summary (2014-2018) (Continued)

	11. Washington St at Chestnut St	12. Washington St at Davis Ct / Jacob's Auto Sales Dwy	13. Washington St at Dunstan St	14. Washington St at Kempton Pl	15. Washington St at Cross St	16. Washington St at Lowell Ave	17. Washington St at Walnut St	18. Watertown St at Eden Ave	19. Watertown St at Davis Ct	20. Watertown St at Davis Ave
Signalized?	Yes	No	No	No	No	Yes	Yes	No	No	No
MassDOT Average Crash Rate	0.71	0.52	0.52	0.52	0.52	0.71	0.71	0.52	0.52	0.52
Calculated Crash Rate	0.73	0.18	0.17	0.05	0.09	0.39	0.70	0.06	0.13	0.18
Exceeds Average?	Yes	No	No	No	No	No	No	No	No	No
Year										
2014	2	1	0	0	0	0	8	1	1	0
2015	3	0	2	0	0	3	3	0	0	0
2016	4	1	0	1	1	5	6	0	0	0
2017	3	1	2	0	1	7	6	0	1	1
2018	6	1	0	0	0	1	10	0	0	2
Total	18	4	4	1	2	16	33	1	2	3
Collision Type										
Angle	8	3	2	0	1	6	11	0	1	1
Head-on	0	0	0	0	0	4	0	0	0	0
Rear-end	4	0	1	1	0	2	8	0	0	1
Rear-to-rear	0	0	0	0	0	0	0	0	0	0
Sideswipe, opposite direction	0	0	0	0	0	0	0	0	0	0
Sideswipe, same direction	3	0	0	0	1	3	9	0	0	0
Single Vehicle Crash	2	1	0	0	0	1	4	0	0	0
Unknown/Not Reported	1	0	1	0	0	0	1	1	1	1
Severity										
Fatal Injury	0	0	0	0	0	0	0	0	0	0
Non-Fatal Injury	4	0	0	1	0	8	7	0	0	0
Property Damage Only	12	4	3	0	2	8	26	0	1	2
Unknown/Not Reported	2	0	1	0	0	0	0	1	1	1
Time of day										
Weekday ,7:00 AM - 9:00 AM	3	0	0	0	0	1	3	0	0	0
Weekday, 4:00 – 6:00 PM	3	1	1	0	1	3	7	1	0	0
Saturday 11:00 AM – 2:00 PM	1	0	0	1	0	0	0	0	0	0
Weekday, other time	8	3	3	0	1	11	20	0	2	2
Weekend, other time	3	0	0	0	0	1	3	0	0	1
Pavement Conditions										
Dry	13	3	4	1	2	13	29	0	1	3
Wet	4	1	0	0	0	3	3	1	1	0
Snow	0	0	0	0	0	0	0	0	0	0
Sand, Mud, Dirt, Oil, Gravel	0	0	0	0	0	0	0	0	0	0
Ice / Slush	1	0	0	0	0	0	1	0	0	0
Unknown/Not Reported	0	0	0	0	0	0	0	0	0	0
Non-Motorist (Bike, Pedestrian)	2	0	0	0	0	1	2	0	0	0

Source: Crash data was obtained from MassDOT Crash Portal, accessed in March 2021.

Table 3 Vehicular Crash Summary (2014-2018) (Continued)

	21. Watertown St at Dunstan St	22. Watertown St at Adella Ave (west)	23. Watertown St at Adella Ave (east) / Cross St	24. Watertown St at Albemarle Rd	25. Watertown St at Walnut St	26. Webster St at Elm St	27. Webster St at Cherry St	28. Waltham St at Webster St	29. Waltham St at River St	30. Chestnut St at Austin St
Signalized?	No	No	No	Yes	Yes	No	Yes	No	No	No
MassDOT Average Crash Rate	0.52	0.52	0.52	0.71	0.71	0.52	0.71	0.52	0.52	0.52
Calculated Crash Rate	0.28	0.06	0.27	0.27	0.53	0.88	1.26	0.54	0.00	0.09
Exceeds Average?	No	No	No	No	No	Yes	Yes	Yes	No	No
Year										
2014	1	0	1	0	9	3	2	3	0	0
2015	2	0	1	0	3	3	4	0	0	1
2016	1	1	1	3	5	5	9	2	0	1
2017	0	0	0	2	1	5	5	2	0	0
2018	1	0	2	2	6	2	7	1	0	0
Total	5	1	5	7	24	18	27	8	0	2
Collision Type										
Angle	3	0	3	0	13	11	20	2	0	1
Head-on	0	0	0	0	2	1	1	0	0	0
Rear-end	1	1	0	5	3	0	2	0	0	0
Rear-to-rear	0	0	0	0	0	0	0	0	0	0
Sideswipe, opposite direction	0	0	1	0	0	0	1	1	0	0
Sideswipe, same direction	1	0	1	1	6	2	0	5	0	0
Single Vehicle Crash	0	0	0	1	0	4	3	0	0	1
Unknown/Not Reported	0	0	0	0	0	0	0	0	0	0
Severity										
Fatal Injury	0	0	0	0	0	0	0	0	0	0
Non-Fatal Injury	1	1	1	1	3	4	3	0	0	0
Property Damage Only	3	0	4	6	19	13	22	5	0	2
Unknown/Not Reported	1	0	0	0	2	1	2	3	0	0
Time of day										
Weekday ,7:00 AM - 9:00 AM	1	0	1	0	4	0	3	1	0	1
Weekday, 4:00 – 6:00 PM	0	1	2	1	1	2	2	3	0	0
Saturday 11:00 AM – 2:00 PM	0	0	0	1	0	0	2	1	0	0
Weekday, other time	2	0	1	5	15	13	14	2	0	1
Weekend, other time	2	0	1	0	4	3	6	1	0	0
Pavement Conditions										
Dry	4	1	4	3	19	11	21	6	0	2
Wet	1	0	1	4	4	5	4	1	0	0
Snow	0	0	0	0	1	0	0	0	0	0
Sand, Mud, Dirt, Oil, Gravel	0	0	0	0	0	1	0	1	0	0
Ice / Slush	0	0	0	0	0	0	1	0	0	0
Unknown/Not Reported	0	0	0	0	0	1	1	0	0	0
Non-Motorist (Bike, Pedestrian)	0	0	1	0	0	3	0	0	0	0

Source: Crash data was obtained from MassDOT Crash Portal, accessed in March 2021.

As shown in Table 3, review of the accident data indicates that six of the study area intersections are above the district crash rate averages; the intersections of Washington Street at Highland Street, Washington Street at Waltham Street / Watertown Street, Washington Street at Chestnut Street, Webster Street at Elm Street, Webster Street at Cherry Street, and Waltham Street at Webster Street. The majority of crashes throughout the study area were angle crashes and rear-end crashes occurring on dry pavement resulting in property damage only. Based on the MassDOT records, there was one fatal accident that occurred within the study area during the five-year period. The fatal accident occurred in March 2016 when a vehicle traveling down Chestnut Street lost control and plowed into the front of the Sweet Tomatoes restaurant on Washington Street. In addition, three intersections reported a total of three or more crashes involving bicyclists or pedestrians over the five-year period: Washington Street at Cherry Street, Washington Street at Waltham Street / Watertown Street, and Webster Street at Elm Street.

Highway Safety Improvement Program

In addition to calculating the crash rate, study area intersections should also be reviewed in the MassDOT's Highway Safety Improvement Program (HSIP) database. An HSIP-eligible cluster is one in which the total number of "equivalent property damage only"[1] crashes in the area is within the top 5% of all clusters in that region. Being HSIP-eligible makes the location eligible for FHWA and MassDOT funds to address the identified safety issues at these locations.

As part of this effort, VHB reviewed this database and found that the following intersections are potential HSIP-eligible clusters:

2008-2017 HSIP Pedestrian Cluster:

- Washington Street at Elm Street
- Washington Street at Cherry Street
- Washington Street at Highland Street
- Washington Street at Watertown Street and Waltham Street
- Washington Street at Chestnut Street
- Washington Street at Davis Court
- Watertown Street at Eden Avenue

[1] Equivalent property damage only" is a method of combining the number of crashes with the severity of the crashes based on a weighted scale. Crashes involving property damage only are reported at a minimal level of importance, while collisions involving personal injury (or fatalities) are weighted more heavily.

- Watertown Street at Davis Court
- Chestnut Street at Austin Street
- Washington Street at Walnut Street

Further analysis is necessary to determine if all of these locations are actual HSIP-eligible locations or not. It should be noted that the City of Newton has plans to reconstruct Washington Street and several approaching streets through West Newton village, which encompasses several HSIP-eligible locations listed above. There are also plans to improve the intersection of Washington Street at Walnut Street as mitigation for a nearby private development, Washington Place. These roadway improvements are expected to address many of the safety issues that exist today. Full descriptions of all roadway improvement projects are described later in this report.

3

Future Conditions

Traffic volumes in the study area were projected to a seven-year traffic-planning horizon. Independent of the Project, volumes on the roadway network under the future No-Build conditions were assumed to include existing traffic and new traffic resulting from background traffic growth. Under the Build condition, Project generated traffic volumes were added to the No-Build volumes to reflect the Build conditions within the Project study area.

Background Traffic Growth

Traffic growth on area roadways is a function of the expected land development, economic activity, and changes in demographics. Several methods can be used to estimate this growth. A procedure frequently employed is to estimate an annual percentage increase and apply that increase to study area traffic volumes. An alternative procedure is to identify estimated traffic generated by planned new major developments that would be expected to impact the project study area roadways. For the purpose of this assessment, both methods were considered.

Historic Traffic Growth

Previously submitted traffic studies in the area were reviewed to determine an appropriate growth rate. Specifically, VHB looked at the traffic memo submitted in August 2017 for the West Newton roadway improvements project (described below), which assumed annual growth rates of 0.3-percent and 0.4-percent to determine

future traffic projections for the weekday morning and weekday evening peak periods, respectively[2]. In addition, the recently submitted Transportation Impact and Access Study for the Riverside MBTA Station redevelopment used an annual growth rate of 0.5-percent to project future traffic conditions[3].

VHB also researched historic traffic data in the area to assess the change in traffic in Newton over the past several years. The *West Newton Enhancements Project Traffic Analysis Technical Memo* prepared by HDR in August 2017 was reviewed, which included traffic counts from June 2016 along Washington Street between I-90 and Chestnut Street. Additionally, the *Washington Place Mixed Use Transit Oriented Redevelopment* prepared by VHB in May 2016 was reviewed, which included traffic counts from November 2015 along Washington Street between Lowell Avenue and Walnut Street. Based on a comparison between the traffic volumes in these documents and those counted by VHB in 2019 for this study it was determined that 2019 counts indicated slightly lower traffic volumes. A table summarizing the change in traffic volumes from 2015-2016 to 2019 is included in the Appendix to this report.

To present a conservative analysis and to be consistent with previous traffic studies conducted in the area, a growth rate of 0.5-percent was determined to be appropriate for this study.

Site-Specific Growth

In addition to accounting for background growth, the traffic associated with other planned and/or approved developments near the Site was also considered. Based on research by VHB and discussions with the City of Newton, it was determined that there are several planned development projects within the vicinity of the study area that would need to be considered as part of the future traffic conditions, independent of the Project. The planned/approved projects are described below in detail and the projected traffic volumes expected to be generated by each project were taken from filed traffic impact studies or estimated based on ITE projections and added to the study area roadways based on existing travel patterns. The associated site-specific growth traffic volumes are included in the Appendix to this report.

- **429 Cherry Street**: The project involves the construction of 13 residential units and 900 sf of office space at 429 Cherry Street in West Newton village. This project is under construction as of April 2019.
- **424-432 Cherry Street**: The project involves the conversion of 5,000 sf of commercial space into six residential units and to construct a separate

[2] West Newton Enhancement Project Traffic Analysis Technical Memo; HDR; August, 2017.
[3] The Station at Riverside Redevelopment Transportation Impact and Access Study; VHB; April 2019.

building on-site with three additional residential units for a total of nine residential units at 424-432 Cherry Street in West Newton village. This project has been approved but has not started construction as of April 2019.

- **1314 Washington Street**: The project involves a three-story addition to the two-story Santander Bank building at 1314 Washington Street in West Newton village. Once completed, the site will consist of a 30,000 sf building which will contain a 2,400 sf bank, 13,200 sf of office space, and a 120-seat restaurant. This project has been approved but has not started construction as of April 2019.
- **1440-1450 Washington Street:** The project involves the construction of a daycare facility operating with 45 students and six staff members at 1440-1450 Washington Street in West Newton. Construction on this project is expected to start in Spring 2019.
- **Washington Place**: The project involves the construction of 140 residential units and 43,860 sf of retail space at the intersection of Washington Street and Walnut Street in the Newtonville neighborhood of Newton. This project is under construction is currently under construction.
- **28 Austin Street:** The project involves the construction of 68 residential units and 5,000 sf of retail at 28 Austin Street in the Newtonville neighborhood of Newton. The project includes the reconstruction of a municipal parking lot and is under construction.
- **697 Washington Street**: The existing Garden Remedies medical marijuana dispensary at 697 Washington Street in the Newtonville neighborhood of Newton has been approved for recreational marijuana sales. However, recreational sales had not yet started at the time of the traffic counts in April 2019, and therefore all projected traffic associated with recreational sales were added to the study area roadways.
- **386-394 Watertown Street**: The project involves the construction of 9 residential units and ground floor retail space to replace an existing ground floor commercial space at 386-394 Watertown Street in the Nonantum neighborhood of Newton. This project is approved but not yet under construction as of Autumn 2020.
- **182-184 California Street**: The project involves the construction of 20 residential units at 182-184 California Street in the Nonantum neighborhood of Newton. This project is approved and is under construction as of Autumn 2020.
- **83-127 Kennedy Circle**: The project involves the construction of 55 residential units of affordable housing under the state's Chapter 40B program at 83-127 Kennedy Circle in the Nonantum neighborhood of Newton. This project is approved but not yet under construction as of April 2019.
- **283 Melrose Street:** The project involves the restoration of a 200-seat theater, construction of an addition to the theater to contain office space, and construction of a second building on-site to contain 16 residential units

at 283 Melrose Street in the Auburndale neighborhood of Newton. This project is currently under construction.

- **236 Auburn Street**: The project involves the construction of 10 residential units and a congregate care living facility with five bedrooms at 236 Auburn Street in the Auburndale neighborhood of Newton. This project is currently under construction.
- **143 Rumford Avenue**: The project involves the construction of a 107,000 sf self-storage facility and a one story 5,520 sf retail/office building at 143 Rumford Avenue in Newton. The self-storage facility opened in early 2019 and as of April 2019 construction had not yet started on the retail/office building. To present a conservative analysis, traffic projections for the full project were added to the study area roadways.
- **160 Stanton Avenue:** The project involves the expansion of the Golda Meir House with the construction of 69 additional residential units at 160 Stanton Avenue in the Woodland neighborhood of Newton. This project has been approved but has not started construction as of April 2019.
- **Riverside Redevelopment**: The project involves the construction of 1.025 million square feet of development on the existing Hotel Indigo and Riverside T Station parking lot on Grove Street in Newton. The proposal includes 280,000 sf of office space, 600 residential units, 52,000 sf of restaurant/retail space, and a 150-key hotel. The proposal has been submitted and approved by the City of Newton as of November 2020.
- **1089 Washington Street/58 Cross Street:** The project involves the reuse of an existing 5,000-square-foot building as a marijuana dispensary. The business is expected to be open in 2020.
- **Russian School of Math:** The project involves the proposed redevelopment of the 4,000 sf medical office at 46-48, 60, and 66-68 Austin Street in Newton to a space designed for the Russian School of Mathematics. The project proposal has not yet been submitted to the City of Newton.
- **131 Rumford Avenue:** The project involves the construction of an approximately 5,500 sf medical marijuana facility. As of January 2021, the project has not yet submitted the special permit application.
- **15-21 Lexington Avenue:** The project involves the construction of 24 residential units. As of January 2021, the project has been approved, but is not yet under construction.
- **20 Kinmonth Road:** The project involves the construction of 24 residential units. As of January 2021, the project has been approved and is under construction.
- **77-83 Court Street:** The project involves the construction of 36 residential units. As of January 2021, the project has been approved, and has been constructed.

- **1114 Beacon Street:** The project involves the construction of 34 residential units replacing the existing 6,059 square foot restaurant building. This project is currently under review by the City of Newton
- **1158 Beacon Street:** The project involves the construction of a 2,300 square foot marijuana establishment. As of February 2021, the project is currently under review by the City of Newton.
-

Roadway Improvements

In assessing future traffic conditions, proposed roadway improvements within the study area were considered. Based on research by VHB and discussions with the City of Newton, there are several roadway improvement projects that may affect traffic volumes within the seven-year horizon. The proposed roadway improvement projects are described in detail below:

- **West Newton Square Enhancements:** The City of Newton approved in 2018 a series of roadway improvements to Washington Street through West Newton Village. The enhancements include roadway, sidewalk, and streetscape improvements along the roadway with the goals of applying a "complete streets" approach to the core area along Washington Street prioritizing safety for all and upgrading the landscape and streetscape conditions to create a more inviting environment. Some of the improvements include changes to the lane geometry and the addition of bike lanes in both directions on Washington Street between I-90 and Chestnut Street, the reconstruction of sidewalks and crosswalk ramps on both sides of Washington Street, and updated signal timings at the signalized intersections in West Newton village. Construction is expected to start in 2021 and the traffic sign and pavement marking plans for the roadway improvements are included in the Appendix to this document for reference. It should be noted that the No Build and Build analyses take into account the West Newton Square enhancements.
- **Washington Street at Walnut Street Improvements:** Roadway and signal improvements associated with the proposed Washington Place development were recently installed at the intersections of Washington Street at Lowell Avenue and Washington Street and Walnut Street. The signals at these two intersections be coordinated during the weekday morning and weekday afternoon peak hours. Geometric improvements were implemented at the intersection of Washington Street at Walnut Street including curb extensions at the intersection, bike lanes along Walnut Street, signal equipment upgrades, and new signs and pavement markings. Lane use in the southbound direction will be modified from a single lane to a left-turn lane and a shared through/right lane.

Potential Washington Street Improvements: The City of Newton has recently finished a long-range vision plan for the Washington Street corridor called Hello Washington Street! While specific details of the overall vision plan are provided below, the plan included several proposed roadway improvement recommendations along Washington Street, including providing a narrower roadway cross section to provide a single lane of travel in each direction, on-street parking on both sides, a separated bike lane in each direction between I-90 and Newtonville, and sidewalks on both sides. In the vicinity of the intersection of Washington Street and Walnut Street in Newtonville, the cross section is recommended to include one lane of travel in each direction separated by a raised median or two-way left-turn lane, on-street parking along the north side, and a separated bike lane in each direction, and sidewalks on both sides. However, all plans presented in the vision plan are preliminary and the City of Newton does not have any immediate plans to implement the suggested improvements. Therefore, the No Build Condition does not incorporate the improvements outlined in the Washington Street Vision Plan. Public Transportation Improvements

In addition to the proposed roadway improvements listed above, proposed public transportation improvements within the study area were also considered. Based on research by VHB, there are several public transportation improvement projects planned by the MBTA in the upcoming years that may affect capacity on the public transportation services provided in the study area. The proposed public transportation improvement projects are described in detail below:

- **Better Bus Project:** The Better Bus Project is an initiative by the MBTA to improve bus service throughout the MBTA system. The initiative includes proposed near-term changes, multi-year investment strategies, and a full bus network redesign. As part of the proposal, in 2018 the MBTA announced 47 proposals that would affect 63 bus routes to help improve service. It should be noted that none of the three MBTA bus routes in proximity to the Site were listed to be affected by the 47 proposals.
- **West Newton Station Improvements:** Under existing conditions, the platform at the West Newton Station on the Framingham/Worcester Line is not ADA accessible and it only serves one of the two tracks that travels through the station. This restricts the number of trains that can stop at West Newton and limits it mainly to inbound trains in the weekday morning peak period and outbound trains in the weekday evening peak period. Long-term plans by the MBTA include reconstructing West Newton Station (along with the two other commuter rail stations in Newton; Auburndale and Newtonville) to make it ADA accessible and to serve both of the tracks that travel through the station. However, funding is not currently in place for this project and there is no existing timeline for these improvements.

Washington Street Vision Plan

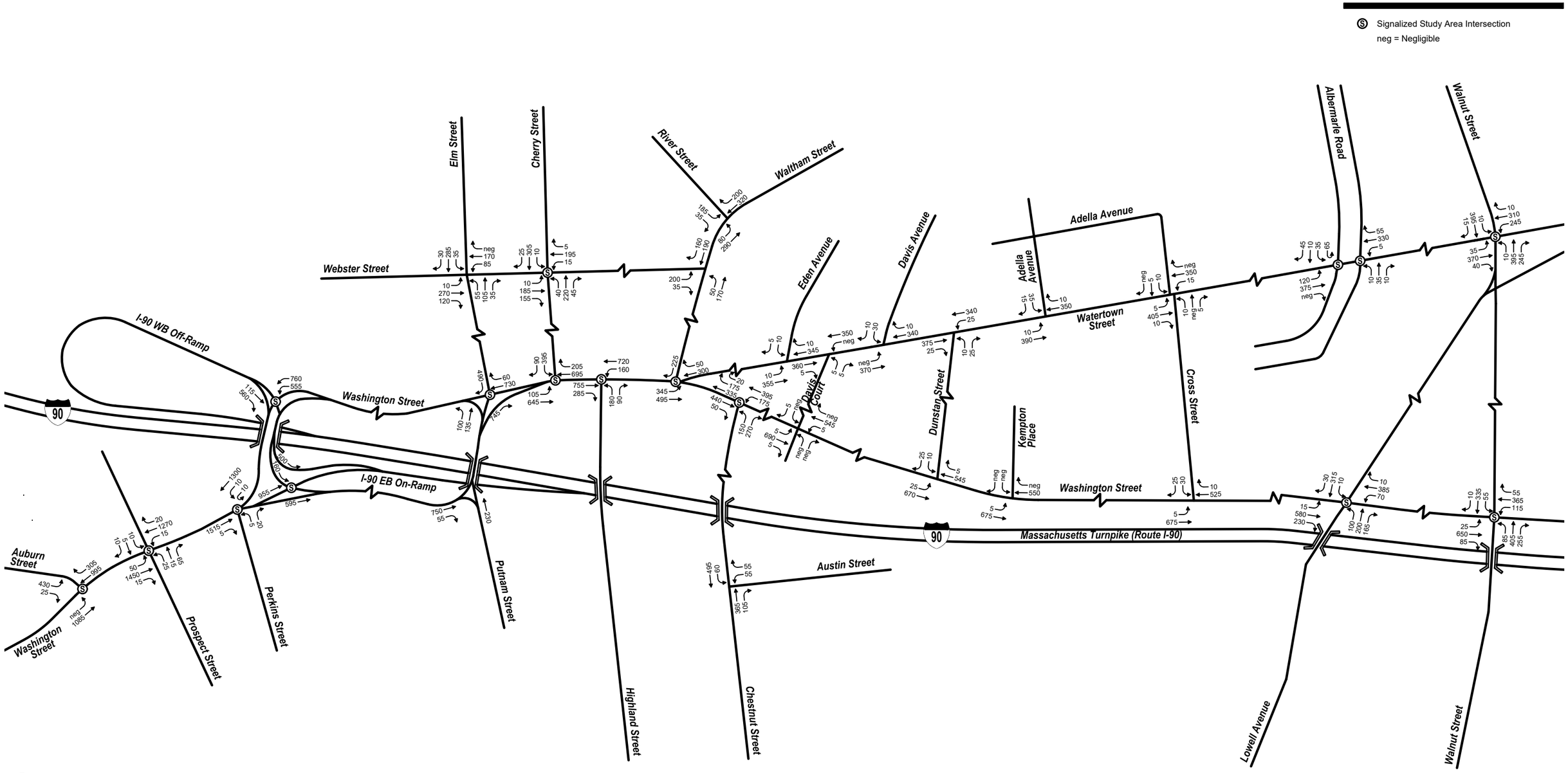
As mentioned previously, the City of Newton is currently preparing the Washington Street Vision Plan to act as a guideline for future development along the Washington Street corridor. The vision plan is a result of the Hello Washington Street planning process and incorporates the segment of Washington Street from West Newton village to Newton Corner. The plan identifies a specific vision for the corridor and focuses on creating lively village centers, making Washington Street safe for everyone, creating diverse housing options, developing places for Newton residents to connect with their community, being sensitive to climate and environmental necessities, and incorporating excellence in placemaking principles.

Specifically, the Washington Street Vision Plan focuses on converting the Washington Street corridor into a dense, walkable neighborhood and transforming the roadway from a high-speed throughway into a local neighborhood street. The Vision Plan proposed to reduce the cross-section on Washington Street from four-lanes to two-lanes and provide enhanced pedestrian and bicycle accommodations along the corridor. In addition, the Vision Plan encourages the development of dense, multi-family housing units near commuter rail stations along the corridor.

While no specific recommendations from the Vision Plan were incorporated into the No Build or Build Conditions, analysis results under future conditions for the unsignalized intersections along the segment of Washington Street that is recommended to be reduced from four to two travel lanes are included in the Appendix for informational purposes.

No-Build Traffic Volumes

The 2028 No-Build traffic volumes were developed using a growth rate of 0.5-percent per year and adding in the background projects and roadway improvement projects described above. The resulting 2026 No-Build weekday morning, weekday evening, and Saturday midday peak hour traffic volume networks are shown in Figures 8, 9, and 10, respectively.

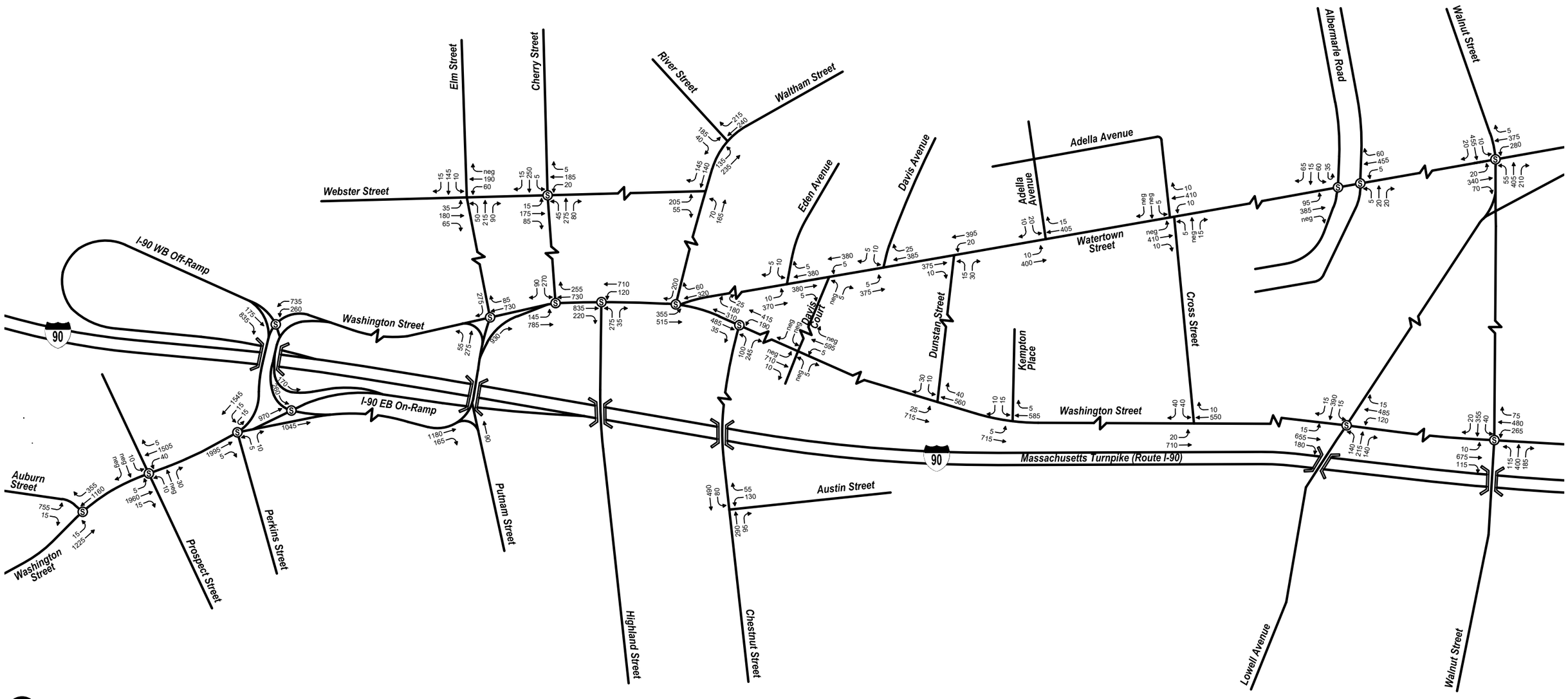


Not to Scale

Figure 8

2028 No Build Conditions
Weekday Morning Peak Hour Traffic Volumes

West Newton Redevelopment
Newton, Massachusetts



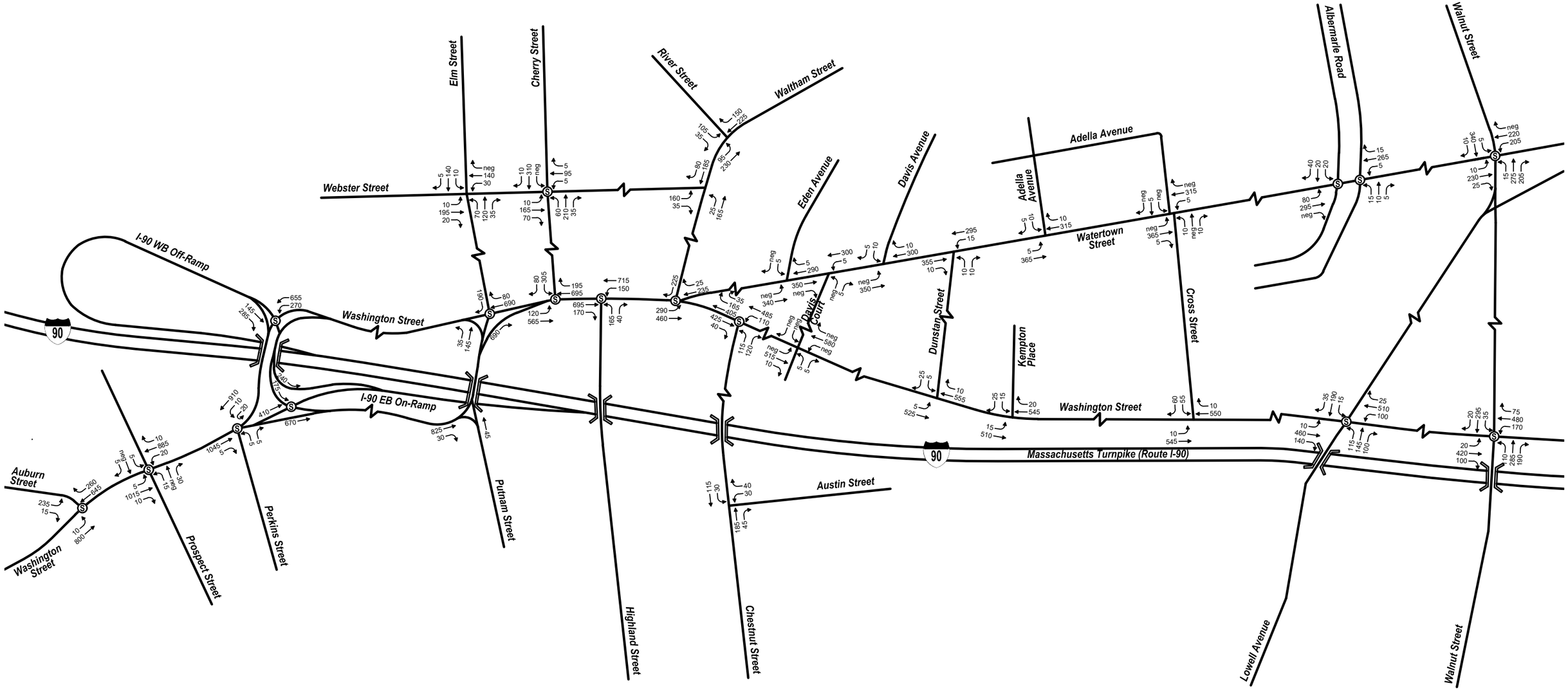
Not to Scale

Figure 9

2028 No Build Conditions
Weekday Evening Peak Hour Traffic Volumes

West Newton Redevelopment
Newton, Massachusetts

Ⓢ Signalized Study Area Intersection
neg = Negligible



Not to Scale

Figure 10
2028 No Build Conditions
Saturday Midday Peak Hour Traffic Volumes

West Newton Redevelopment
Newton, Massachusetts

Trip Generation

The rate at which any development generates traffic is dependent upon the size, location, and concentration of surrounding developments. As mentioned previously, the Project is comprised of retail and residential uses. The ITE *Trip Generation Manual*[4] categorizes these land uses and provides weekday daily, weekday morning peak hour, weekday evening peak hour, Saturday daily, and Saturday midday peak hour unadjusted vehicle trip generation estimates for each use. The trip generation estimates for the proposed uses were projected using Land Use Code (LUC) 221 (Mid-Rise Residential) and LUC 820 (Shopping Center). The trip generation analyses are presented below.

Project-Generated Trips

Estimating future conditions volumes for the Site involved a review of the existing development on those parcels, along with the additional trip generation expected from the Project development.

Existing Site-Generated Traffic

Field observations conducted by VHB indicate that some of the planned development parcels currently are occupied including The Barn Family Shoe Store and The Kids Barn, which are both active retail uses located off Kempton Place. The other uses on planned development parcels were either observed to be inactive or were assumed to have a negligible trip generation.

The vehicular Site trip generation for the weekday morning, weekday evening, and Saturday midday peak hours under existing conditions was estimated based on turning movement counts conducted at the intersection of Washington Street and Kempton Place. While the existing auto glass shop that will remain in place with the Project on the northeast corner of the intersection of Washington Street and Kempton Place was observed to be active, it was determined that the level of activity was negligible during the peak hours, and therefore it was assumed that trips entering or exiting from Kempton Place during the peak hours was mainly attributed to traffic associated with The Barn Family Shoe Store and The Kids Barn. Table 4 summarizes the Project-related trips for the existing uses on Site.

[4] Trip Generation Manual, 10th Edition, Institute of Transportation Engineers, Washington, D.C., 2017.

Table 4 Existing Site Trip Generation

	Total Vehicle Trips[a]
Weekday Morning	
Enter	**5**
Exit	**0**
Total	**5**
Weekday Evening	
Enter	**10**
Exit	**25**
Total	**35**
Saturday Midday	
Enter	**35**
Exit	**40**
Total	**75**

a Based on turning movement counts conducted by VHB in April 2019.

As shown in Table 4, the existing retail uses under existing conditions currently generate approximately five entering vehicular trips during the weekday morning peak hour, 35 vehicular trips (10 entering / 25 exiting) during the weekday evening peak hour, and 75 vehicular trips (35 entering / 40 exiting) during the Saturday midday peak hour. It is expected that these existing Site generated vehicular trips will be displaced by the Site under future conditions and were therefore taken as credit from future conditions.

Unadjusted Project-Generated Traffic

The proposed development will consist of approximately 302 residential units, 5,821 sf of retail space, and 326 parking spaces located in an underground parking garage. Traffic associated with the residential units was estimated using ITE LUC 221 (Mid-Rise Residential) and traffic associated with the retail space was estimated using ITE LUC 820 (Shopping Center).

It should be noted that the retail uses are expected to be smaller, Main Street style businesses catering to the residential space on-Site and the adjacent neighborhoods as opposed to large big-box style retail stores. Potential uses will include small eating establishments, coffee shops, pharmacies, convenience stores, or gallery uses. While these do not fit the exact description of a traditional ITE "Shopping Center", retail traffic was estimated using this land use code, which results in an overly conservative analysis.

The unadjusted new vehicle trip estimates are presented in Table 5 and trip generation worksheets are included in the Appendix.

Table 5 Project Trip Generation – New Unadjusted Vehicle Trips

	Residential [a]	Retail [b]	Total New Unadjusted Vehicle Trips
Weekday Daily			
Enter	822	456	**1,278**
Exit	822	456	**1,278**
Total	1,644	912	**2,556**
Weekday Morning			
Enter	26	96	**122**
Exit	75	59	**134**
Total	101	155	**256**
Weekday Evening			
Enter	78	34	**112**
Exit	50	36	**86**
Total	128	70	**198**
Saturday Daily			
Enter	668	799	**1,467**
Exit	668	799	**1,467**
Total	1,336	1,598	**2,934**
Saturday Midday			
Enter	65	36	**101**
Exit	68	33	**101**
Total	133	69	**202**

a Based on ITE LUC 221 (Mid-Rise Residential) for 302 residential units.
b Based on ITE LUC 820 (Shopping Center) for 5,821 sf

Person Trips

The unadjusted vehicle trips are converted into person trips by applying the average vehicle occupancy (AVO) of 1.18 for residential trips and of 1.82 for retail trips, as outlined by the U.S. Department of Transportation[5]. The unadjusted vehicle trips were converted into person trips in order to apply internal capture credits and applicable mode share credits, as described below. Applying these credits to person trips allows for estimates to be made for the total number of Site-generated transit users, walkers, and bicyclists in addition to the total number of Site-generated vehicles.

5 Summary of Travel Trends: 2017 National Household Survey, US Department of Transportation, Federal Highway Administration, Washington D.C., 2017.

Internal Capture Trips

Since the proposed development is a mixed-use project, the trip generation characteristics of the Site will be different from a single-use project. Some of the traffic to be generated by the proposed development will be contained on site as "internal" or "shared vehicle" trips. For example, residents who live in the development may also shop at the retail uses. While these shared trips represent new traffic to the individual uses, they would not show up as new vehicle trips on the surrounding roadway network.

As described in the ITE Trip Generation Handbook[6] "because of the complementary nature of these land uses, some trips are made among the on-site uses. This capture of trips internal to the site has the net effect of reducing vehicle trip generation between the overall development site and the external street system (compared to the total number of trips generated by comparable land uses developed individually on stand-alone sites) an internal capture rate can generally be defined as the percentage of total person trips generated by a site that are made entirely within the site. The trip origin, destination, and travel path are all within the site."

Based on the methodology outlined in the ITE Trip Generation Handbook, internal capture rates were applied to the gross person trips.

Mode Share

It is expected that residents, visitor, and commuters to the Site will use a variety of transportation options to reach the Site, including private vehicles, walking, bicycling, and public transportation. The Project is conveniently located within one-half mile of the West Newton MBTA Commuter Rail Station, providing direct access to Boston via the Framingham/Worcester line to South Station. Additionally, several MBTA bus routes are available in the vicinity of the Project. The Project is also located in a dense, walkable neighborhood with sidewalk connections to West Newton Village and Newtonville Village.

To determine the potential mode shares for the residential component of the site, mode share data from the US Census Bureau's 2013-2017 American Community Survey was reviewed[7]. Based on that data, approximately 79-percent of all Newton residents that commute to work travel via private vehicle, 13-percent commute via public transit, and 8-percent commute via walking or bicycling. To provide a conservative estimate, a 13-percent transit reduction credit and an 8-percent walk/bike reduction credit was applied to the vehicular trips related to the residential component of the Project. While the Project may have higher transit use

6 Trip Generation Handbook, 3rd Edition, Institute of Transportation Engineers, Washington, D.C., 2017.

7 US Census Bureau, 2013-2017 American Community Survey, City of Newton

than the average household in Newton due to the proximity to the commuter rail, applying a low residential mode share provides the City of Newton with a conservative assessment of future traffic and impacts.

In general, retail uses are expected to generate fewer transit trips than residential uses, as the main trip generator of retail uses are customers, not commuters. While there are expected to be some customers and employees of the retail establishments on Site that will take transit, walk, or bike, to present a conservative analysis, it was assumed that 90-percent of the retail-generated trips will be vehicular trips, 5-percent will be transit trips, and the remaining 5-percent will be walking or bicycle trips. . These retail mode shares are consistent with the *2017 National Household Travel Survey* developed by the US Department of Transportation, which estimates that nationwide the mode share for all trips generated for the purpose of shopping or running errands was approximately 88.5-percent by private vehicle, 1.8-percent by public transit, 8.1-percent by walking, and 1.7-percent by other modes of transportation. Using a 90-percent retail vehicular mode share for this study provides a conservative assessment of future traffic impacts, while using a 5-percent mode share for transit takes into account the high level of public transit available in the area.

Table 6 provides a summary of the projected mode shares by land use and the mode share references are provided in the Appendix to this report.

Table 6 Project Mode Share

Use	Vehicle	Transit	Walk/Bike
Residential	79%	13%	8%
Retail	90%	5%	5%

The mode shares discussed above were applied to the net-new person trips to generate the adjusted Project trips by mode. The local average vehicle occupancy, based US Census data for each primary use, was then applied to the vehicle mode to reflect the number of vehicle trips generated by the Site.

Pass-By Trips

While the ITE rates provide estimates for all the traffic associated with each land use, not all the traffic generated by the Project will be new to the area roadways. A portion of the vehicle-trips generated by the retail land use will likely be drawn from the traffic volume roadways adjacent to the Project Site. For example, someone traveling on Washington Street may choose to deviate from their original travel path to visit the site retail as an intermediate stop on their way to their ultimate destination. For this evaluation, ITE pass-by rates for LUC 820 (Shopping Center) were utilized for the retail trip generation and applied to existing trips on Grove Street. Specifically, 34-percent of the retail trip generation was assumed to be drawn from the surrounding roadway network during the weekday evening peak hour, and 26-percent if the retail trip generation as assumed to be drawn from the surrounding roadway network during the Saturday midday peak hour, as outlined in

the ITE Trip Generation Handbook. For all other time periods studied, a 25-percent pass-by rate was assumed.

Project-Generated Trips

As described above, internal capture credit, mode share credit, and pass-by credit for the Project was applied to the unadjusted new vehicle trips presented in Table 5 to develop the net new trips expected to be generated by the Site. Table 7 presents the Project-generated net new peak hour trips by mode and Table 8 presents the Project-generated net new vehicle peak hour trips by land use.

Table 7 Net New Project-Generated Peak-Hour Trips by Mode

	Net New Vehicle Trips	Net New Transit Trips	Net New Walk and Bike Trips
Weekday Morning			
Enter	85	13	11
Exit	96	16	12
Total	181	29	23
Weekday Evening			
Enter	61	13	9
Exit	27	9	6
Total	88	22	15
Saturday Midday			
Enter	30	11	8
Exit	26	11	8
Total	56	22	16

As shown in Table 7, the Project is expected to generate 29 new transit trips and 23 new walk/bike trips during the weekday morning peak hour. During the weekday evening peak hour, the Project is expected to generate 22 new transit trips and 16 new walk/bike trips. During the Saturday peak hour, the Project is expected to generate 22 new transit trips and 16 new walk/bike trips. The breakdown of the vehicle trips by use are summarized below in Table 8.

Table 8 Project-Generated Peak-Hour Vehicle Trips by Use

	Residential [a]	Retail [b]	Existing Retail Uses [c]	Total Net New Vehicle Trips [d]	Pass-By [e]	Total Net Vehicle Trips w/ Pass-By [f]
Weekday Morning						
Enter	21	69	-5	**85**	17	**102**
Exit	61	35	0	**96**	17	**113**
Total	82	104	-5	**181**	34	**215**
Weekday Evening						
Enter	53	18	-10	**61**	9	**70**
Exit	37	15	-25	**27**	9	**36**
Total	90	33	-35	**88**	18	**106**
Saturday Midday						
Enter	43	22	-35	**30**	7	**37**
Exit	51	15	-40	**26**	7	**33**
Total	94	37	-75	**56**	14	**70**

a Residential vehicle trips with internal capture and mode share credits applied.
b Retail vehicle trips with internal capture and pass-by credits applied.
c Existing retail uses include The Barn Family Shoe Store and The Kids Barn.
d Sum of columns a, b, and c.
e Pass-by Credits of 25% and 34% applied to weekday morning and weekday evening peak hour retail trip generation, respectively.
f Sum of columns d and e.

As shown in Table 8, the Project is expected to generate a total of 215 vehicle trips (102 entering / 113 exiting) during the weekday morning peak hour, 106 vehicle trips (70 entering / 36 exiting) during the weekday evening peak hour, and 70 vehicle trips (37 entering / 33 exiting) during the Saturday midday peak hour.

As noted in the special permit review of the Newton City Ordinances[8], it is expected that the total vehicle trips generated by the mixed-use development will have a net reduction of greater than 10% due to mode share and internal capture credits, but not due to pass-by credits. Based on the Site-generated volumes presented above, the total reduction in total Site-generated vehicular trips due to mode share credit and internal capture credit during the weekday morning, weekday evening, and Saturday midday peak hours is expected to be approximately 14%, 34% and 33%,

[8] Newton City Ordinances Volume II; Chapter 30: Zoning Ordinances; Article 7, Section 7.3: Special Permit Review; 7.3.5: Special Requirements in MU3/TOD; 6.c.ii; December 31, 2017.

respectively. The calculations for these trip reduction percentages are provided in the Appendix to the report.

Rideshare Trip Generation

In the past decade, a rapidly increasing mode of transportation is the use of transportation network companies (TNCs), such as Uber and Lyft. That being said, it is difficult from a trip generation perspective to estimate the total number of TNC users on any given day. Many riders use TNCs for recreation or entertainment purposes and alternate TNC trips with transit and private vehicle trips. In addition, since the popularity of TNCs as a mode of transportation is a relatively new phenomenon, ITE does not provide any hard data on the effects of TNCs on trip generation.

As stated previously, the mode shares used to estimate the trip generation are conservative and result in a higher percentage of Site-generated vehicle trips than is likely to occur. Part of the reason for the conservative vehicular mode share is to consider the presence of TNCs, as some of the vehicles entering and exiting the Site included in the vehicular mode share will be TNCs. However, it is expected that during the peak hours analyzed, the primary reason for travel to and from the Site will be commuting to and from the proposed residential development and customers traveling to and from the proposed retail use. It is likely that a higher percentage of TNC trips will be made during off-peak hours when people are more likely to be traveling for non-work or errand activities.

In addition, in the build year 2028 it is unknown what share of trips will be done via TNCs. Seven years prior to 2021 there were no TNCs and today they are a regular feature on the roadway. As such, it would be challenging to forecast the share of TNC trips seven years into the future due to changing travel patterns and technology. Therefore, a separate TNC mode share percentage has not been developed and instead is included in the conservative vehicle mode share.

The specific details of how TNCs will operate on Site is described later in this report.

Trip Distribution

The directional distribution of the traffic approaching and departing the Site is a function of population densities, the location of employment opportunities, existing travel patterns, and the efficiency of the roadway system. Due to the varying trip characteristics of the Project uses – residential and retail – each use is expected to experience a different distribution pattern. Thus, regional trip distribution percentages were calculated separately for each of the Project's uses.

Trips made from and to the proposed residential development during the peak hours are expected to be predominantly home-to-work and work-to-home trips. Accordingly, the trip distribution for the residential portion of the proposed development has been derived based on Journey-to-Work data for the City of Newton based on a U.S. Census Bureau five-year estimate (2012-2016). The trip distribution for the retail portion of the proposed development have been derived

based on the existing traffic patterns in the study area under existing conditions. As the retail spaces under the proposed development are expected to be more Main Street style businesses catering to neighborhood residents than large-scale retail stores catering to regional customers, it is expected that most trips will start and end in the local area.

Table 9 and Figure 11 illustrate the trip distribution. Detailed trip distribution calculations are provided in the Appendix to this document.

Table 9 Trip Distribution Summary

Travel Route	Direction	Residential Trips [1]	Retail Trips [2]
I-90	East	25%	0%
I-90	West	5%	10%
Washington Street	East	12%	23%
Washington Street (Route 16)	West	14%	16%
Watertown Street (Route 16)	East	8%	8%
Webster Street / Auburn Street	West	12%	3%
Waltham Street / River Street	North	6%	7%
Albemarle Street / Walnut Street	North	1%	2%
Chestnut Street / Highland Street	South	10%	15%
Lowell Avenue / Walnut Street	South	7%	16%

1 Based on Journey-to-Work data for the City of Newton from the U.S Census Bureau's five-year estimate (2012-2016).

2 Based on existing traffic patterns in the study area under existing conditions.

Build Traffic Volumes

The project-related traffic volumes for the Build Condition are assigned to the study area roadway network based on the trip distribution patterns shown in Table 9. The assigned volumes are then added to the 2028 No-Build peak hour traffic volume networks to develop the 2028 Build Condition weekday morning and weekday evening peak hour traffic volume networks. The 2028 Build Condition traffic volumes are shown in Figures 12, 13, and 14 for the weekday morning, weekday evening, and Saturday midday peak hours, respectively. The site-generated traffic volume networks are provided in the Appendix to this report.

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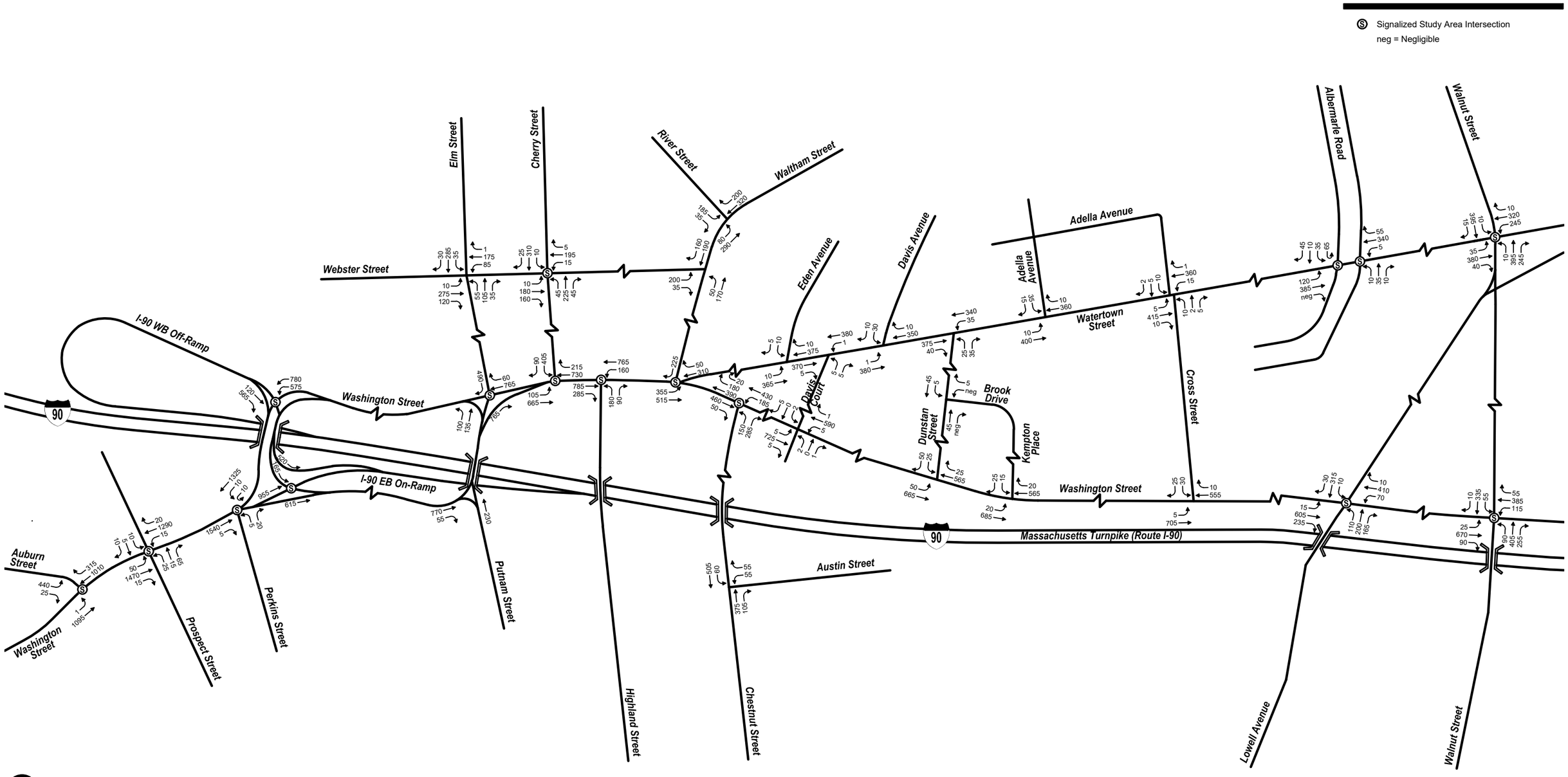
Trip Distribution

Figure 11

West Newton Redevelopment
Newton, Massachusetts

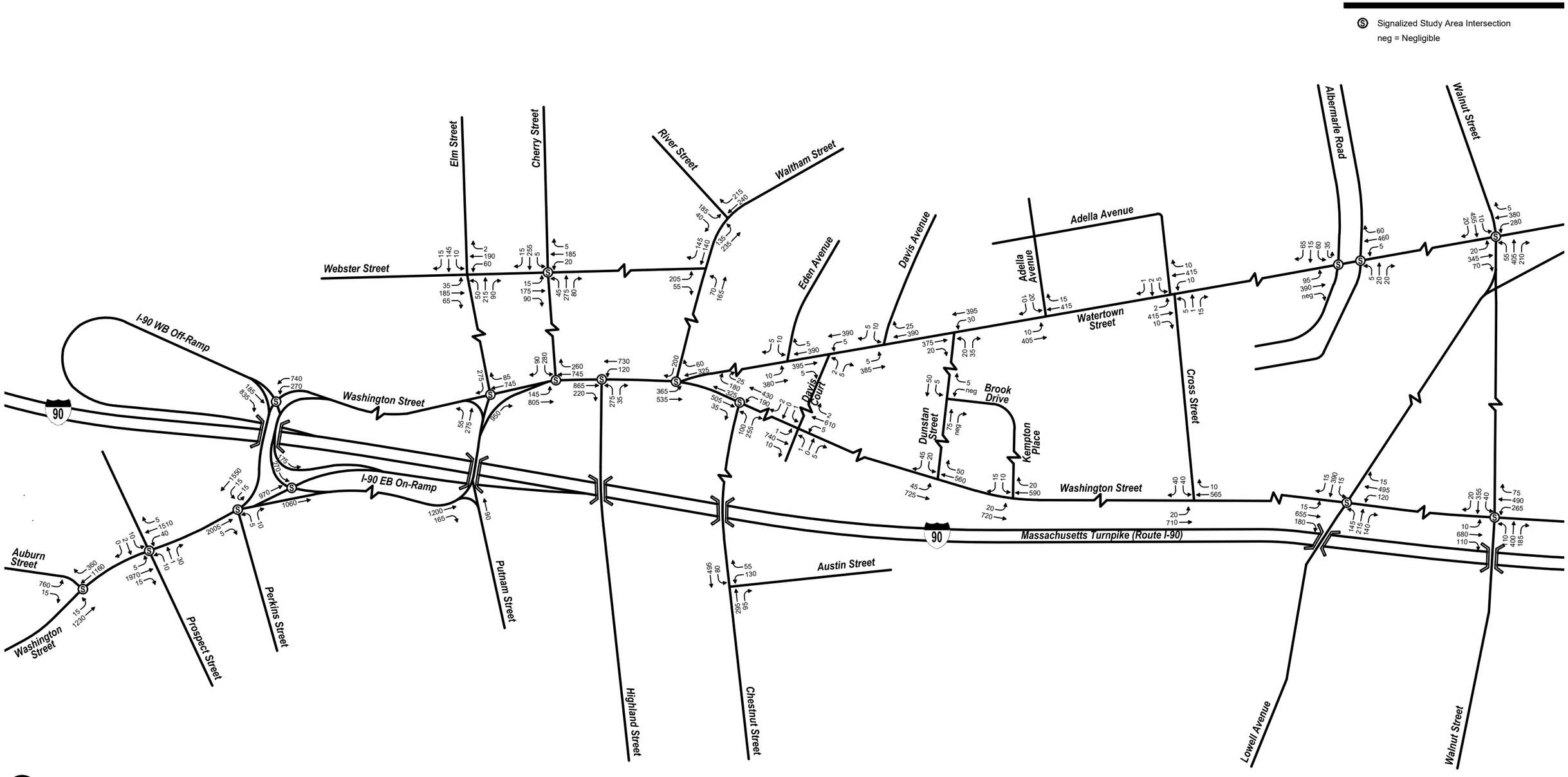


Not to Scale

Figure 12

2028 Build Conditions
Weekday Morning Peak Hour Traffic Volumes

West Newton Redevelopment
Newton, Massachusetts



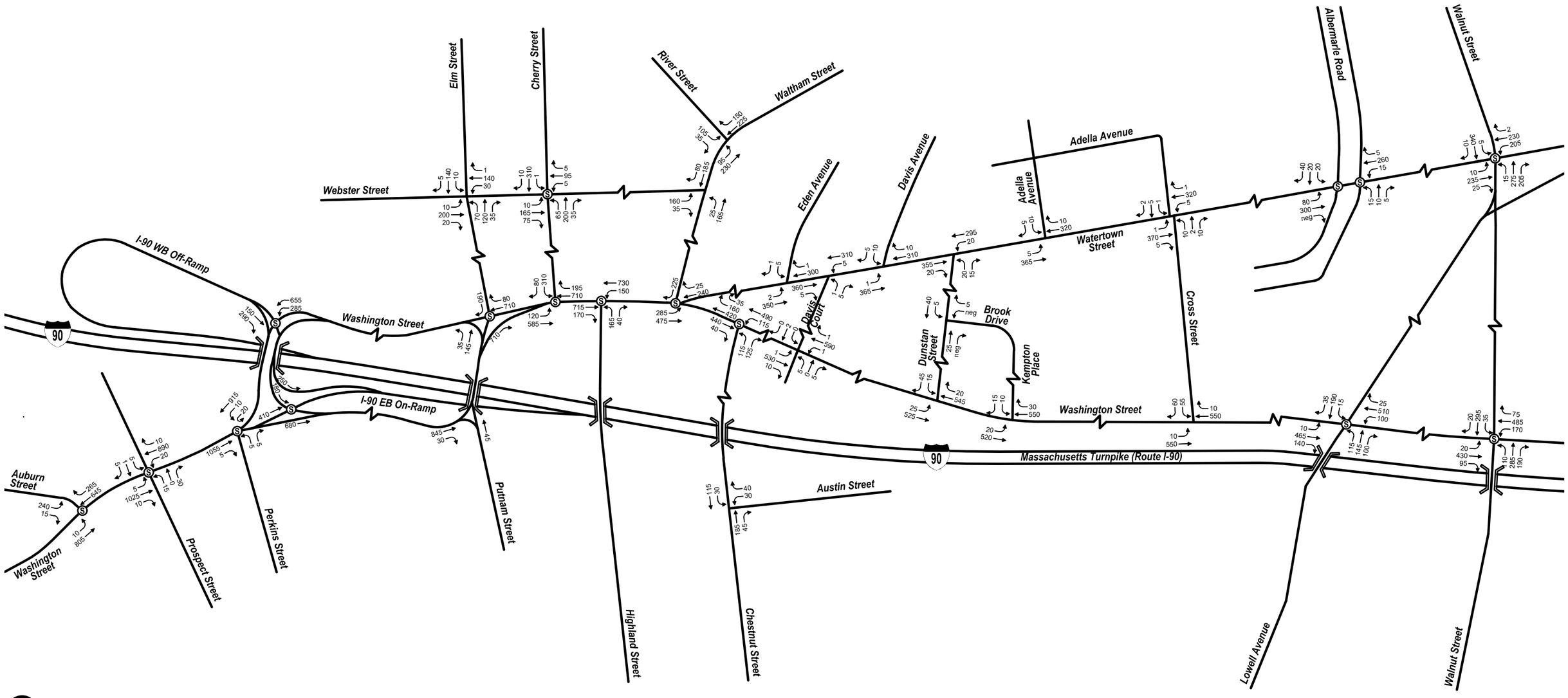
Not to Scale

Figure 13

2028 Build Conditions
Weekday Evening Peak Hour Traffic Volumes

West Newton Redevelopment
Newton, Massachusetts

Ⓢ Signalized Study Area Intersection
neg = Negligible



Not to Scale

Figure 14

2028 Build Conditions
Saturday Midday Peak Hour Traffic Volumes

West Newton Redevelopment
Newton, Massachusetts

4

Transportation Operations Analysis

Measuring existing traffic volumes and projecting future traffic volumes quantifies traffic flow within the study area. To assess quality flow, roadway capacity analyses were conducted with respect to the 2021 Existing Conditions, 2028 No Build Conditions, and 2028 Build Conditions. Capacity analyses provide an indication of how well the roadway facilities serve the traffic demands placed upon them. For the purpose of this document, both intersection capacity analyses and highway facility analyses were conducted. In addition, existing and future transit capacity analyses were conducted as well to determine the impact of the Project on the existing transit system.

Intersection Capacity Analysis

The evaluation criteria used to analyze area intersections in this traffic study are based on the Highway Capacity Manual (HCM)[9]. The term 'Level of Service' (LOS) is used to denote the different operating conditions that occur on a given roadway segment under various traffic volume loads. It is a qualitative measure that considers several factors including

[9] Transportation Research Board, *Highway Capacity Manual*, 6th Edition, Washington, D.C., 2016.

roadway geometry, speed, travel delay and freedom to maneuver. LOS provides an index to the operational qualities of a roadway segment or an intersection. LOS designations range from A to F, with LOS A representing the best operating conditions and LOS F representing the worst operating conditions.

In addition to LOS, two other measures of effectiveness are typically used to quantify the traffic operations at intersections; volume-to-capacity ratio (v/c) and delay (expressed in seconds per vehicle). For example, an existing v/c ratio of 0.90 for an intersection indicates that the intersection is operating at 90 percent of its available capacity. A delay of 15 seconds for a particular vehicular movement or approach indicates that vehicles on the movement or approach will experience an average additional travel time of 15 seconds. For a given LOS letter designation there may be a wide range of values for both v/c ratios and delay. Comparison of intersection capacity results therefore requires that, in addition to the LOS, the other measures of effectiveness should also be considered.

The LOS designations, which are based on delay, are reported differently for signalized and unsignalized intersections. For signalized intersections, the analysis considers the operation of all traffic entering the intersection and the LOS designation is for overall conditions at the intersection. For unsignalized intersections, however, the analysis assumes that traffic on the mainline is not affected by traffic on the side streets. Thus, the LOS designation is for the critical movement exiting the side street, which is generally the left turn out of the side street or site driveway. Table 10 shows the LOS criteria for both signalized intersections and unsignalized intersections.

Table 10 Level of Service Criteria for Intersections

Level of Service	Delay – Signalized Intersection	Delay – Unsignalized Intersection
A	0 to 10 seconds	0 to 10 seconds
B	10 to 20 seconds	10 to 15 seconds
C	20 to 35 seconds	15 to 25 seconds
D	35 to 55 seconds	25 to 35 seconds
E	55 to 80 seconds	35 to 50 seconds
F	Greater than 80 seconds	Greater than 50 seconds

Source: Highway Capacity Manual, 6th Edition.

It should be noted that the analytical methodologies typically used for the analysis of unsignalized intersections use conservative analysis parameters, such as long critical gaps. Actual field observations indicate that drivers on minor streets generally accept shorter gaps in traffic than those used in the analysis procedures and therefore experience less delay than reported by the analysis software. The analysis methodologies also do not fully consider the beneficial grouping effects caused by nearby signalized intersections. The net effect of these analysis procedures is the over-estimation of calculated delays at unsignalized intersections in the study area. Cautious judgment should therefore be exercised when interpreting the capacity analysis results at unsignalized intersections.

Signalized Intersection Capacity Analysis

Capacity analyses were conducted for the signalized study area intersections. Table 11 summarizes the results for the 2021 Existing, 2028 No-Build, and 2028 Build Conditions. All capacity analysis worksheets are included in the Appendix.

Table 11 Signalized Intersection Capacity Analysis

Location / Movement	2021 Existing Conditions					2028 No-Build Conditions					2028 Build Conditions				
	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
1: Washington Street at Auburn Street															
Weekday Morning															
EB L/T	0.73	23	C	184	#525	0.69	22	C	193	#547	0.70	22	C	196	#554
WB T/R	>1.20	>120	F	~422	m#494	0.82	37	D	167	m0	0.84	46	D	175	m0
SEB L/R	1.07	102	F	~340	#320	0.90	100	F	229	#405	0.92	101	F	237	#419
Total		**97**	**F***				**41**	**D***				**46**	**D***		
Weekday Evening															
EB L/T	0.86	26	C	234	#586	0.89	28	C	242	#645	0.91	31	C	253	#660
WB T/R	0.83	69	E	192	m0	0.87	71	E	216	m0	0.89	71	E	223	m0
SEB L/R	>1.20	>120	F	~530	#743	>1.20	>120	F	~607	#826	>1.20	>120	F	~636	#857
Total		**94**	**F**				**111**	**F**				**118**	**F**		
Saturday Midday															
EB L/T	0.37	11	B	63	242	0.46	13	B	85	317	0.46	13	B	87	322
WB T/R	0.41	12	B	67	257	0.50	15	B	91	343	0.50	15	B	93	348
SEB L/R	0.61	33	C	84	188	0.64	33	C	96	235	0.65	33	C	98	240
Total		**15**	**B**				**16**	**B**				**16**	**B**		
2: Washington Street at Prospect Street															
Weekday Morning															
EB L/T/R	0.70	19	B	42	m#513	0.80	24	C	52	m#683	0.81	26	C	53	m#689
WB L/T/R	>1.20	>120	F	~460	#620	>1.20	>120	F	~559	#696	>1.20	>120	F	~592	#710
NB L/T/R	0.53	65	E	21	66	0.53	24	C	21	66	0.53	24	C	21	66
SB L/T/R	0.25	27	C	10	25	0.19	26	C	8	30	0.19	26	C	8	30
Total		**>120**	**F**				**>120**	**F**				**>120**	**F**		
Weekday Evening															
EB L/T/R	0.86	34	C	44	m#642	0.90	52	D	53	m#662	0.92	64	E	59	m#662
WB L/T/R	>1.20	>120	F	~683	#752	>1.20	>120	F	~748	#847	>1.20	>120	F	~770	#868
NB L/T/R	0.34	21	C	7	27	0.29	22	C	6	36	0.29	22	C	6	36
SB L/T/R	0.12	35	D	8	20	0.09	35	D	6	23	0.09	35	D	6	23
Total		**>120**	**F**				**>120**	**F**				**>120**	**F**		
Saturday Midday															
EB L/T/R	0.47	12	B	169	216	0.53	13	B	202	263	0.53	13	B	205	267
WB L/T/R	0.54	20	B	199	266	0.64	22	C	256	339	0.64	22	C	258	341
NB L/T/R	0.22	2	A	0	0	0.18	2	A	0	0	0.18	2	A	0	0
SB L/T/R	0.12	31	C	6	15	0.07	32	C	3	19	0.07	32	C	3	19
Total		**15**	**B**				**17**	**B**				**17**	**B**		
3: Washington Street at Perkins Street															
Weekday Morning															
EB T/R	0.65	7	A	27	397	0.74	17	B	50	468	0.76	21	C	53	477
WB L	0.02	2	A	0	m6	0.02	2	A	1	m7	0.02	2	A	1	m7
WB T	0.44	2	A	7	108	0.50	4	A	38	235	0.51	4	A	40	248
NB L/R	0.15	1	A	0	0	0.10	1	A	0	0	0.10	1	A	0	0
Total		**5**	**A**				**11**	**B**				**13**	**B**		
Weekday Evening															
EB T/R	1.02	66	E	360	#861	1.03	65	E	84	m#948	1.05	64	E	390	m#948
WB L	0.03	6	A	5	m17	0.02	5	A	4	m13	0.02	5	A	4	m12
WB T	0.60	10	B	208	383	0.62	10	A	231	#417	0.63	10	A	236	#557
NB L/R	0.07	1	A	0	0	0.06	0	A	0	0	0.06	0	A	0	0
Total		**41**	**D**				**40**	**D**				**40**	**D**		
Saturday Midday															
EB T/R	0.48	7	A	62	259	0.54	8	A	76	333	0.55	8	A	77	339
WB L	0.03	5	A	2	20	0.03	5	A	2	20	0.03	5	A	2	20
WB T	0.31	5	A	38	166	0.37	6	A	49	212	0.38	6	A	50	213
NB L/R	0.07	1	A	0	0	0.04	0	A	0	0	0.04	0	A	0	0
Total		**6**	**A**				**7**	**A**				**7**	**A**		

*Intersection 1 during the weekday morning peak hour improves between existing and no-build conditions due to using a future peak hour factor of 0.92, as specified by MassDOT in the TIA guidelines.

Table 11 Signalized Intersection Capacity Analysis (continued)

Location /	2021 Existing Conditions					2028 No-Build Conditions					2028 Build Conditions				
Movement	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
4: Washington Street at I-90 EB On-Ramp															
Weekday Morning															
EB T	0.98	85	F	209	#370	1.07	84	F	~297	#424	1.07	84	F	~297	#424
EB BR	0.46	4	A	16	38	0.53	5	A	26	52	0.54	5	A	27	53
SB T	0.09	10	B	35	32	0.08	8	A	32	21	0.09	8	A	32	20
Total		**51**	**D**				**49**	**D**				**49**	**D**		
Weekday Evening															
EB T	>1.20	>120	F	~356	m#338	>1.20	>120	F	~338	m#318	>1.20	>120	F	~351	m#315
EB BR	0.71	19	B	51	m64	0.74	27	C	52	m77	0.78	48	D	63	m89
SB T	0.12	7	A	38	31	0.12	6	A	27	37	0.13	6	A	26	42
Total		**75**	**E**				**69**	**E**				**83**	**F**		
Saturday Midday															
EB T	0.31	15	B	75	115	0.43	20	C	104	113	0.43	21	C	104	114
EB BR	0.40	7	A	37	107	0.54	8	A	45	110	0.55	9	A	46	110
SB T	0.09	9	A	20	22	0.09	7	A	16	26	0.09	7	A	16	27
Total		**10**	**A**				**12**	**B**				**12**	**B**		
5: Washington Street at I-90 WB Off-Ramps															
Weekday Morning															
EB T	0.20	18	B	44	58	0.22	20	B	46	74	0.23	20	B	48	76
EB R	0.71	27	C	163	153	0.71	29	C	151	182	0.71	29	C	152	183
WB T	0.28	14	B	88	m92	0.31	11	B	75	132	0.32	11	B	78	138
WB L	0.37	15	B	122	m132	0.42	12	B	113	193	0.43	12	B	118	201
Total		**19**	**B**				**17**	**B**				**17**	**B**		
Weekday Evening															
EB T	0.21	14	B	50	72	0.23	14	B	55	85	0.25	14	B	60	92
EB R	0.74	23	C	204	223	0.74	23	C	203	247	0.74	23	C	203	247
WB T	0.16	18	B	33	61	0.18	15	B	41	73	0.19	15	B	45	78
WB L	0.44	20	B	105	168	0.50	18	B	146	220	0.51	19	B	150	226
Total		**20**	**C***				**20**	**B***				**20**	**B***		
Saturday Midday															
EB T	0.22	10	B	14	44	0.28	12	B	21	61	0.28	12	B	22	65
EB R	0.33	10	B	17	45	0.37	12	B	23	59	0.37	12	B	25	61
WB T	0.21	7	A	12	30	0.21	7	A	15	39	0.23	8	A	18	41
WB L	0.43	9	A	32	66	0.50	9	A	43	96	0.50	9	A	47	96
Total		**9**	**A**				**10**	**A**				**10**	**A**		
7: Washington Street at Elm Street															
Weekday Morning															
WB T/R	0.35	13	B	103	m25	0.81	56	E	231	m#513	0.86	84	F	232	m#514
NB L/T	0.36	13	B	53	93	0.62	25	C	65	154	0.62	25	C	65	154
NB R	0.53	15	B	119	118	0.76	70	E	112	#740	0.78	71	E	119	#875
SB R	0.90	29	C	134	172	0.69	8	A	0	69	0.68	7	A	0	69
Total		**18**	**B**				**47**	**D**				**58**	**E**		
Weekday Evening															
WB T/R	0.37	7	A	66	m144	0.78	86	F	199	m#425	0.80	85	F	206	m#426
NB L/T	0.52	20	C	117	m95	0.88	51	D	154	#325	0.88	51	D	154	#325
NB R	0.66	17	B	177	119	0.91	79	E	177	#1135	0.94	82	F	194	#1190
SB R	0.45	4	A	0	21	0.37	1	A	0	0	0.38	1	A	0	0
Total		**12**	**B**				**69**	**E**				**69**	**E**		
Saturday Midday															
WB T/R	0.43	7	A	25	89	0.65	40	D	220	503	0.66	50	D	231	#550
NB L/T	0.31	8	A	11	65	0.41	20	C	47	140	0.41	20	C	47	141
NB R	0.22	1	A	0	53	0.63	8	A	59	435	0.64	8	A	62	460
SB R	0.29	1	A	0	0	0.29	1	A	0	0	0.29	1	A	0	0
Total		**5**	**A**				**22**	**C**				**26**	**C**		

*For intersection 5 during the weekday evening peak hour, the overall delay under existing conditions is 20.4 seconds under existing conditions and 19.5 seconds under no-build and build conditions, which moves past the threshold of 20.0 seconds between LOS C and B.

Table 11 Signalized Intersection Capacity Analysis (continued)

Location / Movement	2021 Existing Conditions					2028 No-Build Conditions					2028 Build Conditions				
	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
8: Washington Street at Cherry Street															
Weekday Morning															
EB L	0.13	10	B	39	73	0.65	56	E	55	m90	0.65	55	D	54	m87
EB T	0.27	16	B	133	167	>1.20	>120	F	~648	#942	>1.20	>120	F	~684	#979
WB T	0.93	95	F	142	#255	0.96	65	E	359	m139	0.99	65	E	393	m140
WB R	0.51	17	B	30	111	0.20	2	A	7	m4	0.20	2	A	7	m4
SB L	0.82	46	D	165	#310	0.73	51	D	190	252	0.7r	52	D	194	257
SB R	0.20	15	B	16	51										
Total		**46**	**D**				**107**	**F**				**113**	**F**		
Weekday Evening															
EB L	0.17	7	A	0	52	0.66	54	D	86	m94	0.66	53	D	85	m91
EB T	0.32	9	A	0	96	>1.20	>120	F	~761	m#931	>1.20	>120	F	~815	m#938
WB T	>1.20	>120	F	~257	#369	1.02	62	E	~366	m216	1.07	64	E	~369	m217
WB R	0.85	59	E	88	m#204	0.24	3	A	19	m14	0.25	3	A	21	m14
SB L	0.69	40	D	111	172	0.51	41	D	122	172	0.54	42	D	131	183
SB R	0.23	12	B	9	42										
Total		**102**	**F**				**120**	**F**				**>120**	**F**		
Saturday Midday															
EB L	0.71	43	D	20	#172	0.48	65	E	95	169	0.47	66	E	97	169
EB T	0.23	11	B	27	115	0.85	107	F	616	#827	0.88	110	F	665	#915
WB T	0.54	16	B	80	216	0.86	52	D	455	m485	0.87	68	E	493	m480
WB R	0.32	8	A	23	113	0.20	4	A	33	m43	0.20	4	A	39	m42
SB L	0.70	40	D	69	#306	0.62	66	E	219	288	0.63	67	E	230	293
SB R	0.21	19	B	9	64										
Total		**20**	**B**				**66**	**E**				**74**	**E**		
9: Washington Street at Highland Street															
Weekday Morning															
EB T	1.04	107	F	~207	m#308	0.60	21	C	95	m83	0.63	23	C	98	m84
EB R	0.58	26	C	92	m140	0.27	2	A	7	m6	0.27	2	A	7	m6
WB L	0.18	11	B	11	m73	0.83	73	E	115	m#169	0.83	71	E	112	m#153
WB T	0.31	10	B	27	141	>1.20	>120	F	~797	m#972	>1.20	>120	F	~880	m#1036
NB L/R	0.59	30	C	101	170	0.66	47	D	191	289	0.65	46	D	191	289
Total		**48**	**D**				**>120**	**F**				**>120**	**F**		
Weekday Evening															
EB T	>1.20	>120	F	~296	#384	0.64	30	C	159	m113	0.67	39	D	176	m116
EB R	0.69	28	C	63	#79	0.22	3	A	24	m16	0.22	4	A	26	m17
WB L	0.14	14	B	25	m85	0.49	48	D	71	m102	0.49	47	D	71	m96
WB T	0.31	71	E	76	m220	>1.20	>120	F	~630	#854	>1.20	>120	F	~698	#923
NB L/R	0.80	47	D	131	200	0.85	69	E	248	#405	0.85	69	E	248	#405
Total		**>120**	**F**				**88**	**F**				**102**	**F**		
Saturday Midday															
EB T	0.54	19	B	84	227	0.48	20	B	111	203	0.50	22	C	132	214
EB R	0.29	10	A	2	109	0.17	3	A	9	m45	0.17	3	A	16	m44
WB L	0.30	13	B	16	84	0.44	53	D	121	183	0.45	55	E	124	183
WB T	0.30	11	B	37	150	1.03	>120	F	~991	#941	1.05	>120	F	~1049	#982
NB L/R	0.54	32	C	50	177	0.58	66	E	223	323	0.57	65	E	227	323
Total		**17**	**B**				**64**	**E**				**64**	**E**		

Table 11 Signalized Intersection Capacity Analysis (continued)

Location / Movement	2021 Existing Conditions					2028 No-Build Conditions					2028 Build Conditions				
	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
10: Washington Street at Waltham Street and Watertown Street															
Weekday Morning															
EB L	0.38	31	C	176	m137	0.52	48	D	281	301	0.53	48	D	290	303
EB T	0.25	3	A	16	m17	0.36	6	A	77	101	0.37	6	A	81	106
WB T/R	0.46	26	C	119	#256	0.66	72	E	223	#361	0.70	94	F	236	#405
SB R	0.31	1	A	0	0	0.45	4	A	0	0	0.45	4	A	0	0
SWB BR/R	0.84	46	D	156	#251	0.89	118	F	255	#593	0.92	120	F	265	#612
Total		**22**	**C**				**51**	**D**				**58**	**E**		
Weekday Evening															
EB L	0.42	17	B	46	m5	0.47	62	E	308	m363	0.49	68	E	318	m368
EB T	0.26	4	A	95	m7	0.36	9	A	138	m158	0.38	9	A	134	m166
WB T/R	0.41	22	C	95	164	0.69	101	F	201	278	0.72	100	F	214	#314
SB R	0.30	1	A	0	0	0.42	4	A	0	0	0.42	4	A	0	0
SWB BR/R	0.88	53	D	166	#327	0.77	81	F	259	#593	0.80	105	F	268	#602
Total		**21**	**C**				**56**	**E**				**62**	**E**		
Saturday Midday															
EB L	0.44	21	C	106	141	0.43	27	C	135	288	0.43	27	C	141	295
EB T	0.24	5	A	61	82	0.32	5	A	19	174	0.33	5	A	20	181
WB T/R	0.42	28	C	98	#164	0.68	40	D	177	347	0.68	43	D	184	354
SB R	0.36	2	A	0	0	0.54	5	A	0	0	0.55	5	A	0	0
SWB BR/R	0.78	46	D	125	171	0.62	42	D	151	312	0.62	42	D	157	319
Total		**20**	**C**				**25**	**C**				**26**	**C**		
11: Washington Street at Chestnut Street															
Weekday Morning															
EB T	0.20	6	A	0	138	0.48	17	B	144	398	0.51	18	B	149	443
EB R						0.05	7	A	1	21	0.05	8	A	0	21
WB L	0.36	11	B	34	148	0.35	11	B	35	106	0.38	11	B	37	112
WB T						0.35	12	B	93	254	0.38	12	B	104	282
NB L	0.62	43	D	75	126	0.73	69	E	121	#229	0.74	71	E	121	#229
NB R	0.60	10	A	0	61	0.47	5	A	0	44	0.49	5	A	0	44
Total		**13**	**B**				**18**	**B**				**18**	**B**		
Weekday Evening															
EB T	0.19	2	A	1	35	0.48	17	B	164	477	0.52	19	B	178	#573
EB R						0.04	10	A	5	21	0.04	10	B	5	20
WB L	0.34	9	A	27	138	0.38	11	B	32	121	0.41	11	B	32	121
WB T						0.33	10	B	76	260	0.35	11	B	85	289
NB L	0.49	41	D	47	89	0.59	64	E	82	138	0.59	64	E	82	138
NB R	0.61	12	B	0	61	0.47	5	A	0	40	0.48	5	A	0	40
Total		**10**	**A**				**15**	**B**				**16**	**B**		
Saturday Midday															
EB T	0.16	8	A	17	70	0.72	33	C	162	438	0.73	34	C	171	458
EB R						0.08	20	B	9	45	0.08	20	B	10	45
WB L	0.26	9	A	25	115	0.27	12	B	18	77	0.28	12	B	19	80
WB T						0.49	15	B	102	359	0.50	14	B	104	364
NB L	0.56	42	D	59	104	0.44	44	D	52	157	0.44	45	D	53	160
NB R	0.42	10	B	0	43	0.19	4	A	0	30	0.20	4	A	0	31
Total		**12**	**B**				**22**	**C**				**23**	**C**		

Table 11 Signalized Intersection Capacity Analysis (continued)

Location / Movement	2021 Existing Conditions					2028 No-Build Conditions					2028 Build Conditions				
	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
16: Washington Street at Lowell Avenue															
Weekday Morning															
EB L/T/R	0.64	27	C	248	298	0.65	24	C	216	285	0.68	25	C	229	301
WB L/T/R	0.44	26	C	115	162	0.55	21	C	69	m116	0.58	22	C	77	m123
NB L	0.59	43	D	62	98	0.46	30	C	49	91	0.50	32	C	55	98
NB T/R	0.99	81	F	~311	#436	0.61	29	C	191	296	0.61	29	C	191	296
SB L/T/R	>1.20	>120	F	~378	#569	0.95	74	E	~269	#454	0.95	74	E	~269	#454
Total		**75**	**E**				**33**	**C**				**33**	**C**		
Weekday Evening															
EB L/T/R	0.56	24	C	228	294	0.66	25	C	227	296	0.67	25	C	233	304
WB L/T/R	0.61	28	C	170	235	>1.20	26	C	118	m103	>1.20	27	C	124	m104
NB L	0.69	49	D	75	#132	0.55	32	C	68	#130	0.61	36	D	73	#155
NB T/R	0.71	45	D	205	#338	0.49	25	C	163	256	0.54	27	C	188	290
SB L/T/R	1.02	91	F	~340	#536	0.94	71	E	~325	#517	1.02	90	F	~362	#558
Total		**42**	**D**				**34**	**C**				**38**	**D**		
Saturday Midday															
EB L/T/R	0.35	15	B	51	158	0.44	22	C	105	296	0.44	22	C	106	300
WB L/T/R	0.45	19	B	67	194	0.61	28	C	126	361	0.61	28	C	126	361
NB L	0.36	18	B	26	86	0.46	31	C	46	119	0.46	31	C	46	119
NB T/R	0.49	23	C	58	161	0.71	46	D	122	271	0.71	46	D	122	271
SB L/T/R	0.64	30	C	88	176	0.82	60	E	133	291	0.82	60	E	133	291
Total		**20**	**C**				**33**	**C**				**33**	**C**		
17: Washington Street at Walnut Street															
Weekday Morning															
EB L/T/R	0.85	52	D	309	393	0.63	26	C	173	m246	0.65	27	C	183	m257
WB L/T/R	0.68	37	D	157	207	0.73	33	C	170	#263	0.75	34	C	180	#281
NB L	0.29	33	C	44	86	0.62	50	D	46	#106	0.65	52	D	49	#111
NB T	0.61	39	D	274	407	0.90	60	E	273	#456	0.92	63	E	273	#456
NB R	0.36	7	A	12	75	0.45	7	A	1	64	0.46	7	A	1	64
SB L	0.85	64	E	301	#546	0.69	82	F	38	#114	0.90	>120	F	38	#118
SB T/R						1.20	>120	F	~326	#508	>1.20	>120	F	~326	#508
Total		**43**	**D**				**51**	**D**				**65**	**E**		
Weekday Evening															
EB L/T/R	0.79	49	D	307	382	0.70	29	C	170	m244	0.72	30	C	177	m252
WB L/T/R	>1.20	66	E	258	#398	>1.20	>120	F	~372	#497	>1.20	>120	F	~394	#521
NB L	0.47	39	D	63	109	0.80	67	E	64	#154	0.76	63	E	61	#145
NB T	0.60	42	D	256	361	0.83	52	D	239	#394	0.91	61	E	269	#450
NB R	0.28	6	A	0	52	0.36	6	A	0	54	0.36	6	A	0	54
SB L	0.95	85	F	306	#498	0.43	54	D	25	62	0.60	75	E	26	#81
SB T/R						>1.20	>120	F	~312	#495	>1.20	>120	F	~365	#553
Total		**55**	**D**				**98**	**F**				**115**	**F**		
Saturday Midday															
EB L/T/R	0.58	35	C	118	177	0.45	28	C	200	274	0.45	28	C	202	276
WB L/T/R	0.63	30	C	152	217	0.85	45	D	343	#498	0.86	45	D	346	#505
NB L	0.34	28	C	45	88	0.50	39	D	81	132	0.50	39	D	81	132
NB T	0.44	29	C	134	219	0.46	36	D	234	327	0.47	36	D	234	327
NB R	0.30	6	A	0	47	0.30	5	A	0	56	0.30	5	A	0	56
SB L	0.77	49	D	188	#332	0.16	46	D	29	64	0.16	46	D	29	64
SB T/R						0.84	66	E	312	#434	0.84	67	E	312	#434
Total		**31**	**C**				**39**	**D**				**39**	**D**		

Table 11 Signalized Intersection Capacity Analysis (continued)

Location / Movement	2021 Existing Conditions					2028 No-Build Conditions					2028 Build Conditions				
	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
24a: Watertown Street at Albemarle Street SB															
Weekday Morning															
EB T/R	0.72	45	D	335	#474	0.74	71	E	349	#534	0.75	85	F	359	#550
WB L/T	0.30	2	A	4	6	0.36	2	A	5	7	0.37	2	A	5	7
SB L/T/R	0.71	65	E	131	#213	0.64	60	E	116	#215	0.64	60	E	116	#215
Total		**35**	**C**				**45**	**D**				**52**	**D**		
Weekday Evening															
EB T/R	0.60	29	C	161	412	0.67	34	C	187	#504	0.68	34	C	189	#513
WB L/T	0.40	2	A	7	24	0.44	3	A	8	28	0.45	4	A	8	29
SB L/T/R	0.70	54	D	96	#252	0.66	52	D	89	#249	0.66	52	D	89	#249
Total		**23**	**C**				**24**	**C**				**24**	**C**		
Saturday Midday															
EB T/R	0.41	18	B	102	309	0.43	19	B	109	344	0.44	19	B	110	349
WB L/T	0.23	1	A	4	5	0.23	1	A	4	6	0.24	1	A	4	6
SB L/T/R	0.50	45	D	46	105	0.43	43	D	38	108	0.43	43	D	38	108
Total		**15**	**B**				**15**	**B**				**15**	**B**		
24b: Watertown Street at Albemarle Street NB															
Weekday Morning															
EB L/T	0.97	37	D	~429	#597	1.10	80	F	~503	#793	1.14	95	F	~527	#817
WB T/R	0.50	29	C	202	299	0.60	31	C	255	370	0.62	32	C	263	381
NB L	0.05	46	D	7	25	0.05	46	D	7	25	0.05	46	D	7	25
NB T/R	0.24	48	D	32	70	0.24	48	D	33	71	0.24	48	D	33	71
Total		**35**	**C**				**60**	**E**				**69**	**E**		
Weekday Evening															
EB L/T	0.88	26	C	106	#564	1.09	74	E	186	#796	1.10	81	F	188	#806
WB T/R	0.66	30	C	182	#492	0.73	33	C	209	#577	0.74	33	C	212	#585
NB L	0.03	43	D	3	16	0.02	43	D	2	15	0.02	43	D	2	15
NB T/R	0.22	44	D	21	65	0.21	44	D	20	65	0.21	44	D	20	65
Total		**28**	**C**				**54**	**D**				**58**	**E**		
Saturday Midday															
EB L/T	0.37	2	A	7	21	0.39	2	A	8	35	0.40	2	A	9	35
WB T/R	0.32	17	B	76	216	0.33	17	B	77	253	0.34	17	B	79	258
NB L	0.11	37	D	10	29	0.07	37	D	6	33	0.07	37	D	6	33
NB T/R	0.11	37	D	10	28	0.07	37	D	6	33	0.07	37	D	6	33
Total		**10**	**B**				**10**	**A**				**10**	**A**		

Table 11 Signalized Intersection Capacity Analysis (continued)

Location / Movement	2021 Existing Conditions					2028 No-Build Conditions					2028 Build Conditions				
	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
25: Watertown Street at Walnut Street															
Weekday Morning															
EB L	0.19	34	C	19	48	0.24	36	D	20	51	0.25	36	D	20	51
EB T/R	0.84	53	D	249	#420	0.93	65	E	287	#488	0.95	69	E	~301	#504
WB L	0.98	80	F	~119	#255	1.16	>120	F	~159	#322	1.16	>120	F	~159	#322
WB T/R	0.43	26	C	147	225	0.49	27	C	173	261	0.51	27	C	180	271
NB L	0.07	27	C	5	20	0.08	28	C	5	20	0.08	28	C	5	20
NB T	0.70	38	D	236	349	0.74	40	D	253	#398	0.74	40	D	253	#398
NB R	0.50	33	C	134	215	0.54	34	C	145	229	0.54	34	C	145	229
SB L	0.08	28	C	5	20	0.08	28	C	5	20	0.08	28	C	5	20
SB T/R	0.71	39	D	242	#363	0.76	42	D	265	#421	0.76	42	D	265	#421
Total		**43**	**D**				**54**	**D**				**55**	**D**		
Weekday Evening															
EB L	0.14	30	C	8	31	0.14	30	C	7	33	0.14	31	C	7	34
EB T/R	0.89	53	D	203	#427	0.84	48	D	190	#493	0.85	49	D	192	#500
WB L	0.90	59	E	61	#267	0.88	56	E	65	#266	1.12	115	F	~88	#367
WB T/R	0.48	22	C	115	289	0.50	23	C	123	311	0.52	23	C	128	321
NB L	0.46	41	D	20	#90	0.48	42	D	21	#93	0.50	44	D	21	#95
NB T	0.63	31	C	153	357	0.66	32	C	161	#400	0.66	32	C	164	#407
NB R	0.29	25	C	50	137	0.32	25	C	58	153	0.41	27	C	76	194
SB L	0.05	25	C	3	19	0.06	25	C	3	20	0.06	25	C	3	20
SB T/R	0.76	36	D	196	#493	0.77	37	D	200	#512	0.78	37	D	203	#520
Total		**38**	**D**				**37**	**D**				**45**	**D**		
Saturday Midday															
EB L	0.03	24	C	4	20	0.04	24	C	4	20	0.04	24	C	4	20
EB T/R	0.42	27	C	89	215	0.48	28	C	104	245	0.49	28	C	106	250
WB L	0.27	16	B	32	98	0.50	21	C	59	162	0.51	21	C	59	162
WB T/R	0.22	16	B	49	138	0.28	17	B	65	176	0.30	17	B	69	184
NB L	0.06	21	C	5	24	0.06	21	C	5	24	0.06	21	C	5	24
NB T	0.39	23	C	90	222	0.42	23	C	101	245	0.42	23	C	101	245
NB R	0.24	21	C	44	123	0.38	23	C	74	190	0.38	23	C	74	190
SB L	0.02	21	C	2	13	0.02	21	C	2	11	0.02	21	C	2	11
SB T/R	0.51	25	C	125	296	0.55	26	C	136	321	0.55	26	C	136	321
Total		**22**	**C**				**23**	**C**				**23**	**C**		

Table 11 Signalized Intersection Capacity Analysis (continued)

Location / Movement	2021 Existing Conditions					2028 No-Build Conditions					2028 Build Conditions				
	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
27: Webster Street at Cherry Street															
Weekday Morning															
EB L/T/R	0.71	23	C	102	156	0.69	22	C	98	175	0.70	22	C	98	174
WB L/T/R	0.38	17	B	56	102	0.43	18	B	63	112	0.43	18	B	63	112
NB L/T/R	0.32	10	B	48	119	0.37	11	B	58	143	0.39	11	B	61	150
SB L/T/R	0.34	11	B	58	138	0.39	11	B	67	160	0.39	11	B	68	162
Total		**16**	**B**				**16**	**B**				**16**	**B**		
Weekday Evening															
EB L/T/R	0.60	21	C	70	131	0.61	21	C	76	139	0.62	21	C	77	141
WB L/T/R	0.46	20	C	57	105	0.47	20	B	61	112	0.47	20	B	61	112
NB L/T/R	0.39	9	A	57	136	0.44	10	A	67	163	0.46	10	B	71	173
SB L/T/R	0.25	8	A	36	88	0.27	8	A	42	104	0.29	9	A	45	111
Total		**14**	**B**				**14**	**B**				**14**	**B**		
Saturday Midday															
EB L/T/R	0.57	25	C	60	158	0.60	24	C	66	175	0.61	24	C	67	177
WB L/T/R	0.28	21	C	28	82	0.26	20	B	28	83	0.26	20	B	28	83
NB L/T/R	0.29	11	B	33	158	0.38	12	B	45	207	0.38	12	B	46	210
SB L/T/R	0.28	11	B	36	165	0.34	12	B	48	211	0.34	12	B	49	213
Total		**16**	**B**				**16**	**B**				**16**	**B**		

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.
~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal

As shown in Table 11, the majority of signalized intersections in the study area are expected to have negligible changes in operations between the 2028 No Build Conditions and the 2028 Build Conditions. Of the 30 signalized study area intersections, only the following six intersections are expected to see a degrade in overall LOS between the 2028 No-Build Conditions and the 2028 Build Conditions during the weekday morning, weekday evening, or Saturday Midday peak periods:

- Washington Street at I-90 EB On-Ramp: From LOS E to LOS F (PM)
- Washington Street at Elm Street: From LOS D to LOS E (AM)
- Washington Street at Waltham Street and Watertown Street: From LOS D to LOS E (AM)
- Washington Street at Lowell Avenue: From LOS C to LOS D (PM)
- Washington Street at Walnut Street: From LOS D to LOS E (AM)
- Watertown Street at Albemarle Street Northbound: From LOS D to LOS E (AM).

All other signalized intersections are expected to see the overall LOS maintained from the 2028 No-Build Conditions to the 2028 Build Conditions.

While the Project is not expected to have a major effect on operations at the majority study area signalized intersections, several of the intersections are expected to operate at poor conditions with and without the Project. The following signalized intersections are expected to operate at overall LOS E or F under the 2028 No Build Conditions and the

2028 Build Conditions during the weekday morning, weekday evening, or Saturday Midday peak periods:

- Washington Street at Auburn Street: LOS F (PM).
- Washington Street at Prospect Street: LOS F (AM and PM)
- Washington Street at I-90 EB On-Ramp: LOS F (PM)
- Washington Street at Elm Street: LOS E (AM and PM)
- Washington Street at Cherry Street: LOS F (AM and PM), LOS E (SAT)
- Washington Street at Highland Street: LOS F (AM and PM), LOS E (SAT)
- Washington Street at Waltham Street and Watertown Street: LOS E (AM and PM)
- Washington Street at Walnut Street: LOS E (AM), LOS F (PM)
- Watertown Street at Albemarle Street NB: LOS E (AM and PM)

As stated above, these intersections are expected to operate with failing overall LOS with and without the Project, and the Project is not expected to noticeably worsen operations beyond the current failing conditions.

Unsignalized Intersection Capacity Analysis

Capacity analyses were also conducted for the unsignalized study area intersections. Table 12 summarizes the results for the 2021 Existing, 2028 No-Build, and 2028 Build without Mitigation Conditions. All capacity analysis worksheets are included in the Appendix.

Table 12 Unsignalized Intersection Capacity Analysis

Location / Movement	2021 Existing Condition					2028 No-Build Conditions					2028 Build Conditions				
	D [a]	v/c [b]	Del [c]	LOS [d]	95 Q [e]	D	v/c	Del	LOS	95 Q	D	v/c	Del	LOS	95 Q
6: Washington Street at Putnam Street															
Weekday Morning															
NB BR	220	0.57	22	C	90	230	0.42	16	C	53	230	0.43	16	C	55
Weekday Evening															
NB BR	85	0.30	20	C	30	90	0.24	17	C	23	90	0.24	17	C	23
Saturday Midday															
NB BR	45	0.12	13	B	10	45	0.09	12	B	8	45	0.09	12	B	8
12: Washington Street at Davis Court and Jacob's Auto Sales Driveway															
Weekday Morning															
EB L	5	0.01	8	A	0	5	0.01	9	A	0	5	0.01	9	A	0
WB L	5	0.01	9	A	0	5	0.01	9	A	0	5	0.01	9	A	0
NB L/T/R	3	0.03	19	C	3	3	0.01	21	C	0	3	0.02	23	C	3
SB L/T/R	7	0.02	13	B	3	7	0.02	14	B	3	7	0.02	15	B	3
Weekday Evening															
EB L	1	0.00	9	A	0	1	0.00	9	A	0	1	0.00	9	A	0
WB L	5	0.01	9	A	0	5	0.01	9	A	0	5	0.01	10	A	0
NB L/T/R	6	0.01	12	B	0	6	0.02	14	B	0	6	0.02	14	B	3
SB L/T/R	3	0.01	14	B	0	3	0.01	16	C	0	3	0.01	16	C	0
Saturday Midday															
EB L	1	0.00	8	A	0	1	0.00	9	A	0	1	0.00	9	A	0
WB L	1	0.00	8	A	0	1	0.00	9	A	0	1	0.00	9	A	0
NB L/T/R	10	0.04	13	B	3	10	0.03	16	C	3	10	0.03	16	C	3
SB L/T/R	2	0.02	19	C	0	2	0.01	26	D	0	2	0.01	27	D	0
13: Washington Street at Dunstan Street															
Weekday Morning															
EB L	25	0.03	8	A	3	25	0.03	9	A	3	50	0.06	9	A	5
SB L/R	35	0.09	13	B	8	35	0.09	14	B	8	75	0.23	18	C	23
Weekday Evening															
EB L	25	0.03	9	A	3	25	0.03	9	A	3	45	0.05	9	A	5
SB L/R	40	0.10	13	B	8	40	0.11	15	C	10	65	0.21	18	C	20
Saturday Midday															
EB L	5	0.01	8	A	0	5	0.01	9	A	0	25	0.03	9	A	3
SB L/R	30	0.06	11	B	5	30	0.06	12	B	5	60	0.14	14	B	13
14: Washington Street at Kempton Place															
Weekday Morning															
EB L	5	0.01	8	A	0	5	0.01	9	A	0	20	0.02	9	A	3
SB L/R	2	0.01	13	B	0	2	0.01	15	B	0	40	0.12	16	C	10
Weekday Evening															
EB L	5	0.01	9	A	0	5	0.01	9	A	0	20	0.02	9	A	3
SB L/R	25	0.09	16	C	8	25	0.09	19	C	8	25	0.08	17	C	8
Saturday *Midday*															
EB L	15	0.02	8	A	3	15	0.02	9	A	3	20	0.02	9	A	3
SB L/R	40	0.13	13	B	13	40	0.10	15	B	8	25	0.07	15	B	5

Table 12 Unsignalized Intersection Capacity Analysis (continued)

Location / Movement	2021 Existing Condition					2028 No-Build Conditions					2028 Build Conditions				
	D [a]	v/c [b]	Del [c]	LOS [d]	95 Q [e]	D	v/c	Del	LOS	95 Q	D	v/c	Del	LOS	95 Q
15: Washington Street at Cross Street															
Weekday Morning															
EB L	5	0.01	8	A	0	5	0.01	9	A	0	5	0.01	9	A	0
SB L/R	30	0.09	14	B	8	55	0.16	16	C	15	55	0.18	18	C	15
Weekday Evening															
EB L	20	0.02	9	A	3	20	0.02	9	A	3	20	0.02	9	A	3
SB L/R	25	0.06	14	B	5	80	0.27	20	C	28	80	0.28	21	C	28
Saturday Midday															
EB L	10	0.01	9	A	0	10	0.01	9	A	0	10	0.01	9	A	0
SB L/R	25	0.05	12	B	5	115	0.33	19	C	35	115	0.34	19	C	35
18: Watertown Street at Eden Avenue															
Weekday Morning															
EB L	10	0.01	8	A	0	10	0.01	8	A	0	10	0.01	8	A	0
SB L/R	15	0.05	14	B	3	15	0.04	14	B	3	15	0.04	15	B	3
Weekday Evening															
EB L	10	0.01	8	A	0	10	0.01	8	A	0	10	0.01	8	A	0
SB L/R	15	0.04	14	B	3	15	0.04	15	B	3	15	0.04	15	C	3
Saturday *Midday*															
EB L	2	0.00	9	A	0	2	0.00	9	A	0	2	0.00	9	A	0
SB L/R	6	0.02	14	B	3	6	0.02	14	B	3	6	0.02	14	B	3
19: Watertown Street at Davis Court															
Weekday Morning															
WB L	1	0.00	8	A	0	1	0.00	8	A	0	1	0.00	8	A	0
NB L/R	10	0.04	12	B	3	10	0.02	13	B	3	10	0.02	13	B	3
Weekday Evening															
WB L	5	0.01	8	A	0	5	0.01	8	A	0	5	0.01	8	A	0
NB L/R	7	0.03	12	B	3	7	0.02	12	B	0	7	0.02	12	B	0
Saturday Midday															
WB L	5	0.01	8	A	0	5	0.00	8	A	0	5	0.00	8	A	0
NB L/R	6	0.02	10	B	3	6	0.01	11	B	0	6	0.01	11	B	0
20: Watertown Street at Davis Avenue															
Weekday Morning															
EB L	1	0.00	8	A	0	1	0.00	8	A	0	1	0.00	8	A	0
SB L/R	40	0.10	14	B	8	40	0.11	15	B	10	40	0.11	15	C	10
Weekday Evening															
EB L	5	0.01	8	A	0	5	0.01	8	A	0	5	0.01	8	A	0
SB L/R	15	0.05	14	B	3	15	0.04	15	B	3	15	0.04	15	C	3
Saturday Midday															
EB L	1	0.00	8	A	0	1	0.00	8	A	0	1	0.00	8	A	0
SB L/R	15	0.05	14	B	5	15	0.04	13	B	3	15	0.04	13	B	3
21: Watertown Street at Dunstan Street															
Weekday Morning															
WB L	25	0.02	8	A	3	25	0.02	8	A	3	35	0.03	8	A	3
NB L/R	35	0.09	12	B	8	35	0.08	13	B	5	60	0.15	15	B	13
Weekday Evening															
WB L	20	0.02	8	A	3	20	0.02	8	A	3	30	0.03	8	A	3
NB L/R	45	0.10	13	B	8	45	0.11	14	B	8	55	0.14	14	B	13
Saturday Midday															
WB L	15	0.02	8	A	3	15	0.01	8	A	0	20	0.02	8	A	3
NB L/R	20	0.05	13	B	3	20	0.05	13	B	3	35	0.08	14	B	8

Table 12 Unsignalized Intersection Capacity Analysis (continued)

Location / Movement	2021 Existing Condition					2028 No-Build Conditions					2028 Build Conditions				
	D [a]	v/c [b]	Del [c]	LOS [d]	95 Q [e]	D	v/c	Del	LOS	95 Q	D	v/c	Del	LOS	95 Q
22: Watertown Street at Adella Avenue (west)															
Weekday Morning															
EB L	10	0.01	8	A	0	10	0.01	8	A	0	10	0.01	8	A	0
SB L/R	50	0.20	16	C	20	50	0.14	16	C	13	50	0.14	16	C	13
Weekday Evening															
EB L	10	0.01	8	A	0	10	0.01	8	A	0	10	0.01	8	A	0
SB L/R	30	0.10	16	C	8	30	0.09	16	C	8	30	0.09	16	C	8
Saturday *Midday*															
EB L	5	0.01	8	A	0	5	0.01	8	A	0	5	0.01	8	A	0
SB L/R	15	0.04	14	B	3	15	0.04	14	B	3	15	0.04	14	B	3
23: Watertown Street at Adella Avenue (east) and Cross Street															
Weekday Morning															
EB L	5	0.01	8	A	0	5	0.01	8	A	0	5	0.01	8	A	0
WB L	15	0.01	8	A	0	15	0.02	8	A	0	15	0.02	8	A	0
NB L/T/R	17	0.08	16	C	8	17	0.06	17	C	5	17	0.06	18	C	5
SB L/T/R	17	0.06	17	C	5	17	0.06	18	C	5	17	0.07	19	C	5
Weekday Evening															
EB L	2	0.00	8	A	0	2	0.00	8	A	0	2	0.00	8	A	0
WB L	10	0.01	8	A	0	10	0.01	8	A	0	10	0.01	8	A	0
NB L/T/R	21	0.06	13	B	5	21	0.05	14	B	5	21	0.05	14	B	5
SB L/T/R	8	0.04	18	C	3	8	0.03	20	C	3	8	0.03	20	C	3
Saturday Midday															
EB L	1	0.00	8	A	0	1	0.00	8	A	0	1	0.00	8	A	0
WB L	5	0.01	8	A	0	5	0.01	8	A	0	5	0.01	8	A	0
NB L/T/R	22	0.08	15	B	8	22	0.06	14	B	5	22	0.06	14	B	5
SB L/T/R	8	0.02	15	C	3	8	0.02	15	B	3	8	0.02	15	C	3
26: Webster Street at Elm Street															
Weekday Morning															
EB L/T/R	375	0.85	37	E	218	400	0.81	33	D	198	405	0.83	35	D	208
WB L/T/R	240	0.53	19	C	78	255	0.57	20	C	88	260	0.59	21	C	93
NB L/T/R	180	0.45	17	C	58	195	0.45	17	C	58	195	0.46	17	C	58
SB L/T/R	340	0.88	42	E	238	350	0.75	28	D	160	350	0.75	29	D	163
Weekday Evening															
EB L/T/R	265	0.51	16	C	73	280	0.53	16	C	78	285	0.54	16	C	80
WB L/T/R	245	0.44	15	B	58	255	0.49	16	C	68	255	0.49	16	C	68
NB L/T/R	335	0.60	18	C	100	355	0.65	20	C	118	355	0.65	20	C	120
SB L/T/R	165	0.41	14	B	50	170	0.34	13	B	38	170	0.34	13	B	38
Saturday Midday															
EB L/T/R	200	0.33	11	B	35	225	0.36	11	B	40	230	0.37	12	B	43
WB L/T/R	155	0.25	10	B	25	170	0.28	11	B	30	175	0.29	11	B	30
NB L/T/R	205	0.32	11	B	35	225	0.36	11	B	43	225	0.37	11	B	43
SB L/T/R	145	0.28	10	B	28	155	0.26	10	B	25	155	0.26	11	B	25

Table 12 Unsignalized Intersection Capacity Analysis (continued)

Location / Movement	2021 Existing Condition					2028 No-Build Conditions					2028 Build Conditions				
	D [a]	v/c [b]	Del [c]	LOS [d]	95 Q [e]	D	v/c	Del	LOS	95 Q	D	v/c	Del	LOS	95 Q
28: Waltham Street at Webster Street															
Weekday Morning															
EB L/R	220	0.59	23	C	93	235	0.55	22	C	83	235	0.55	22	C	83
NB L	50	0.05	8	A	5	50	0.05	8	A	3	50	0.05	8	A	3
Weekday Evening															
EB L/R	245	0.51	19	C	70	260	0.57	22	C	88	260	0.57	22	C	88
NB L	70	0.06	8	A	5	70	0.06	8	A	5	70	0.06	8	A	5
Saturday Midday															
EB L/R	185	0.39	17	C	48	195	0.40	16	C	48	195	0.40	16	C	48
NB L	25	0.03	8	A	3	25	0.02	8	A	3	25	0.02	8	A	3
29: Waltham Street at River Street and Driveway															
Weekday Morning															
EB L/T/R	215	0.87	71	F	180	225	0.99	99	F	238	220	0.98	95	F	228
WB L/T/R	0	0.00	0	A	0	0	0.00	0	A	0	0	0.00	0	A	0
NB L	70	0.08	9	A	8	135	0.14	9	A	13	80	0.09	9	A	8
SB L	0	0.00	0	A	0	1	0.00	8	A	0	0	0.00	0	A	0
Weekday Evening															
EB L/T/R	220	1.03	105	F	268	220	0.97	92	F	225	225	0.99	99	F	238
WB L/T/R	0	0.00	0	A	0	0	0.00	0	A	0	0	0.00	0	A	0
NB L	120	0.12	9	A	10	135	0.14	9	A	13	135	0.14	9	A	13
SB L	1	0.00	8	A	0	1	0.00	8	A	0	1	0.00	8	A	0
Saturday Midday															
EB L/T/R	135	0.46	26	D	58	140	0.47	25	D	60	140	0.47	25	D	60
WB L/T/R	0	0.00	0	A	0	0	0.00	0	A	0	0	0.00	0	A	0
NB L	75	0.09	9	A	8	95	0.09	9	A	8	95	0.09	9	A	8
SB L	0	0.00	0	A	0	0	0.00	0	A	0	0	0.00	0	A	0
30: Chestnut Street at Austin Street															
Weekday Morning															
WB L/R	105	0.37	22	C	40	105	0.37	23	C	40	110	0.40	25	C	45
SB L	55	0.05	9	A	5	55	0.06	9	A	5	60	0.06	9	A	5
Weekday Evening															
WB L/R	180	0.68	40	E	115	185	0.74	48	E	133	185	0.75	50	E	135
SB L	75	0.07	8	A	5	80	0.08	8	`A	5	80	0.08	8	A	5
Saturday *Midday*															
WB L/R	70	0.13	11	B	10	70	0.11	11	B	10	70	0.11	11	B	10
SB L	30	0.03	8	A	3	30	0.03	8	A	3	30	0.03	8	A	3
31: Dunstan Street at Brook Drive															
Weekday Morning															
WB L/R											5	0.01	9	A	0
SB L											5	0.01	7	A	0
Weekday Evening															
WB L/R	*Intersection does not exist under 2021 Existing Conditions*					*Intersection does not exist under 2028 No-Build Conditions*					5	0.01	9	A	0
SB L											5	0.01	7	A	0
Saturday *Midday*															
WB L/R											5	0.01	9	A	0
SB L											5	0.01	7	A	0

a Demand.
b Volume to capacity ratio.
c Average total delay, in seconds per vehicle.
d Level-of-service.
e 95th percentile queue, in feet.

~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.

As shown in Table 12, the Project is expected to have minimal impacts at the majority of the unsignalized study area intersections. However, the Project is expected to have a noticeable impact at several of the unsignalized study area intersections. The following intersection movements are expected to see a degrade in LOS between the 2028 No Build Conditions and the 2028 Build Conditions during the weekday morning, weekday evening, and Saturday midday peak periods:

Washington Street at Dunstan Street:

- Dunstan Street SB approach: From LOS B to LOS C (AM and PM).

Washington Street at Kempton Place:

- Kempton Place SB approach: From LOS B to LOS C (AM)

Watertown Street at Eden Avenue

- Eden Avenue SB approach: From LOS B to LOS C (PM)

Watertown Street at Davis Avenue:

- Davis Avenue SB approach: From LOS B to LOS C (AM and PM)

Watertown Street at Adella Avenue (east) and Cross Street

- Cross Street NB approach: From LOS B to LOS C (SAT)

All of the remaining intersection movements are expected to maintain LOS between the 2028 No Build and 2028 Build Conditions.

As shown in the list above, the additional Site-generated traffic will have the most significant impact to the unsignalized intersections along Washington Street and Watertown Street near the Site. Operations at nearly all other minor street approaches are expected to experience a negligible impact to operations between the 2028 No Build and 2028 Build Conditions.

Washington Street Vision Plan Analyses

As stated previously, the Washington Street Vision Plan outlines a vision for the corridor that reduces the cross section of the roadway from two-lanes in each direction to one-lane in each direction. While the City of Newton does not have any specific plans to reconstruct Washington Street in the immediate future, analyses have been conducted at the unsignalized intersections along Washington Street to understand the impact of reducing the cross-section on left-turns and minor street operations. A summary of the analyses and the capacity analysis worksheets are included in the Appendix.

Sight Distance

Sight distance analysis, in conformance with the guidelines of the American Association of State Highway and Transportation Officials (AASHTO)[10] was performed for the site access intersections of Washington Street at Dunstan Street, Washington Street at Kempton Place, and Watertown Street at Dunstan Street. Speed observations that were recorded by the ATRs were used to calculate the required stopping sight distance (SSD) for traffic approaching these intersections from Washington Street and Watertown Street and intersection sight distance (ISD) for traffic exiting from Dunstan Street and Kempton Place.

SSD is the distance required for a vehicle approaching an intersection from either direction to perceive, react, and come to a complete stop before colliding with an object in the road, in this case a vehicle exiting from Dunstan Street or Kempton Place. In this respect, SSD can be considered as the minimum visibility criterion for the safe operation of an unsignalized intersection.

ISD is based on the time required for perception, reaction, and completion of the desired critical exiting maneuver (typically, a left turn) once the driver on a minor street approach decides to execute the maneuver. Calculation for the critical ISD includes the time to (1) turn left, and to clear the near half of the intersection without conflicting with the vehicles approaching from the left; and (2) upon turning left, to accelerate to the operating speed on the roadway without causing approaching vehicles on the main road to unduly reduce their speed. In this context, ISD can be considered as a desirable visibility criterion for the safe operation of an unsignalized intersection. Table 13 summarizes the sight distance analysis.

As shown in Table 13, the required SSD is exceeded in both directions at all three intersections. The desirable ISD is also met at all three intersections. It is recommended that vegetation be kept clear near these intersections and that parked cars be restricted within 25 feet of these intersections to provide clear sightlines.

Table 13 Sight Distance Summary

	Stopping Sight Distance (feet)			Intersection Sight Distance (feet)		
Location	**Traveling**	**Required [a]**	**Measured [b]**	**Looking**	**Desirable [a]**	**Measured [b]**
Washington Street at Dunstan Street	EB	290	>500	Left	440	>500
	WB	280	>500	Right	440	>500
Washington Street	EB	290	>500	Left	440	450

[10] A Policy on the Geometric Design of Highways and Streets, American Association of State Highway and Transportation Officials, 2013

at Kempton Place	WB	280	>500	Right	440	>500
Watertown Street at Dunstan Street	EB	240	>500	Left	375	>500
	WB	240	>500	Right	375	450

a. Based on standards established in A Policy on the Geometric Design of Highways and Streets, American Association of State Highway and Transportation Officials, 2013.
b. Based on field measurements taken by VHB.

Signal Warrant Analysis

A traffic signal warrant analysis was conducted to determine if the traffic volumes utilizing the intersections of Washington Street at Dunstan Street and Washington Street at Kempton Place would exceed the thresholds for the installation of a traffic signal.

The methodology used to determine if traffic signal controls are warranted is based on the criteria set in the Manual on Uniform Traffic Control Devices (MUTCD)[11]. There are nine warrants defined in the MUTCD. The MUTCD is the established standard for Warrant analyses. The Warrants consider the roadway geometry, traffic volume entering the intersection, and speeds. Specifically, the traffic volumes were evaluated for following three volume-based Warrants.

- **Warrant 1 (Eight Hour Vehicular Volume)** – Warrant 1 is based on any eight hours of a day where the traffic entering the intersection reaches a threshold that warrants considering signal control.
- **Warrant 2 (Four Hour Vehicular Volume)** – Warrant 2 is for any four hours of a day
- **Warrant 3 (Peak Hour)** – Warrant 3 is for the peak hour of any given day.

To run the signal warrant analysis, the eight-hour vehicular volume warrant was analyzed for the peak hours of the day using the anticipated weekday morning and evening peak hours. The eight-hour vehicular volume was not met for the weekday morning or evening peak hours at either intersection, so it was assumed that this warrant would also not be met for any other hours during the day. Furthermore, because there are higher volume thresholds for the four-hour and peak hour warrants, it was assumed that these warrants would also not be met.

Table 14 presents the results of the three most commonly utilized warrants analysis completed for these two intersections. The traffic warrants analysis worksheets are located in the appendix.

[11] Manual on Uniform Traffic Control Devices; Part 4 – Highway Traffic Signals; U.S. Department of Transportation/Federal Highway Administration; 2009 Edition.

Table 14 Traffic Signal Warrant Analysis Summary

	Warrant Met?		
	Warrant 1: Eight Hour	**Warrant 2: Four Hour**	**Warrant 3: Peak Hour**
Washington Street at Dunstan Street	No	No	No
Washington Street at Kempton Place	No	No	No

There are six other warrants that this intersection likely does not meet. These are:

- Warrant 4 – Pedestrian Volume: Pedestrian volumes would need to exceed 107 persons per hour for four hours or 133 persons per hour for one hour to meet criteria for this warrant
- Warrant 5 – School Crossing: This warrant is not applicable to the project area.
- Warrant 6 – Coordinated Signal System: This warrant is not applicable to the project area.
- Warrant 7 – Crash Experience: Five or more crashes correctable by traffic control would have needed to occur within a 12-month period.
- Warrant 8 – Roadway Network: This warrant is not applicable to the project area.
- Warrant 9 – Intersection Near a Grade Crossing: There is no active at-grade rail crossing of the project area roadways.

5

Proposed Mitigation and Site Access

The preceding study has outlined the general impacts of the proposed Project on the study area roadways as they currently exist. In general, the Project will have a minor impact at the majority of study area intersections on the operations and safety of the roadway network. However, with the current roadway configuration, the proposed Project is expected to have impacts on some study intersections that are expected to drop a letter grade in LOS.

This chapter outlines the proposed infrastructure improvements and the proposed site access and circulation based on development plan. Capacity analyses for the Build with Mitigation condition have been analyzed and are summarized within. In addition, this chapter summarizes the proposed transportation demand management plan for the Project.

Proposed Signal Timing Mitigation

The proposed Project is expected to have impacts on some of the study area intersections. These signalized intersections are expected to drop a letter grade during the peak hour from future no-build to build conditions to LOS E or F. Therefore, the Proponent is proposing timing adjustments (optimization) at these intersections to maintain the no-build LOS.

Washington Street at Prospect Street

The eastbound approach from Washington Street at this intersection is expected to drop from LOS D under no-build conditions to LOS E under build conditions during the weekday evening peak hour. Therefore, signal timing modifications are proposed to improve the operation of this movement to LOS D.

Washington Street at I-90 Eastbound On-Ramp

This intersection is expected to drop from overall LOS E under no-build conditions to LOS F under build conditions during the weekday evening peak hour. Therefore, signal timing modifications are proposed to improve the overall operation of this intersection to LOS E.

Washington Street at Elm Street

The Washington Street westbound approach at this intersection is expected to drop from LOS E under no-build conditions to LOS F under build conditions during the weekday morning peak hour. Therefore, signal timing modifications are proposed to improve the operation of this movement to LOS E.

Washington Street at Lowell Avenue

The Lowell Avenue southbound approach at this intersection is expected to drop from LOS E under no-build conditions to LOS F under build conditions during the weekday evening peak hour. Therefore, signal timing modifications are proposed to improve the operation of this movement to LOS E.

Washington Street at Walnut Street

This intersection is expected to drop in overall LOS from D under no-build conditions to E under build conditions during the weekday morning peak hour. While signal timing modifications would improve the overall LOS of this intersection, it should be noted that signal and roadway improvements are already proposed at this intersection under the Washington Place project.

Washington Street at Albermarle Street Southbound

The Washington Street eastbound approach at this intersection is expected to drop from LOS E under no-build conditions to LOS F under build conditions during the weekday evening peak hour. Therefore, signal timing modifications are proposed to improve the operation of this movement to LOS E.

Washington Street at Albermarle Street Northbound

The overall LOS at this intersection is expected to drop from D under no-build conditions to E under build conditions during the weekday morning peak hour. Therefore, signal

timing modifications are proposed to improve the overall LOS of this intersection from E to D.

Pedestrian and Bicycle Facilities

In addition to the improvements described above, the proposed roadway mitigation includes several improvements for pedestrians and bicycles. As previously mentioned, there are other projects in the study area that propose improvements to pedestrian and bicycle facilities. The West Newton Square project proposes roadway, sidewalk, and streetscape improvements along Washington Street between I-90 and Chestnut Street. The Washington Place project proposes curb extensions and bike lanes at the intersection of Washington Street at Walnut Street.

As part of this project, the proponent proposes to reconstruct the sidewalk along the site frontage consistent with the Washington Street Vision Plan. It is also recommended that the sidewalk improvements at the intersections of Washington Street at Kempton Place and Washington Street at Dunstan Street not preclude the installation of future signal equipment at these intersections.

Additional pedestrian and bicycle accommodations within the Site are described later in this chapter under the Site Access Plan section.

Traffic Operations Analysis with Mitigation

Based on the signal timing improvements described above, updated capacity analyses have been conducted for the 2028 Build with Mitigation Conditions to evaluate the signal timing improvements. The 2028 Build Conditions traffic volumes were used for this assessment.

Intersection Capacity Analyses with Mitigation

Intersection capacity analyses were conducted with respect to the 2028 Build with Mitigation Conditions at the signalized intersections with proposed timing modifications. The signalized and unsignalized intersections were analyzed with Synchro software.

Table 14 presents the signalized capacity analyses, and the capacity worksheets are included in the Appendix.

Table 14 Signalized Intersection Capacity Analysis with Mitigation

Location / Movement	2028 No-Build Conditions					2028 Build Conditions					2028 Build Conditions w/ Mitigation				
	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
2: Washington Street at Prospect Street															
Weekday Evening															
EB L/T/R	0.90	52	D	53	m#662	0.92	64	E	59	m#662	0.92	43	D	242	m#663
WB L/T/R	>1.20	>120	F	~748	#847	>1.20	>120	F	~770	#868	>1.20	>120	F	~761	#840
NB L/T/R	0.29	22	C	6	36	0.29	22	C	6	36	0.29	22	C	6	36
SB L/T/R	0.09	35	D	6	23	0.09	35	D	6	23	0.09	35	D	6	23
Total		**>120**	**F**				**>120**	**F**				**>120**	**F**		
4: Washington Street at I-90 EB On-Ramp															
Weekday Evening															
EB T	>1.20	>120	F	~338	m#318	>1.20	>120	F	~351	m#315	1.19	114	F	~338	m#301
EB BR	0.74	27	C	52	m77	0.78	48	D	63	m89	0.77	47	D	56	m77
SB T	0.12	6	A	27	37	0.13	6	A	26	42	0.13	6	A	32	42
Total		**69**	**E**				**83**	**F**				**71**	**E**		
7: Washington Street at Elm Street															
Weekday Morning															
WB T/R	0.81	56	E	231	m#513	0.86	84	F	232	m#514	0.80	74	E	231	m#477
NB L/T	0.62	25	C	65	154	0.62	25	C	65	154	0.69	29	C	67	159
NB R	0.76	70	E	112	#740	0.78	71	E	119	#875	0.78	71	E	119	#875
SB R	0.69	8	A	0	69	0.68	7	A	0	69	0.71	9	A	3	108
Total		**47**	**D**				**58**	**E**				**55**	**D**		
16: Washington Street at Lowell Avenue															
Weekday Evening															
EB L/T/R	0.66	25	C	227	296	0.67	25	C	233	304	0.72	29	C	247	322
WB L/T/R	>1.20	26	C	118	m103	>1.20	27	C	124	m104	1.14	35	C	140	m118
NB L	0.55	32	C	68	#130	0.61	36	D	73	#155	0.54	29	C	70	#127
NB T/R	0.49	25	C	163	256	0.54	27	C	188	290	0.50	24	C	178	274
SB L/T/R	0.94	71	E	~325	#517	1.02	90	F	~362	#558	0.90	60	E	~323	#519
Total		**34**	**C**				**38**	**D**				**35**	**C**		
17: Washington Street at Walnut Street															
Weekday Morning															
EB L/T/R	0.63	26	C	173	m246	0.65	27	C	183	m257	0.70	38	D	234	m306
WB L/T/R	0.73	33	C	170	#263	0.75	34	C	180	#281	0.83	41	D	191	#308
NB L	0.62	50	D	46	#106	0.65	52	D	49	#111	0.51	37	D	47	89
NB T	0.90	60	E	273	#456	0.92	63	E	273	#456	0.82	48	D	261	#419
NB R	0.45	7	A	1	64	0.46	7	A	1	64	0.43	6	A	0	59
SB L	0.69	82	F	38	#114	0.90	>120	F	38	#118	0.52	59	E	36	#106
SB T/R	1.20	>120	F	~326	#508	>1.20	>120	F	~326	#508	1.20	>120	F	~321	#534
Total		**51**	**D**				**65**	**E**				**54**	**D**		

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.

~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal

Table 14 Signalized Intersection Capacity Analysis with Mitigation (continued)

Location / Movement	2028 No-Build Conditions					2028 Build Conditions					2028 Build Conditions w/ Mitigation				
	v/c [a]	Del [b]	LOS [c]	50 Q [d]	95 Q [e]	v/c	Del	LOS	50 Q	95 Q	v/c	Del	LOS	50 Q	95 Q
24a: Watertown Street at Albemarle Street SB															
Weekday Morning															
EB T/R	0.74	71	E	349	#534	0.75	85	F	359	#550	0.73	65	E	353	#538
WB L/T	0.36	2	A	5	7	0.37	2	A	5	7	0.36	2	A	5	7
SB L/T/R	0.64	60	E	116	#215	0.64	60	E	116	#215	0.68	69	E	117	#226
Total		**45**	**D**				**52**	**D**				**43**	**D**		
24b: Watertown Street at Albemarle Street NB															
Weekday Evening															
EB L/T	1.09	74	E	186	#796	1.10	81	F	188	#806	1.07	70	E	185	#791
WB T/R	0.73	33	C	209	#577	0.74	33	C	212	#585	0.73	32	C	206	#575
NB L	0.02	43	D	2	15	0.02	43	D	2	15	0.02	44	D	2	15
NB T/R	0.21	44	D	20	65	0.21	44	D	20	65	0.22	45	D	20	66
Total		**54**	**D**				**58**	**E**				**52**	**D**		

a Volume to capacity ratio.
b Average total delay, in seconds per vehicle.
c Level-of-service.
d 50th percentile queue, in feet.
e 95th percentile queue, in feet.

~ Volume exceeds capacity, queue is theoretically infinite.
# 95th percentile volume exceeds capacity, queue may be longer.
m Volume for 95th percentile queue is metered by upstream signal

As shown in Table 14, the proposed timing improvements are expected to improve the operations of the signalized intersections. In general, the proposed mitigation is expected to significantly improve operations in the study area as compared to the 2028 Build Conditions without mitigation.

Site Access and Circulation

In addition to the off-Site traffic operations analysis, a review of the proposed Site access plan also was conducted as part of this evaluation as described in the following sections. Figure 15 illustrates the overall Site plan.

Proposed Site Access

Under proposed conditions, access into an out of the Site will be provided via four access driveways to the parking garages below the proposed buildings. The parking garage located between Dunstan Street and Kempton Place will have one driveway on Kempton Place and one driveway on Brook Drive, which connects Dunstan Street and Kempton Place north of the parking garage. The parking garage located east of Kempton Place will have one access driveway on Kempton Place. These site driveways will all be unsignalized.

Connections to the regional roadway network will be the same as today, with Kempton Place intersecting Washington Street in the south at an unsignalized intersection and Dunstan Street intersecting Washington Street in the south and Watertown Street in the north at two unsignalized intersections. While Kempton Place currently dead ends at The Barn Family Shoe Store, under proposed conditions Kempton Place will be connected to

Dunstan Street with a new roadway connection known as Brook Drive. This will allow for multiple entry/exit points for the Site driveways that connect directly to Kempton Place.

Based on the analysis, under future build conditions the queues exiting from Dunstan Street and Kempton Place onto Washington Street and the queues exiting from Dunstan Street onto Watertown Street are expected to be less than 25 feet, or one car length. Therefore, it is expected that there will be no significant queuing at the site driveway intersections with Dunstan Street or Kempton Place.

Curbside and Service / Loading Activity

Curbside activity will be regulated throughout and adjacent to the Site. Under existing conditions, on-street parking is allowed along Washington Street adjacent to the Site. Under proposed conditions, curbside regulations will be the same as existing conditions along Washington Street with on-street parking allowed. Internal to the Site, loading areas will be designated along Kempton Place and Dunstan Street.

Service and loading locations will be provided for retail establishments either through loading docks or through designated on-street parking locations for service and loading vehicles.

The exact number and timing of deliveries will vary depending on the nature of the various retail establishments, in addition to standard residential delivery activity. Most retail activity typically occurs during morning hours so as not to interfere with the operation of the business. Due to the smaller sizes of the retail uses, most deliveries likely will be made by smaller, single-unit trucks. Smaller single-unit trucks can more easily be accommodated and would typically be on Site for a short period of time.

Figure 15
Proposed Conditions

TNC Operations

Ridesharing services, such as Uber and Lyft, have become a regular mode of transportation in the past decade. With the rise in TNC operations in the region, curbside operations have become more frequent with TNC drivers picking up and dropping off passengers at any convenient location. To accommodate TNCs, the Proponent will work with the City on determining specific TNC pick-up and drop-off locations on Site. The Proponent will consider a geofence or similar limit/control such activities if appropriate.

Site Parking

As stated previously, the Project will be supported by 286 parking spaces on-Site. Unmetered on-street parking is also available along both sides of Washington Street in the vicinity of the site.

Transportation Demand Management

In addition to the proposed roadway mitigation described previously, the Proponent is committed to providing a variety of Transportation Demand Management (TDM) measures. The goal of a Transportation Demand Management (TDM) plan is to reduce the Project's overall traffic impact through the implementation of measures that are aimed at affecting the demand side of the transportation equation, rather than the supply side. By their nature, TDM programs are intended to change people's behavior, and to be successful, they must rely on incentives or disincentives to make these shifts in behavior attractive to the commuter or retail customer.[12] TDM programs are designed to maximize the people-moving capability of the existing transportation infrastructure by increasing the number of persons in a vehicle, providing and/or encouraging the use of alternate modes of travel, or influencing the time of, or need to, travel.

TDM measures are most often directed at commuter travel and implemented at office sites. However, due to the mixed-use and transit-orientated nature of the Proposed Project, there are opportunities to bring TDM programs to the Proposed Project's other land uses, including the retail shops and residential units.

[12] Implementing Effective Travel Demand Management Measures: Inventory of Measures and Synthesis of Experience, prepared by Comsis Corporation and the Institute of Transportation Engineers, for the U.S. Department of Transportation, DOT-T-94-02, September 1993, p. I-1.

General TDM Measures

Transportation Coordinator

In conjunction with the development, an overall on-site TDM coordinator will be designated to oversee all TDM programs for each building of the Proposed Project, and the Project Site in its entirety. The person(s) in this role will coordinate with organizations within the area to help promote a reduced reliance on single-occupant motor-vehicle travel to the Project Site. To that end, the TDM measures identified in the following sections will be implemented under the direction and supervision of this person.

The final job description for this role will be determined over time, but the duties of the on-site TDM coordinator may include, but not be limited to:

- Acting as a liaison with site employers and MassRIDES.
- Assisting site residents with ride matching and transportation planning.
- Developing and implementing appropriate TDM measures.
- Disseminating information on alternate modes of transportation and developing transportation related marketing and education materials, including a website.
- Developing and maintaining information pertaining to pedestrian and cycling access to and from the Project Site.
- Hosting occasional transportation-related events to promote the use of commuting alternatives.
- Distributing transit maps and passes.
- Advocating with the state and local governments to improve transportation infrastructure and services.
- Monitoring the effectiveness of TDM measures through surveys and other tools and adjusting them as needed.
- Completing regulatory reports to state and city agencies, as required.
- Implementing a website providing travel-related information and promoting awareness of the items listed above.

Promote Transit Use

Access to public transportation will reduce demand for vehicular travel and parking spaces. With the existing West Newton MBTA Commuter Rail Station and MBTA bus stops located near the Site it is expected that the Development will be attractive to residents or retail employees wishing to commute via public transportation, but additional measures can still be implemented to further encourage public transit use. The on-Site TDM coordinator will provide a central commuter information center within the Project Site in a prominent location such as in a building foyer, or near garage elevators. This will provide employees, visitors, and residents with transit maps and schedules and route information for pedestrians and cyclists. One or two smaller centers also may be provided at central locations within the overall development. This also could include the residential lobby among other possible locations that would be identified by the on-site TDM coordinator in consultation with the City of Newton planning staff.

Facilitate Bicycle and Pedestrian Travel

Travel to the Project Site by cycling or walking will be promoted by the Proponent through the provision of improved bicycle and pedestrian connections within the Project Site. Walking to and from, and throughout the Project Site will be encouraged by the provision of a pedestrian-friendly site layout, which features sidewalks and crosswalks at key points both within the Site and connecting to adjacent developments. Pedestrian shortcuts, such as connections between and around buildings, will be constructed and walking areas will be clean, attractive, and interesting to encourage walking. Street furniture, such as benches, trash cans, and street lights, will be provided throughout the area as well. Facility designs will accommodate special needs, including people using wheelchairs, walkers, strollers, and hand carts.

In addition to secured, covered bike storage within each building, bicycle racks also will be provided at locations near various buildings within the overall development. The Proponent will also work with the City of Newton with providing a bike-sharing service on Site, either through the dock-less Limebike system that the City is currently using or through any new bike sharing system that the City is participating in when the Project comes online.

The design of the development and the proposed roadway network within the Site will also encourage walking between uses on Site as opposed to driving. Shared parking uses will encourage visitors to park once on-Site and walk between different uses.

Retail

The Proponent will seek to attract a variety of retail shops and service tenants as ground-floor supporting uses. These shops will potentially include restaurants, apparel, furnishings, general merchandise, and service uses like banks and office supplies. As most of these businesses will be small shops, there will not be the same levels of TDM opportunities internal to each individual business as will be available with larger employers, but employees who work on the Project Site will be able to take advantage of the transportation guidance and programs coordinated by the transportation coordinator.

The suite of TDM measures to be implemented in association with the retail shops are fewer than for traditional offices but will still have an impact in reducing single-occupant vehicle travel. The retail TDM program may include the following:

- Improved site amenities, like cycling facilities and pedestrian crossings which enhance the ability of employees to walk or cycle to work.
- Ride matching services and transit information provided by the on-site TDM coordinator or MassRIDES.
- Hold promotional events for cyclists, pedestrians, and transit-riders.
- Offer direct deposit to employees.
- Bike share.
- Electric car charging stations.

- Preferential electric car/low emission car parking within the parking areas by designating spaces near building entrances within the parking areas as a convenience to commuters and customers and to promote environmentally-friendly transportation.
- Shared parking for all uses, encouraging customers to park once and walk between all destinations on-Site.

Residential

In addition to providing a pedestrian friendly environment, the Proponent will enact a variety of additional strategies to reduce the need for auto trips by residents. This will include working with a car-sharing service (such as Zipcar) to provide cars for periodic use by residents. Additional residential-based TDM measures may include the following programs:

- Disseminating information on alternate modes of transportation and developing transportation.
- Provide incentives for bicycle and pedestrian commutes, like covered bicycle storage to be available to all residents.
- Bike storage with fix-it station.
- Hold promotional events for transit-riders, cyclists, and pedestrians.
- Preferential electric car/low emission car parking within the parking garages by designating spaces and providing electric vehicle charging stations within the parking garages as a convenience to residents and to promote environmentally-friendly transportation.
- "Unbundling" of parking costs from rent/leases so that residents with vehicles will pay more to allow access to the parking garage.
- Financial incentives for alternative transportation modes, such as discounted MBTA passes.
- Electric car charging stations.

Consistency with the Washington Street Vision Plan

As mentioned previously, the City of Newton is currently preparing the Washington Street Vision Plan to act as a guideline for future development along the Washington Street corridor. The plan identifies a specific vision for the corridor and focuses on creating lively village centers, making Washington Street safe for everyone, creating diverse housing options, developing places for Newton residents to connect with their community, being sensitive to climate and environmental necessities, and incorporating excellence in placemaking principles.

Specifically, the Washington Street Vision Plan focuses on converting the Washington Street corridor into a dense, walkable neighborhood and transforming the roadway from a high-speed throughway into a local neighborhood street. The Vision Plan proposed to reduce the cross-section on Washington Street from four-lanes to two-lanes and provide

enhanced pedestrian and bicycle accommodations along the corridor. In addition, the Vision Plan encourages the development of dense, multi-family housing units near commuter rail stations along the corridor.

The proposed Project has been designed to follow the vision plan very closely and become an exemplary project in the area that relies on more alternative means of transportation improvements than the traditional capacity-adding infrastructure improvements.

6

Conclusion

VHB has prepared a detailed Transportation Impact and Access Study for the proposed Dunstan Residences Redevelopment project, which is comprised of three mixed use buildings ranging from three to six stories on two blocks in West Newton. The Project is located on an approximately three-acre site adjacent to Dunstan Street, Kempton Place and Washington Street. The Site currently contains various existing residential, retail, auto service, and office buildings. Under proposed conditions, the site will be redeveloped and will consist approximately 302 apartment units and approximately 5,821 sf of retail space. The Project will be supported by approximately 326 parking spaces.

To support the additional Site-generated traffic, the Proponent is proposing timing modifications at the following intersections:

- Washington Street at Prospect Street
- Washington Street at I-90 Eastbound On-Ramp
- Washington Street at Elm Street
- Washington Street at Lowell Avenue
- Watertown Street at Albemarle Street NB
- Watertown Street at Albemarle Street SB

The Site has been designed to accommodate Project-generated vehicular traffic, as well as pedestrians, bicyclists, and transit riders. In summary, the Project will provide the following overall transportation-related benefits:

- The sidewalk along the site frontage will be reconstructed consistent with the Washington Street Vision Plan. The sidewalk improvements at the intersections of Washington Street at Kempton Place and Washington Street at Dunstan Street should not preclude the installation of future signal equipment installation.
- Installation of a Rapid Reflectorized Flashing Beacon (RRFB)/crosswalk along Washington Street to the east of the site.
- Installation of a Crosswalk along Watertown Street to the east of Dunstan Street

Overall, the additional new traffic generated by the Proposed Project can be accommodated with some signal timing modifications to the surrounding study area intersections and minimal impacts are expected beyond the Site from this proposed development.