T O W N o f B R O O K L I N E
Massachusetts
Department of Public Works

Erin Chute Gallentine
Commissioner

MEMORANDUM

TO: Transportation Board

FROM: Todd M. Kirrane
Transportation Administrator

DATE: January 10, 2022

SUBJECT: January 12, 2022 Special Meeting of the Transportation Board

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Item # 2: WASHINGTON STREET COMPLETE STREETS PROJECT KICKOFF

Staff would like to state that there is no planned action to be taken at this meeting on this issue. In conjunction with our consultants, World Tech Engineering, we are using this opportunity to introduce the Board and the public to the Washington Street Complete Streets Design Project that is expected to go through the MassDOT design process to secure federal transportation improvement program funds through the Boston Region Metropolitan Planning Organization (MPO). Our consultant will walk through a presentation that will cover the following:

- Intro to the Consulting Team
- Discuss Project Limits (Station Street to Beacon Street)
- Discuss TIP Funding Process & Important Benchmarks
- Discuss Project Status to Date
- Initial High Level Design Thoughts
- Design Review Committee up to pre-25% MassDOT submittal

In advance of the meeting we are sharing some initial steps that have already been taken by Town staff and our consultants to get us to this point. If you would like to learn about the TIP process, current budgeted projects, and how a municipality secures TIP funding for their project at the following site: https://www.ctps.org/tip

As one of our key arterial corridors that provides important connections for pedestrians, cyclists, micro-mobility users, public transit, motor vehicles, freight, etc. to and through the Town, we expect that there will be many viewpoints within the community on how to best design the right of way to

- improve safety,
- promote our multi-modal transportation network,
- support the local commercial, educational, and governmental services along the corridor,
- maintain access for abutting residences,
- advance our climate and sustainable transportation goals, and
- support critical emergency management functions such as police, fire, and ems.

Therefore, following the presentation and Q & A, staff hopes to discuss the formation of a Design Review Committee, appointed by Chair Kane and ratified by the Board, to work with Town Staff and our consultants to oversee the design aspects of the project through the pre-25% MassDOT submittal. This DRC will make the critical decisions and tradeoffs to develop a preferred concept design, which the Transportation Board will approve, within the confines and restrictions of the TIP program guidelines and the right of way constraints. Staff is proposing the following makeup of the DRC:

1. 2 Transportation Board Members
2. The Chair of the Bicycle Advisory Committee or their designee
3. The Chair of the Pedestrian Advisory Committee or their designee
4. The Chair of the Shared Mobility Advisory Committee or their designee
5. A member of the local disability community, preferably a direct abutter or nearby resident
6. A parent of a K-8 student from the Pierce School designated by the Safe Routes to School Townwide Task Force
7. A direct residential abutter
8. A direct commercial abutter

Ideally this 9 member committee, or at least a large percentage of the committee, would be ready to be appointed at the January 26th meeting of the Board.

DPW RECOMMENDATION:

No Action Necessary

Attachments: *1) Washington Street Functional Design Report*
2) Washington Street Road Safety Audit
3) Washington Street MPO Evaluation
4) Washington Street Project Scoring

FUNCTIONAL DESIGN REPORT

Rehabilitation of Washington Street
Brookline, MA

DRAFT

SEPTEMBER 2020

Prepared for:

City of Brookline
333 Washington St
Brookline, MA 02445

Prepared by:

Table of Contents

1.0 Introduction

WorldTech Engineering, LLC (WorldTech) has been retained by the City of Brookline to assist the Town in preparing information and submitting to MassDOT a formal request to include the rehabilitation of Washington Street utilizing Federal and/or State for inclusion in the State Transportation Improvement Program (STIP). The project limits include Washington Street from Station Street up to and including its intersection with Beacon Street and including approaches at intersecting side streets, approximately 6,800 feet (1.3 miles).

Washington Street provides a major connection between Route 9 (to/from Boston) and Beacon Street as well as Commonwealth Avenue and Cambridge Street in the Allston/ Brighton area of Boston. In addition to vehicles, the roadway provides a significant connection for bicyclists to Washington Square and Brookline Center.

This Functional Design Report (FDR) summarizes the data collection, analysis, and results of the traffic and safety study conducted as part of the Conceptual Design process.

2.0 Existing Conditions

In this section, existing conditions such as roadway and intersection geometrics, traffic volumes, and crash history are examined in detail.

2.1 Study Area Description

Washington Street generally extends in a northwest/southeast direction between two commercial districts: Washington Square to the northwest and Brookline Village to the southeast. It provides a connection to Brookline High School via the recently improved Greenough Street. The project begins at the Washington Street/ Beacon Street intersection (MBTA C Line) and continues in southeasterly direction to Gardner Road where Washington Street becomes southbound heading toward Route 9. It also intersects with the Brookline Station stop on the D Line and is served by the Route 65 MBTA bus. There are Brookline City Hall, the Public Library of Brookline, and the Public Safety Building and a fire station along Washington Street as well as a large residential neighborhood. On-street bike lanes are present for portions of the corridor and competes with on-street parking for use of the limited pavement width.

The Washington Street corridor project area includes seven signalized intersections, one Emergency Signal and many unsignalized intersections. For this FDR, the following intersections were analyzed:

Signalized

- Washington Street at Beacon Street – Westbound
- Washington Street at Beacon Street – Eastbound
- Washington Street at Park Street
- Washington Street at School Street and Cypress Street
- Washington Street at Harvard Street and Kent Street
- Washington Street at Davis Avenue
- Washington Street at Station Street

Unsignalized

- Washington Street at Gardner Road
- Washington Street at Holden Street

Improvements to the project include updates to an existing 6,800 feet (1.3 miles) roadway that would address measures to upgrade roadway and traffic control operations, with a focus on pedestrian and bicycle accommodations throughout the corridor. Washington Street is a two-lane urban arterial roadway with auxiliary turn lanes at major intersections. Well-marked crosswalks are generally present at major intersections with protected signal phases.

Bicycle accommodations consist of a bike lane along portions of Washington Street and on street parking throughout. In the southern portion of the project, the bicycle lanes are striped in the northbound direction only. In the northern portion of the project, bicycle lanes are striped in both directions. All roadways and traffic control signals in the project area are under the jurisdiction of the City of Brookline. The project location graphic is provided in Figure 1.

In addition, the Top Crash Location website data from MassDOT shown the following locations have been identified as being high crash clusters and are eligible for funding assistance through the Highway Safety Improvement Program (HSIP):

- Washington Street from Boylston Street to Holden Street (2007-2016 HSIP Bicycle & Pedestrian Cluster);
- Harvard Street from Washington Street to School Street (2007-2016 HSIP Bicycle & Pedestrian Cluster);
- Washington Street at Beacon Street (Washington Square) is (2007-2016 HSIP Bicycle Cluster)

Washington Street at Beacon Street

This location is commonly known as Washington Square. Washington Street intersects Beacon Street to form a 4-way signalized intersection, bisected by the Green Line Rail. Beacon Street is an east-west major roadway and is functionally classified as an urban principal arterial. Beacon WB has two through lanes, while Beacon EB has two through lanes and a left turn lane. Both Washington northbound and southbound have a left turn lane and a through/right lane. The Washington Square Green Line stop is adjacent to this intersection. The MBTA also operates the Route 65 bus at this location, with stops in the vicinity of the intersection. This location is designated as an HSIP high crash location for bicycles.

Washington Street at Fire Station #7

Washington Street is a bi-directional two-lane roadway consisting of one lane in each direction separated by a double yellow center line. Bike lanes are provided in each direction with parking allowed on the outside except for directly in front of the Fire Station.

Washington Street at Park Street

Park Street intersects with Washington Street to form a 3-legged signalized intersection. Park Street is functionally classified as an urban collector. Park Street provides a left/right lane. Washington northbound provides a through/right lane and a bike lane with parking on the outside. Washington southbound provides an exclusive left turn lane and a through lane with sharrows. MBTA Route 65 operates through this location with bus stops near this location.

Washington Street at Cypress Street/ School Street

School Street and Cypress Street meet with Washington Street to form a 4-way signalized intersection. All roadways at this location are classified as urban minor arterials. Washington Street southbound provides an exclusive left turn lane, a through lane with sharrows, and a channelized right turn. Washington Street northbound provides an exclusive left turn lane, a through lane with sharrows, and a channelized right turn. School Street provides two lanes. Cypress Street provides an exclusive left turn lane and a through/right lane.

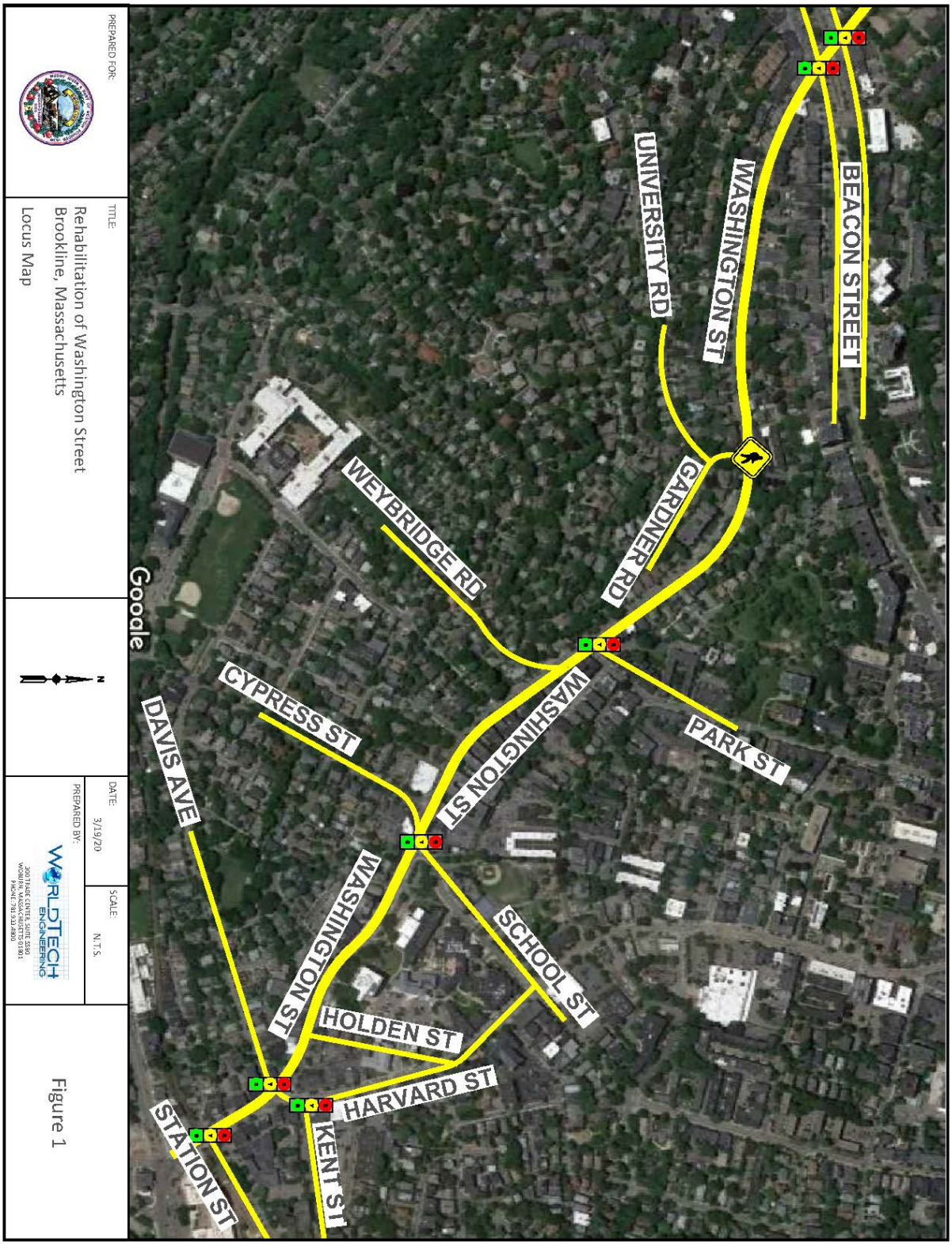
MBTA Route 65 operates through this intersection and has bus stops nearby. The intersection provides marked crosswalks, pedestrian signal heads, and pushbuttons equipped with APS. Crosswalks have brick treatment.

All crosswalk ramps have detectable warning panels. All signals have countdown displays.

Washington Street at Harvard Street/Davis Avenue/Kent Street/Andem Place

Washington Street meets Harvard Street and Davis Avenue and Andem Place and Harvard at Kent Street to form a two offset signalized intersection. Washington Street and Harvard Street are north-south roadways which and are functionally classified as urban principal arterials. Davis Avenue and Andem Place are east-west local roads. Kent Street is an east-west urban collector. Washington Street northbound provides a left turn lane (Washington Street) and a through lane (Harvard Street) with a bike lane. Kent Street is one way towards the intersection of Harvard Street. Harvard Street has one lane in both directions approaching Washington Street. Washington Street southbound provides one lane with bike lanes and parking in both directions. Left turns to Harvard Street are prohibited. Davis Avenue also has a travel lane in both directions, with parking allowed on the north side of the street.

MBTA Routes 65 and 66 operate through this location with bus stops near the intersection. The intersection provides marked crosswalks, pedestrian signal heads, and pushbuttons. Detectable warning panels are not provided at all crosswalk ramps.


PREPARED FOR:
TITLE:
Rehabilitation of Washington Street
Brookline, Massachusetts
Locus Map
PREPARED BY:
WORLDTECH ENGINEERING
DATE:
3/19/20
SCALE:
N.T.S.
Figure 1
Google
BEACON STREET
WASHINGTON ST
UNIVERSITY RD
GARDNER RD
WEYBRIDGE RD
PARK ST
CYPRESS ST
DAVIS AVE
WASHINGTON ST
SCHOOL ST
HOLDEN ST
HARVARD ST
KENT ST
STATION ST

Washington Street at Station Street

Station Street meets Washington Street to form a 3-legged signalized intersection that essentially functions as a signalized pedestrian crossing. Station Street is an east-west roadway that is classified as an urban collector. Station Street is one-way eastbound, away from the intersection. Washington Street southbound and northbound allow for two lanes of traffic in each direction with parking on the outside, north of the intersection. Washington Street provides a bike lane in each direction. MBTA Routes 65 and 66 operate through this location and there are bus stops nearby this intersection. The Brookline Village Green line stop is in the vicinity of this intersection. The intersection provides marked crosswalks, pedestrian signal heads, and pushbuttons. Detectable warning panels are not provided at three of the wheelchair ramps. The signals are not equipped with countdown displays. The pushbuttons are not equipped with APS.

Side Streets

All other intersecting streets with Washington Street are classified as local roads and provide access to the residential neighborhood abutting the Washington Street corridor. Traffic volumes were collected at two of the major side streets to aid in the analysis of traffic operations in the corridor.

2.2 Washington Street – Pedestrian Accommodation and ADA accessibility

Washington Street has a pedestrian sidewalk the entire length of the corridor on both sides of the roadway. A description of the sidewalk segments is described below.

2.2.1 Sidewalks on the Southern & Northern Side of Washington Street

West of Beacon Street the sidewalk is cement concrete and in good condition.

Between Beacon Street and Gardner Road, the sidewalk is cement concrete and varies in width and condition. The section close to Beacon Street is narrow and in poor condition.

Between Gardner Road and Park Street , the sidewalk is cement concrete and in good condition on both sides of the roadway.

Between Park Street and School Street & Cypress Street, the sidewalk is cement concrete and varies in condition, has poor delineation between the sidewalk and driveway and parking areas on both sides of the roadway.

Between School Street & Cypress Street and Holden Street, the sidewalk is cement concrete and is in poor condition and has sections that are raised and are not ADA compliant due to excessive side slopes on both sides of the roadway.

Between Holden Street and Harvard Square, the sidewalk is typically cement concrete and brick on both sides of the roadway. The sidewalk is in poor condition and has sections that are raised and not ADA compliant. The cement concrete sidewalk varies in width and condition.

From Kent Street to Davis Avenue & Andem Place, the cement concrete sidewalk varies in width and condition on both sides of the roadway. The triangular plaza between Washington Street and Harvard Street is in good condition.

From Davis Avenue & Andem Place to Station Street, the cement concrete sidewalk is primarily 6 feet wide and is in good condition on both sides of the roadway. There are electric scooter rental spots on the edge of the sidewalk. The brick sidewalk buffer is 2-ft wide between on-street parking and the concrete sidewalk.

2.2.2 Crosswalks

Crosswalks across Washington Street are located at thirteen locations. Five of the locations are signalized and eight location are unsignalized. A description of each crosswalk is below:

Across Washington Street, at Beacon Street (Signalized)

Style - two white stripes.

The Washington Street at Beacon Street intersection provides marked crosswalks, pedestrian signal heads, and pushbuttons equipped with APS (accessible pedestrian signals). Countdown displays are not provided on the signals. All crosswalk ramps have detectable warning panels. This location operates with a concurrent pedestrian phase on automatic recall. Two of the pushbuttons are extremely quiet when pressed, and one of the pushbuttons is non-responsive. The Washington Square Green Line stop is adjacent to this intersection.

During the collection of the traffic data, pedestrian volumes were very high. The data was collected in March with temperatures around 45 degrees. The project peak hour pedestrian and bike volume graphic is provided in Figure 2.

Across Washington Street, south of Fairbanks Street

Style -White Ladder

The Fairbanks Street crossing lacks ADA compliant ramps on both ends. The MBTA bus stop sign on the north side of sidewalk is too close to the crosswalk.

Across Griggs Road east of Washington Street, (west intersection)

Style - White Ladder

The Griggs Road crossing has ADA compliant ramp on the east sides.

Across Washington Road, at Gardner Road

Style - White Ladder

This intersection has three pedestrian crossing signs on each side of the road, A refuge island is provided in the center of Washington Street. The crosswalks do not have detectable warning panels. The ramps on the southern side of Washington Street are not ADA compliant.

Across Griggs Road, east of Washington Street, (east intersection)

Style - White Ladder

The Griggs Road crossing has ADA compliant ramps on both ends.

Across Washington Street, at Park Street (Signalized)

Style - two white stripes

The intersection provides two marked crosswalks, pedestrian signal heads, and pushbuttons. Detectable warning panels are not provided at the wheelchair ramps. The signals are not equipped with countdown displays. The pushbuttons are not equipped with APS.

Across Weybridge Road, west of Washington Street

Style - White Ladder

The Weybridge Road crossing lacks ADA compliant ramps on both sides of the roadway. The length of this crosswalk is more than 120 ft. There is one pedestrian crossing sign on the southeastern corner of the intersection.

Across Washington Street, west of Greenough Street

Style - two white stripes

This intersection has two pedestrian crossing signs on each side of the road, with in-street “yield to pedestrian” pylons in the center of Washington Street. The crosswalk does not have ADA compliant curb ramps.

Across Washington Street, School Street and Cypress Street (Signalized)

Style - two white stripes with red inlaid brick pattern

The intersection provides marked crosswalks, pedestrian signal heads, and pushbuttons equipped with APS. Crosswalks have inlaid brick pattern. All crosswalk ramps have detectable warning panels. All signals have countdown displays.

Across Washington Street, south of Thayer Street

Style - White Ladder

This intersection has two pedestrian crossing signs on each side of the road, with in-street “yield to pedestrian” pylons in the center of Washington Street. The crosswalk does not have detectable warning panels. In addition, the parking spaces on Thayer Street southbound is too close to the crosswalk.

Across Washington Street, north of Holden Street

Style - White Ladder

The Holden Street crossing lacks ADA compliant ramps on the both ends.

Across Washington Street, at Harvard Street/Davis Avenue/Kent Street/Andem Place (Signalized)

Style - two white stripes

There are five marked crosswalks at Washington Street and two marked crosswalks at Harvard Street at Kent Street. ADA compliant ramps and detectable warning panels are not provided on the ramps on the western and southern sides of the intersection. Signals are not equipped with countdown displays. Pushbuttons are not equipped with APS. A median island with pedestrian refuge is provided on the southern leg of Washington Street.

Across Washington Road, at Station Street (Signalized)

Style - two white stripes (standard)

There are two marked crosswalks, one is on the north side, another is on the east side of the intersection. The crossings across Washington Street and Station Street lack detectable warning panels and also lack pedestrian signal heads on the southeastern corner of the intersection. The curb ramp on the northeastern corner is an Apex ramp.

2.3 Existing Bicycle Accessibility

Existing bicycle accommodations consist of a 5-foot wide bike lane along portions of Washington Street adjacent to a 6-foot wide on street parking throughout. In the southern portion of the project, the bicycle lanes are striped in the northbound direction only. In the northern portion of the project, bicycle lanes are striped in both directions.

The City of Brookline recently prepared an update to their bicycle network plan.[1] The Washington Street corridor has been identified as one of Brookline's major connectors for cyclists travelling from Brookline and Newton to Kenmore Square and downtown Boston. The groundwork for a significant improvement in a "Complete Streets" solution for the corridor has been completed with specific recommendations for improved cycling and pedestrian amenities. We will strive to incorporate as many of these Complete Streets recommendations as feasible in our design solution for Washington Street.

2.4 Transit

The MBTA operates two separate green line routes on either side of the corridor.

At the north end of the corridor, the Washington Square stop on the Green Line C stop is located on the eastern side of the intersection of Washington Street and Beacon Street. This line operates from 4:57 AM to 12:07 AM on weekdays and has

[1] Green Routes Bicycle Network Plan, Brookline Advisory Committee, January 2019

peak hour headways of 6 minutes and off-peak headways of 9-11 minutes.

At the southern end of the corridor, the Green Line D branch intersects the corridor. The Brookline Village stop on the Green Line D branch is located off Station Street approximately 250 feet east of Washington Street. This line operates from 4:56 AM to 12:05 AM on weekdays and has peak hour headways of 6-8 minutes and off-peak headways of 8-11 minutes.

The MBTA bus route 65 operates along the entire Washington Street corridor. None of the bus stops have shelters. The 2020 summer schedule operates from 5:58 AM to 8:28 PM on weekdays. The following are the bus stops within the study limits.

- Washington Street at Beacon Street
  (northbound stop, near side south of Beacon Street, southbound stop 200 feet south of Beacon Street)
- Washington Street at Fairbanks Street
  (northbound stop, near side south of Gardner Road, southbound stop opposite of Fairbanks Street.) Crosswalk across Washington Street
- Washington Street opposite Gardner Road
  (northbound stop far side north of Gardner Road, buses use bike lane to stop; southbound stop near side north of Gardner Road - curb extension)
- Washington Street at Griggs Road
  (northbound stop, near side south of Griggs Street; southbound stop 180 feet south of Gardner Road.)
- Washington Street at Greenough Boulevard
  (northbound stop opposite Greenough Boulevard; southbound stop south of Greenough Boulevard)
- Washington Street at School Street, south side of intersection,
  (northbound stop – near side; southbound stop, far side)
- Washington Street at Harvard Street north side of intersection
  (northbound stop - far side – adjacent to plaza; southbound stop, near side)

The MBTA bus Route 66 has one stop within the study limits. The 2020 summer schedule operates from 5:00 AM to 1:00 PM on weekdays. The following are the bus stops within the study limits.

- Harvard Street at Kent Street north side of intersection
  (northbound stop - far side; southbound stop, near side)

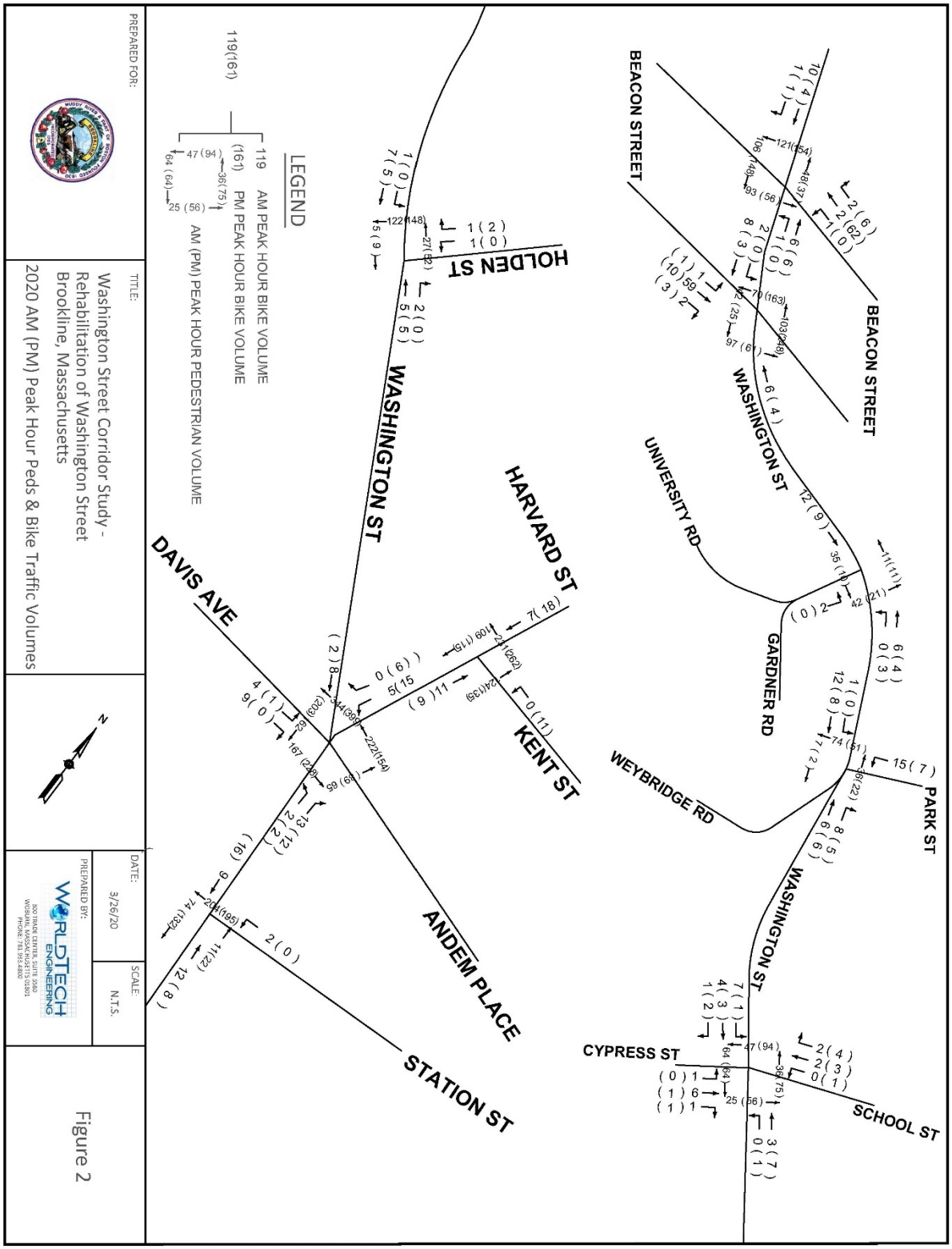

LEGEND
119 AM PEAK HOUR BIKE VOLUME
(161) PM PEAK HOUR BIKE VOLUME
AM (PM) PEAK HOUR PEDESTRIAN VOLUME
BEACON STREET
WASHINGTON ST
HOLDEN ST
HARVARD ST
UNIVERSITY RD
GARDNER RD
WEYBRIDGE RD
PARK ST
DAVIS AVE
KENT ST
ANDEM PLACE
STATION ST
CYPRESS ST
SCHOOL ST
PREPARED FOR:
TITLE:
Washington Street Corridor Study - Rehabilitation of Washington Street Brookline, Massachusetts
2020 AM (PM) Peak Hour Peds & Bike Traffic Volumes
DATE:
3/26/20
SCALE:
N.T.S.
PREPARED BY:
WORLDTECH ENGINEERING

Figure 2

2.5 Traffic Volumes

2.5.1 Traffic Counts

Automatic Traffic Recorder (ATR) counts were collected at the following three (3) locations to determine daily traffic volumes, vehicle classification, and 85th percentile vehicle speeds. ATR counts were collected for a 48-hour period on March 3-4, 2020 along Washington Street.

- *Washington Street southeast of Beacon Street*
- *Washington Street northwest of Cypress Street*
- *Washington Street northwest of Harvard Street*

In addition, manual turning movement counts (TMCs) were collected on March 4, 2020 at 2 unsignalized intersections and 7 signalized intersections. The weather was 45 degrees and partly cloudy during the count. The TMCs were collected at 15-minute intervals for a 12-hour period from 7:00 a.m. to 7:00 p.m. on a typical weekday at the following nine (9) locations:

- *Washington Street at Beacon Street – Westbound (signalized)*
- *Washington Street at Beacon Street – Eastbound (signalized)*
- *Washington Street at Gardner Road*
- *Washington Street at Park Street (signalized)*
- *Washington Street at School Street and Cypress Street (signalized)*
- *Washington Street at Holden Street*
- *Harvard Street and Kent Street (signalized)*
- *Washington Street at Davis Avenue/Andem Place (signalized)*
- *Washington Street at Station Street (signalized)*

Passenger vehicles, trucks, pedestrians, and bicycles were counted as part of the intersection TMCs and are detailed in the count data contained in the appendix.

A summary of the 2020 traffic volumes is shown in Table 1.

2.5.2 Seasonal Adjustments

Traffic on a given roadway typically fluctuates throughout the year depending on the area and the type of roadway. Based on the weekday seasonal factors summarized by MassDOT, the functional classification along Washington Street study corridor is Urban Minor Arterial. The data shows that average annual volumes are approximately 2 percent higher than March, the month of ATR data collection. A seasonal adjustment factor of 1.02 was applied to the traffic count data to arrive at an average month condition. The Massachusetts Highway Department Statewide Traffic Data Collection 2017 Weekday Seasonal Factors report is in the appendix.

2.5.3 Existing Traffic Volumes

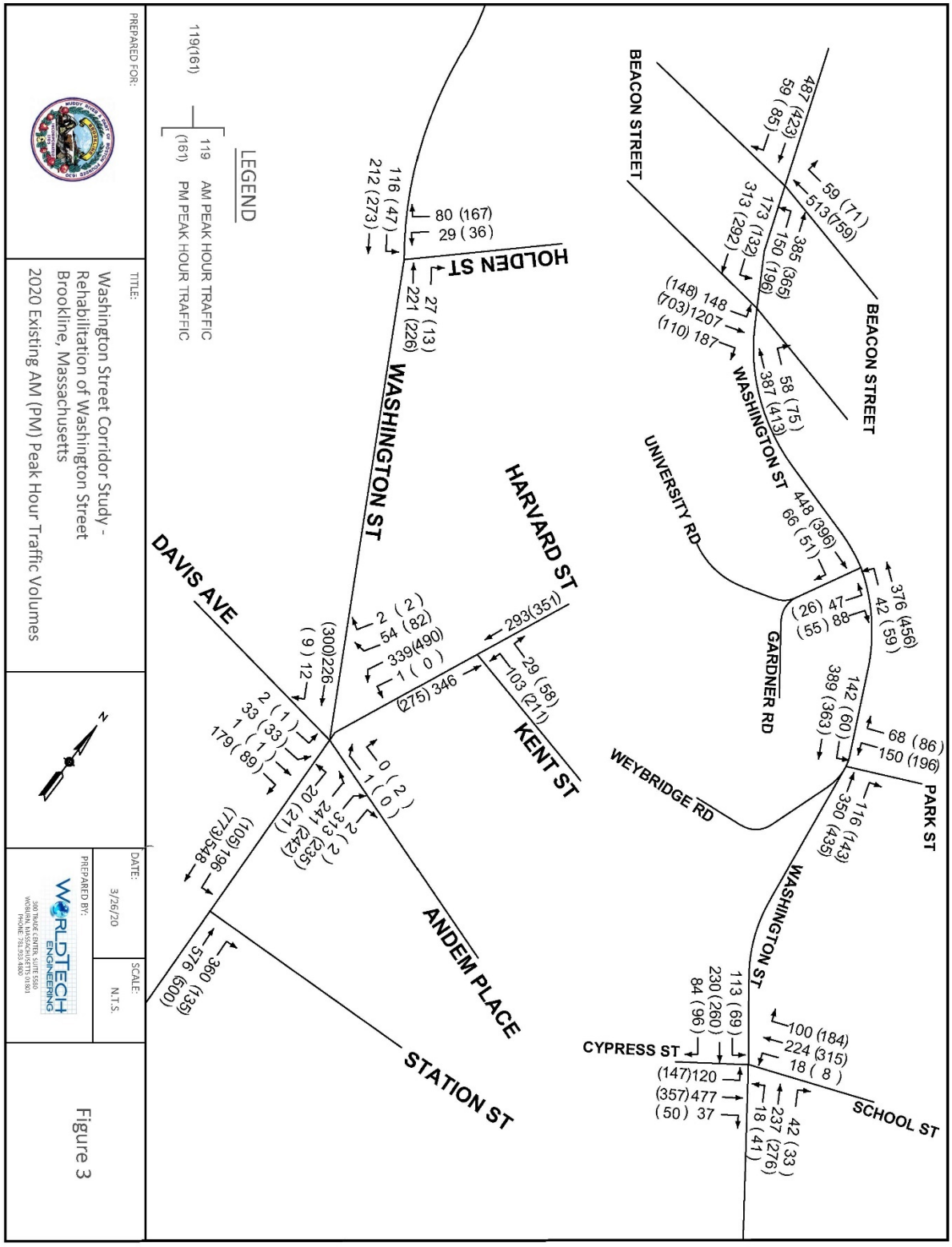
The Average Annual Daily Traffic (AADT) on the study area roadway is given in Table 1 below. The existing daily traffic volume of Washington Street, southeast of Beacon Street is 8,300 vehicles per day, Washington Street northwest of Cypress Street is 13,400 vehicles per day and Washington Street, northwest of Harvard Street is 8,300 vehicle per day.

Table 1 - Existing Traffic Volumes.

Location	Daily Volume	Peak Hour Volume		K Factor (%)	Directional Distribution
Washington Street, southeast of Beacon Street	12,200	AM:	886	7.3 %	51.8% SB
		PM:	900	7.4 %	53.8% NB
Washington Street, northwest of Cypress Street	13,400	AM:	878	6.6 %	51.5% NB
		PM:	1,031	7.7 %	58.1% NB
Washington Street, northwest of Harvard Street	8,300	AM:	612	7.3 %	51.8% SB
		PM:	704	8.4 %	54.7% NB

(ATR) counts conducted by Boston Traffic Data, Average data of March 3 & 4, 2020.

The morning and evening peak hour volumes are summarized in Figure 3. TMC and ATR data are included in the report Appendix.


LEGEND
119(161)
119 AM PEAK HOUR TRAFFIC
(161) PM PEAK HOUR TRAFFIC
BEACON STREET
WASHINGTON ST
HOLDEN ST
HARVARD ST
KENT ST
DAVIS AVE
ANDEM PLACE
STATION ST
UNIVERSITY RD
GARDNER RD
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SCALE:
N.T.S.

Figure 3

2.6 Vehicle Speeds

In addition to traffic volumes, vehicle speeds were collected along study area roadways to determine the average speed, 85th percentile speed, and 10 mph pace speed through the along the corridor. The 85th percentile speed is the speed at or below which 85 percent of the vehicles on a given roadway are traveling. This is typically the fundamental value in the establishment of traffic laws and the design of roadway geometrics. The 10-mph pace speed represents the 10-mph speed range at which the highest percentage of vehicles along a roadway are traveling. When the midpoint of the 10-mph pace corresponds with the average (mean) speed of the roadway, there is a uniform speed of traffic flow on a roadway and therefore increased safety. Table 2 summarizes the average, 85th percentile, and pace speeds on the Washington Street study corridor.

Table 2 - Roadway Speeds

Location	Direction	Posted Speed Limit	Average Speed	85th Percentile Speed	Pace Speed (%)
Washington Street, northwest of Cypress Street	NB	30	21.9	27.8	19-29 (59.6%)
	SB	30	22.9	27.1	19-29 (77.7%)
Washington Street, southeast of Beacon Street	NB	30	22.3	27.1	19-29 (70.9%)
	SB	30	25.0	29.3	21-31 (77.3%)
Washington Street, northwest of Harvard Street	NB	25	18.1	23.1	13-23 (70.0%)
	SB	25	20.5	24.9	16-26 (75.8%)

ATR counts conducted by Boston Traffic Data, Average data of March 3 & 4, 2020.

As indicated in Table 2, all of the average speed of the study locations is lower than the posted speed limit. Meanwhile, all of the 85th percentile speed are slightly lower than the posted speed limit. The low speeds are likely a combination of narrow lane widths, traffic signals, on-street parking and enforcement.

2.7 Safety Analysis

2.7.1 Road Safety Audit

The FHWA, Federal Highway Administration, defines a Road Safety Audit, RSA, as the formal safety examination of an existing or future road or intersection by an independent, multidisciplinary team. The purpose of an RSA is to identify potential safety issues and possible opportunities for safety improvements considering all roadway users.

A Road Safety Audit (RSA) will be completed for the corridor in the Fall of 2020.

Data from MassDOT shows the following locations have been identified as being high crash clusters and are eligible for funding assistance through the Highway Safety Improvement Program (HSIP):

- Washington Street from Boylston Street to Holden Street (2007-

2016 HSIP Bicycle & Pedestrian Cluster);

- Harvard Street from Washington Street to School Street (2007-2016 HSIP Bicycle & Pedestrian Cluster);
- Washington Street at Beacon Street (Washington Square) is (2007-2016 HSIP Bicycle Cluster)

2.7.2 Crash History

Collison data for the corridor were obtained from MassDOT records for the most recent five-year period (2013-2017). For the study area, a total of 104 crashes were recorded during the study period. A summary of the crashes at the study area intersections is provided in Table 3. The collision diagrams and crash information are shown in Appendix.

Table 3 - Intersection and Segment Crashes

Crashes 2013-2017	
Washington Street at Beacon Street (signalized)	27
Washington Street at Gardner Road	7
Washington Street at Park Street (signalized)	5
Washington Street at School Street and Cypress Street (signalized)	9
Washington Street at Holden Street	9
Harvard Street and Kent Street (signalized)	3
Washington Street at Davis Avenue/Andem Place (signalized)	13
Washington Street at Station Street (signalized)	7
Segment	
Washington Street from Gardner Road to School Street	36
Washington Street from Holden Street to Station Street	41

Bold = 2007-2016 HSIP Bicycle Cluster

To evaluate crash data effectively, the number of crashes must relate or be compared to the traffic volumes entering the intersection or traveling along the roadway. A procedure used for this purpose is the calculation of an intersection or roadway segment crash rate, which is a measure of the frequency of crashes compared to traffic volumes. Intersection crash rates are based on crashes per million entering vehicles (C/MEV).

MassDOT releases official Statewide and District rates that can be used as an effective tool to compare safety hazards at a specific intersection.

Crash rates higher than these averages could indicate a potential safety issue. Crash summary sheets and crash rate calculation worksheets are included in the Appendix.

2.7.3 Intersection Crashes

Crash rates were calculated at intersections where 3 or more crashes per year were recorded. Table 4 shows the Statewide and District 6 crash rates for signalized intersection as well as the study area crash rate.

Table 4 - MassDOT Crash Rates

	Intersection Crash Rates (C/MEV)
	Signalized Intersection
Statewide	0.77
District 6	0.71
Washington Street at Beacon Street	0.49

Based on the analysis of crash data, most of the intersections along the Washington Street corridor has a relatively good safety record. However, although the crash rate is below the state average, the signalized intersection of Washington Street at Beacon Street (EB & WB) experienced 27 crashes in the five-year study period which equates to a rate of 0.49 crashes per million entering vehicles (C/MEV). This location had 8 single vehicle crashes (30%), as well as 8 sideswipe, same direction crashes (30%). It was recorded that 25 of the crashes at this intersection occurred during the day (93%), 23 crashes occurred with clear weather (85%) and 23 crashes occurred on dry pavement (85%).

This report will later discuss the alternatives in this corridor that are intended to reduce the number of crashes as well as the severity of crashes.

2.7.4 Roadway Segment Crashes

In addition to analyzing the crashes as intersections only, it was important to analyze the crashes as part of a road segment. Many of the crashes occurred, not because of a single intersection, but because of the characteristics that the corridor presents to motorists. A summary chart was developed for the road segments on Washington Street from Gardner Road to School Street and Washington Street from Holden Street to Station Street. The crash summary is included in the appendix.

This stretch of Washington Street from Gardner Road to School Street roadway tallied a total of 36 crashes over the five years representing a rate of 3.13 C/MVM. The crash rate is lower than the Statewide Avenue Segment Crash Rates for Urban Principal Arterial (3.49 C/MVM).

This stretch of Washington Street from Holden Street to Station Street tallied a total of 41 crashes over the five years representing a rate of 13.70 C/MVM. The crash

rate is higher than the Statewide Avenue Segment Crash Rates for Urban Principal Arterial (3.49 C/MVM) and is due to the multiple closely spaced intersections

Table 5 - MassDOT Crash Rates

Segment Crash Rates for Urban Principal Arterial (C/MVMT)		
Average	**Study Corridor**	
Principal Arterial- other	Washington Street from Gardner Road to School Street	Washington Street from Holden Street to Station Street
3.49	3.13	**13.70**

2016 Average Crash Rates, per Million Vehicle Miles Traveled, by Federal Functional Classification (Based upon crash information queried on June 22, 2018)
Bold = Above State/District 6 Average Rate

Table 6 – Intersection Crash Summary

Crash Category		Location							
		Washington / Station Street	Washington/ Harvard /Andem Street	Harvard/ Kent Street	Washington / Holden Street	Washington School Street/ Cypress Street	Washington/ Park Street	Washington/ Gardner Road	Washington/ Beacon Street
Year	2013	1	3	0	0	0	0	2	3
	2014	1	2	0	0	3	0	0	11
	2015	1	2	1	2	1	1	1	2
	2016	2	3	2	3	3	2	2	5
	2017	2	3	0	4	2	2	2	6
	Total	**7**	**13**	**3**	**9**	**9**	**5**	**7**	**27**
Severity	Property Damage Only	5	9	2	5	6	4	2	21
	Non- fatal Injury	2	2	1	3	2	1	5	6
	Fatality	0	0	0	0	0	0	0	0
	Unknown	0	2	0	1	1	0	0	0
	Total	**7**	**13**	**3**	**9**	**9**	**5**	**7**	**27**
Crash Type	Angle	0	0	0	1	1	0	3	4
	Rear-End	1	2	2	1	2	1	0	6
	Head-On	0	0	0	1	1	0	0	0
	Single vehicle crash	1	4	0	2	1	0	3	4
	Sideswipe	3	4	1	3	3	4	1	8
	Pedestrian	1	2	0	1	1	0	1	3
	Bicycle	0	0	0	0	0	0	0	1
	Other	1	1	0	0	0	0	0	1
	Total	**7**	**13**	**3**	**9**	**9**	**5**	**7**	**27**

The studied intersections both currently present crash rates and crash patterns that demonstrate an urgent need for safety improvements. In addition, a field review of the MassDOT Safety Review Prompt list at many of the project intersections identify physical features contributing to crashes.

2.8 Traffic Signal Warrants

A traffic signal warrant analysis is an engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of a location to help determine if a traffic signal installation is justified at an intersection. Traffic signal warrants are defined in the Manual on Uniform Traffic Control Devices (MUTCD), 2009 Edition published by Federal Highway Administration. Nine warrants are presented in the MUTCD:

- Warrant 1, Eight-Hour Vehicular Volume
- Warrant 2, Four-Hour Vehicular Volume
- Warrant 3, Peak Hour
- Warrant 4, Pedestrian Volume
- Warrant 5, School Crossing
- Warrant 6, Coordinated Signal System
- Warrant 7, Crash Experience
- Warrant 8, Roadway Network
- Warrant 9, Intersection Near a Grade Crossing

Each warrant analysis compares existing conditions at the study location with established thresholds or criteria to establish whether the installation of a traffic signal is warranted. Although satisfaction of one warrant may be sufficient to justify a signal installation, the MUTCD states "the satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal." Furthermore, before and after studies of unwarranted traffic signals typically indicate that an unjustified signal installation causes an increase in the number of crashes at the intersection. Generally, MassDOT requires Warrant 1A or 1B to be satisfied to consider installation of a traffic signal.

Warrants 5, and 6 do not apply to these locations and were not analyzed. The results of the signal warrant analysis for both signalized and unsignalized intersections are summarized in Table 7 & 8, and detailed warrant analysis worksheets are included in the Appendix.

Table 7 – Signal Warrant Analysis for Signalized Intersection

LOCATION	Warrant				
	Warrant 1 8-hour	Warrant 2 4-hour	Warrant 3 Peak Hour	Warrant 4 Pedestrian	Warrant 7 Crash
Washington Street at Beacon Street – EB &WB	✓	✓	✓	✗	✗
Washington Street at Park Street	✓	✓	✓	✗	✗
Washington Street at School Street and Cypress Street	✓	✓	✓	✗	✗
Harvard Street and Kent Street	✗	✗	✗	✗	✗
Washington Street at Harvard Street/Davis Avenue	✓	✓	✓	✗	✗
Washington Street at Station Street	✗	✗	✗	✓	✗

Table 8 – Signal Warrant Analysis for Unsignalized Intersection

LOCATION	Warrant				
	Warrant 1 8-hour	Warrant 2 4-hour	Warrant 3 Peak Hour	Warrant 4 Pedestrian	Warrant 7 Crash
Washington Street at Holden Street	✗	✗	✓	✗	✗
Washington Street at Gardner Road	✗	✗	✗	✗	✗

Unsignalized Intersection:

The Washington Street at Holden Street intersection is currently unsignalized with STOP-sign control on the southbound Holden Street approach, and with no control on the Washington Street approaches. Based on existing traffic volumes and crash history at this location, only warrants 3 is met. Based on the result of signal warrants, intersection signalization was not recommended.

Washington Street at Gardner Road intersection is currently unsignalized with Rectangular Rapid Flashing Beacons. Based on existing traffic volumes and crash history at this location, no warrants are met. Based on the result of signal warrants, intersection signalization was not recommended.

<u>Signalized Intersection:</u>

Traffic signal warrants were reviewed at all six existing signalized intersections. Warrants were met to continue these intersections being operated as traffic control signals. As a result, a traffic signal reconstruction is currently proposed at the following locations:

- Washington Street at Beacon Street – Eastbound & Westbound
- Washington Street at Park Street
- Washington Street at School Street and Cypress Street

- Washington Street at Harvard Street/Davis Avenue & Kent Street

As shown in Table 7, based on the existing traffic volumes and crash history at this location, the intersection of Washington Street at Station Street does not meet any of the volume related Traffic Signal Warrants. However, there is a large volume of pedestrian on the Washington Street southbound approach and the Station Street westbound approach, the pedestrian volume warrant has been met at this location. To improve traffic operations and safety at this intersection, it should continue to operate in the signal control and optimized signal timing at the intersection.

Washington Street at Harvard Street/Davis Avenue and Harvard Street/Kent Street intersections consist of two offset tee intersections controlled by one controller. The traffic signals at the Harvard Street/Kent street intersection function as queue management signals to provide gaps for Kent Street drivers to enter the traffic flow along Harvard Street. Therefore, the warrants analysis are applied to these intersection as one location and warrants 1,2, & 3 are met.

2.9 Existing Deficiencies

Washington Street has a large number is existing deficiencies that are discussed in the Capacity section and the safety section. This section provides a brief listing of the various deficiencies along the corridor.

Roadway Condition

The existing pavement is in poor condition with extensive cracking throughout the length of Washington Street.

Sidewalk / ADA

Along the corridor, the curbing have very little reveal, providing very little delineation vehicles and pedestrians. The sidewalk is not ADA compliant, with excessive cross slopes.

Bicycling Accommodation

There is a bike lane in the northbound direction. However, the 5-foot-wide bike lane is immediately adjacent to a narrow lane of on-street parking. This increases the likelihood of dooring incidents.

Safety

Much of the corridor is a bicycling HSIP cluster, indication a high bicycle crash rate. The segment of Washington Street between Holden Street and Station Avenue has a crash rate significantly higher than the state average for arterial roadways.

Operations

As identified in a later section, there are a number of intersections that currently experience constrained operations along the corridor.

3.0 Future Conditions and Operational Analysis

In this section, existing traffic volumes are projected to a future design year and then evaluated under alternative conditions to arrive at proposed optimal improvements.

3.1 Traffic Volume Projections

In order to make design improvements that will be beneficial for future growth as well as present conditions, existing traffic volumes were projected to a future design year. MassDOT's Traffic and Safety Engineering 25% Design Submission Guidelines require a minimum design year horizon of seven years. However, to ensure an adequate design life for this project, a 12-year growth horizon was selected to design year 2032.

To develop 2032 design year volumes, existing volumes are typically increased by an annual growth rate obtained from the Regional Planning Agency (RPA), or based on methodology used to grow the traffic to the build year based on sound documentation. In this case, CTPS just completed a corridor study for Route 9 in Brookline in January of 2020 and used their Regional Transportation Planning Model to develop traffic forecasts for the 2030 design year. The model predicts that traffic in the Brookline area would increase by 0.25% annually in the AM peak period and by 0.3% annually in the PM peak. Based on this information, a conservative 0.5 percent per year compounded growth rate was selected and applied to the existing traffic volumes to develop the 2032 design year traffic volumes.

In addition, traffic volumes from planned or recent developments were researched from the Current Projects section of the Planning and Community Development Department website. Based on this data , there are two nearby projects that have the potential to increase traffic along the Washington Street corridor.

The following provides a summary of the identified background development projects:

- **20 Boylston Street-** 20 Boylston Street is a proposed 4-story, mixed-use development including commercial space and 16 residential units. The site was previously a single-story Dunkin' Donuts located at the corner of High Street, Walnut Street and Boylston Street. This project is under construction and has not yet opened.

  A traffic study was not submitted for the project. Based on the location of the project, most of the project traffic will be to/from Route 9 and will not have a significant impact on the Washington Street corridor.

- **700 Brookline Avenue/ 25 Washington Street**

  A new hotel is under construction at 700 Brookline Avenue (formerly 25 Washington Street). The project includes an 11-story hotel with 175 rooms with a

parking garage on the second and third levels with no more than 70 parking spaces. The hotel is expected to open in October 2020.

The traffic study for this project was researched. Based on the traffic study, 10 peak hour vehicles trips are anticipated to be added background growth rate and is included in the 2032 Volumes.

The 2032 design year traffic volumes are shown in Figure 4. Traffic and population data used to develop the annual growth rate are detailed in the report Appendix.

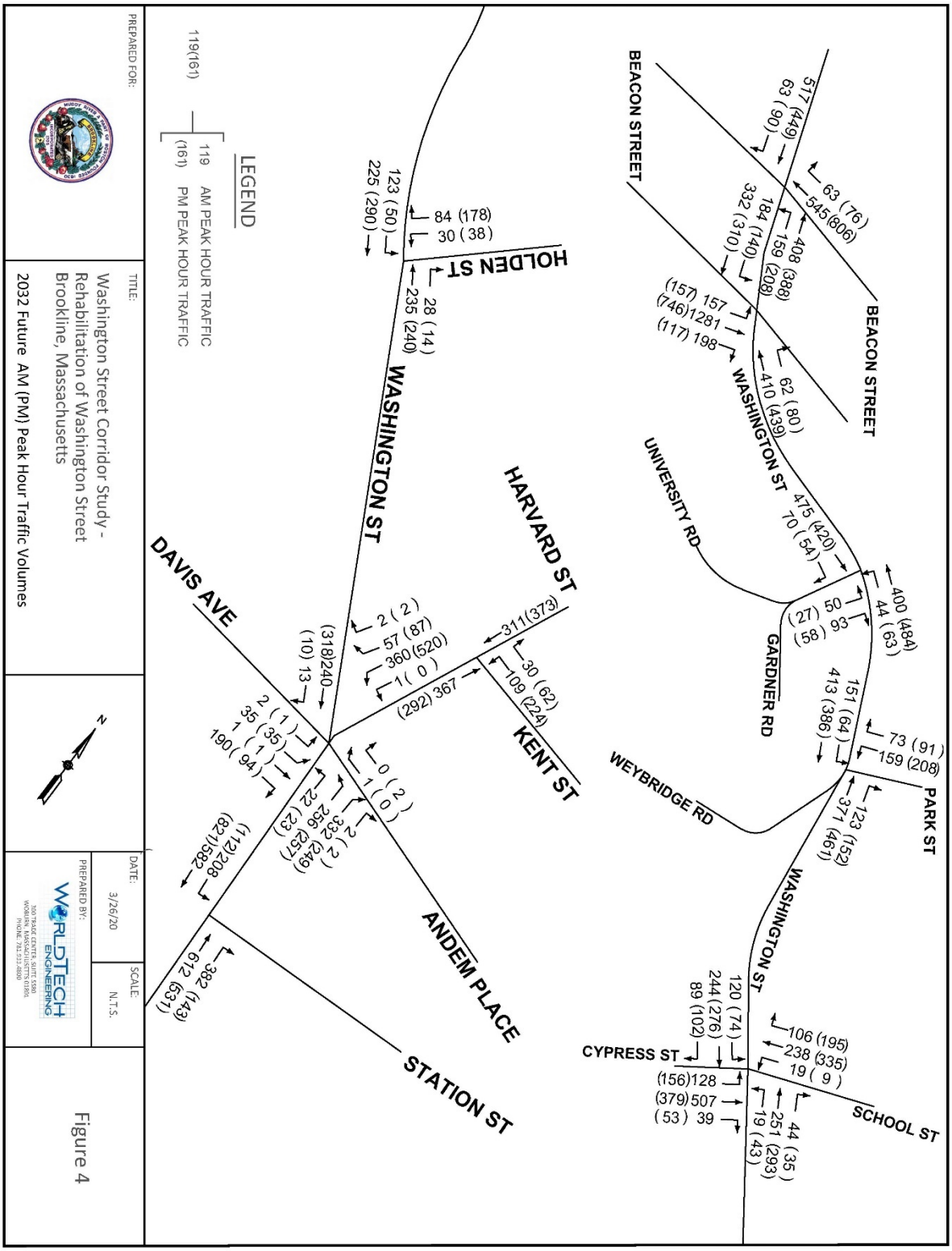

BEACON STREET
WASHINGTON ST
HOLDEN ST
WASHINGTON ST
HARVARD ST
DAVIS AVE
KENT ST
ANDEM PLACE
STATION ST
UNIVERSITY RD
GARDNER RD
WEYBRIDGE RD
PARK ST
WASHINGTON ST
CYPRESS ST
SCHOOL ST
517 (449)
63 (90)
63 (76)
545(806)
184 (140)
332 (310)
159 (208)
408 (388)
(157) 157
(746)1281
(117) 198
62 (80)
410 (439)
475 (420)
70 (54)
400 (484)
44 (63)
(27) 50
(58) 93
151 (64)
413 (386)
73 (91)
159 (208)
123 (152)
371 (461)
120 (74)
244 (276)
89 (102)
106 (195)
238 (335)
19 (9)
(156)128
(379)507
(53) 39
44 (35)
251 (293)
19 (43)
123 (50)
225 (290)
84 (178)
30 (38)
28 (14)
235 (240)
2 (2)
57 (87)
360(520)
1(0)
311(373)
30 (62)
109 (224)
(292) 367
(318)240
(10) 13
2 (1)
35 (35)
1 (1)
190(94)
0 (2)
1 (0)
2 (2)
332 (249)
256 (257)
22 (23)
(821)582
(112)208
382 (431)
612 (531)
LEGEND
119 AM PEAK HOUR TRAFFIC
(161) PM PEAK HOUR TRAFFIC
119(161)
PREPARED FOR:
TITLE:
Washington Street Corridor Study -
Rehabilitation of Washington Street
Brookline, Massachusetts
2032 Future AM (PM) Peak Hour Traffic Volumes
DATE:
3/26/20
SCALE:
N.T.S.
PREPARED BY:
WORLDTECH ENGINEERING

Figure 4

3.2 Capacity Analysis

3.2.1 Capacity Analysis Methodology

The capacity analysis methodology is based on the concepts and procedures described in the 2010 Highway Capacity Manual (HCM), Transportation Research Board, Washington, DC. A capacity analysis is used to assess the quality of traffic operations on a roadway or intersection as a result of traffic volume demands placed on the respective facility. The primary result of a capacity analysis is a level of service (LOS) assignment to the traffic operations of the respective facility. A LOS analysis results in assigning a letter index of A through F to describe the quality of traffic operations at a facility in terms of such factors as speed, traffic interruptions, freedom to maneuver, comfort, convenience, and safety. The six letter designations of A through F define the operating conditions from best to worst, respectively. In general, a LOS C is used as the minimum design criteria although D is acceptable at urban, high volume locations.

LOS for either signalized or unsignalized intersections can be computed by the methodology described below. LOS for signalized intersections is defined in terms of delay, which is a measure of driver discomfort, frustration, fuel consumption and lost travel time. The delay experienced by a motorist is made of factors that relate to intersection control, geometrics, and traffic volumes. This delay is called “control delay” or “signal delay”. Control delay includes initial deceleration delay, queue move-up time, stopped delay and final acceleration delay. Specifically, LOS criteria at an intersection with traffic signals are stated in terms of the average control delay per vehicle.

The LOS for an unsignalized intersection (two-way stop control) is defined for each minor movement, not for the intersection as a whole. The LOS criteria for the unsignalized intersections are somewhat different from the criteria for the signalized intersections. The primary reason for the difference is that motorists expect different levels of performance from the two facilities. Due to these expectations, the control delay threshold for any given LOS is less for an unsignalized intersection than it is for a signalized intersection. Table 9 below summarizes the LOS criteria associated with the letter index and the relationship between signalized and unsignalized intersections.

Table 9- Intersection Level of Service Criteria

Level of Service	Average Stopped Delay per Vehicle (seconds)	
	Signalized Intersection	Unsignalized Intersection
A	0 - 10	0 - 10
B	>10 - 20	>10 - 15
C	>20 - 35	>15 - 25
D	>35 - 55	>25 - 35
E	>55 – 80	>35 - 50
F	>80	>50

2010 Highway Capacity Manual, Transportation Research Board, Washington, DC

The LOS delay criteria may be applied to individual lane groups, to individual intersection approaches or to the entire signalized or unsignalized intersections.

3.2.2 Level of Service Analysis

Level of Service (LOS) analysis was performed at the following intersections:

- *Washington Street at Beacon Street – Westbound (signalized)*
- *Washington Street at Beacon Street – Eastbound (signalized)*
- *Washington Street at Gardner Road*
- *Washington Street at Park Street (signalized)*
- *Washington Street at School Street and Cypress Street (signalized)*
- *Washington Street at Holden Street*
- *Harvard Street and Kent Street (signalized)*
- *Washington Street at Davis Avenue/Andem Place (signalized)*
- *Washington Street at Station Street (signalized)*

Analysis is based on the 2010 Highway Capacity Manual (HCM) using Synchro version 9 software. Since the 2010 HCM methodology does not support the non-NEMA phasing and exclusive pedestrian phases present at study area intersections, the HCM 2000 methodology was used to evaluate signalized intersections.

Existing Queues

In addition to level of service, a review of the 95th percentile queue lengths were performed during each of the peak hours under existing conditions. While an intersection may show acceptable levels of service, extensive queue lengths may exist that impede operations elsewhere by extending into adjacent intersections or other conflict areas. A description of the critical queues at each intersection location is presented below.

Volume-to-Capacity Ratio

In addition to LOS, another factor to take into consideration when discussing operation is the “volume-to-capacity” ratio. The volume-to-capacity (v/c) ratio is the ratio of the volume travelling in a lane group to the capacity of the same lane

group, a percentage of the lane group's capacity being utilized. As with delay, this measure can be utilized for either the individual approach or the intersection. As opposed to delay there is no standard gauge to provide a specific point of reference for a certain volume-to-capacity ratio; however, a lower volume-to-capacity ratio indicates that backups are less likely. As the v/c ratio approaches 1.0, the operation worsens since the facility is reaching capacity. A volume-to-capacity ratio of 1.0 or greater indicates traffic volumes are exceeding capacity. A volume-to-capacity ratio under 1.0 is considered acceptable.

The results of the capacity analysis are discussed and tabulated below. Detailed traffic analyses are provided in the Appendix.

3.2.3 Capacity Analysis with Existing Geometry & Future No-Build Condition

Signalized Intersections

Washington at Beacon Street Eastbound and Westbound

The intersection of Washington and Beacon consists of two offset intersections; bisected by the MBTA Green line tracks located in between the eastbound and westbound sides of Beacon Street. The traffic signal operation consists of three basic phases: 1-Beacon Street eastbound (Protected left), 2-Beacon Street eastbound and westbound throughs and rights, (left prohibited), and 3-Washington Street. The Beacon Street trolleys move during the same phase as the Beacon street vehicular phases. Pedestrians are crossed concurrently for the most part throughout the intersection.

The capacity analysis was performed as two intersections operating on a single traffic signal controller. The capacity analysis indicates that under 2020 Baseline and No Build conditions, the Beacon Street eastbound and Beacon Street westbound sides of the intersection each will operate at an overall LOS "C". Delays for the intersections increase slightly between Baseline and No Build conditions due to the small increases in the No build traffic volumes.

Washington Street at Park Street

The Washington street at Park Street intersection is a simple tee-type intersection with one through lane in each direction on Washington Street and an exclusive left turn lane in the eastbound direction.

The capacity analysis indicates that under 2020 Baseline and No Build conditions, the intersection will operate at an overall LOS "C-D" for both the Baseline and No-build cases. Delays increase slightly between Baseline and No-build condition due to the small increases in No build traffic volumes. The V/C rations are well below 1.0 which indicates the intersection is well under capacity. The Park Street approach has the largest delays in the intersection.

Washington Street at Cypress Street/School Street

Washington Street intersects Cypress and School Streets at a skewed angle making the phasing of the intersection inefficient due to the geometrics of the intersection. School Street and Cypress Street are currently split into separate phases at the intersection and Washington Street has a large distance to cross, resulting in large vehicle and pedestrian crossing intervals. Exclusive left turn lanes are provided on all approaches except the School Street approach, which has a shared left/thru lane and right/thru lane.

The capacity analysis indicates that under 2020 Baseline and No Build conditions, the intersection will operate at an overall LOS "D" for both the Baseline and No-build cases.

Washington at Davis/Andem Place and Harvard Street and Harvard at Kent Street

The intersection of Washington and Harvard Streets is located immediately north of the Washington Street/Station Street intersection. Washington Street proceeds in a northwest direction at the intersection and the through movement becomes the start of Harvard Street. Traffic signal operation consists of two offset intersections; one intersecting lower Washington Street (Davis Avenue & Andem Place) and the other intersecting Harvard Street (Kent Street). Previously, these traffic signals were coordinated with the traffic signals at the Washington Street/Route 9 intersection. Recent traffic signal improvements to the Route 9 Corridor have discontinued the coordination between the traffic signals at Washington and Route 9 and other traffic signals to the north along Washington Street. The traffic signal operation consists of four basic phases: 1-Washington Street, 2-Harvard Street, 3-Kent street, and 4-Davis Avenue/Andem Place. Pedestrians are crossed concurrently for the most part except at Kent Street.

The capacity analysis was summarized as two separate intersections: one for the Washington Street/ Davis-Andem Place portion of the intersection and second for the Harvard Street/Kent Street half of the intersection. The capacity analysis indicates that under 2020 Baseline and No Build conditions, the intersection of Washington Street at Davis Avenue/Andem Place portion will operate at an overall LOS "C". The Harvard Street/Kent Street side of the intersection will operate an overall LOS "F" for the intersection. Delays for the intersections increase slightly between Baseline and No Build conditions due to the small increases in the No build traffic volumes.

Washington Street at Station Street

This intersection basically functions as a pedestrian crossing signal since Station Street is one-way away from the intersection. Significant peak hour traffic volumes are found on Washington Street for southbound vehicle making a left turn and northbound vehicles making a right turn to access Brookline Village Station on the

Green Line. At the same time pedestrian volumes are heavy crossing both Washington Street and Station Street. The traffic signal operation consists of three phases; the first is the northbound and southbound traffic on Washington Street, the second is a lagging phase for southbound traffic to facilitate the left turn movement into Station Street and the third is a pedestrian phase.

The capacity analysis indicates that under 2020 Baseline and No Build conditions, the intersection will result in an overall "B" level of service (LOS) in both the AM peak and PM peak hours depending on the amount of pedestrian activity present.

Unsignalized Intersections

Washington Street at Holden Street & Washington Street at Gardner Road

At the Washington Street unsignalized intersections of Holden street and Gardner Road the LOS is adequate for both the Baseline and No Build traffic conditions.

Table 10 - Intersection Level of Service Summary

Intersection/ Peak Period/Movement	2020 Existing Conditions				2032 No-Build Conditions			
	v/c[a]	Delay[b]	LOS[c]	Queue[e] 50th/95th	v/c	Delay	LOS	Queue 50th/95th
Washington Street at Beacon Street WB								
Weekday Morning Peak Hour:								
Beacon Street WB TR	0.58	27.0	C	157/215	0.64	28.8	C	170/231
Washington Street NB L	0.48	6.4	A	13/m21	0.52	7.3	A	15/m24
Washington Street NB T	0.45	4.5	A	32/m47	0.47	4.6	A	37/m48
Washington Street SB TR	0.59	27.6	C	139/190	0.60	27.3	C	150/203
Overall	**0.59**	**20.1**	**C**		**0.63**	**20.7**	**C**	
Weekday Evening Peak Hour:								
Beacon Street WB TR	0.84	35.9	D	257/#374	0.93	44.5	D	280/#412
Washington Street NB L	0.58	8.2	A	13/m159	0.63	9.8	B	18/m174
Washington Street NB T	0.43	4.1	A	25/m43	0.44	4.3	A	34/m44
Washington Street SB TR	0.56	27.3	C	129/176	0.57	26.7	C	137/188
Overall	**0.77**	**24.6**	**C**		**0.84**	**28.3**	**C**	
Washington Street at Beacon Street EB								
Weekday Morning Peak Hour:								
Beacon Street EB L	0.79	57.4	E	93/#213	0.84	64.7	E	99/#228
Beacon Street EB TR	0.88	23.4	C	412/#587	0.95	31.7	C	~475/#646
Washington Street NB TR	0.56	28.0	C	114/161	0.58	27.6	C	122/172
Washington Street SB L	0.78	20.0	C	18/#95	0.84	27.6	C	26/#217
Washington Street SB TR	0.61	5.1	A	10/17	0.62	5.2	A	11/17
Overall	**0.95**	**23.6**	**C**		**1.03**	**29.3**	**C**	
Weekday Evening Peak Hour:								
Beacon Street EB L	0.77	54.2	D	92/#213	0.82	59.9	E	99/#228
Beacon Street EB TR	0.51	13.2	B	172/231	0.55	14.2	B	190/250
Washington Street NB TR	0.62	29.2	C	128/179	0.64	28.9	C	137/191
Washington Street SB L	0.66	12.3	B	7/47	0.71	16.5	B	11/#75
Washington Street SB TR	0.57	4.6	A	10/14	0.58	4.7	A	11/15
Overall	**0.64**	**19.2**	**B**		**0.69**	**20.3**	**C**	
Washington Street at Gardner Road								
Weekday Morning Peak Hour:								
Washington Street WB LT	0.05	1.4	A	4	0.05	1.4	A	4
Gardner Road NB LR	0.38	20.1	C	44	0.44	22.8	C	54
Weekday Evening Peak Hour:								
Washington Street WB LT	0.06	1.6	A	5	0.06	1.7	A	5
Gardner Road NB LR	0.23	17.3	C	22	0.27	19.1	C	26

Table 10 - Intersection Level of Service Summary (Cont'd)

Intersection/ Peak Period/Movement	2020 Existing Conditions				2032 No-Build Conditions			
	v/c[a]	Delay[b]	LOS[c]	Queue[d] 95th	v/c	Delay	LOS	Queue[d] 95th
Washington Street at Park Street								
Weekday Morning Peak Hour:								
Washington Street EB L	0.38	9.7	A	20/82	0.42	10.4	B	21/86
Washington Street EB T	0.40	8.2	A	65/229	0.42	8.4	A	71/247
Washington Street WB TR	0.81	27.3	C	154/#470	0.84	29.3	C	169/#511
Park Street SB LR	0.72	35.2	D	80/#250	0.76	39.5	D	87/#272
Overall	**0.69**	**20.5**	**C**		**0.73**	**22.2**	**C**	
Weekday Evening Peak Hour:								
Washington Street EB L	0.24	10.7	B	8/40	0.29	11.7	B	9/42
Washington Street EB T	0.38	8.5	A	60/211	0.41	8.7	A	65/227
Washington Street WB TR	0.91	34.6	C	208/#630	0.97	46.3	D	231/#679
Park Street SB LR	0.88	49.9	D	108/#349	0.93	58.8	E	117/#377
Overall	**0.83**	**29.4**	**C**		**0.88**	**36.7**	**D**	
Washington Street at Cypress Street & School Street								
Weekday Morning Peak Hour:								
Washington Street EB L	0.68	46.4	D	80/#191	0.78	59.2	E	91/#219
Washington Street EB TR	0.74	44.0	D	225/#403	0.79	47.8	D	253/#443
Washington Street WB L	0.13	31.9	C	11/37	0.16	33.1	C	12/38
Washington Street WB TR	0.72	43.3	D	199/#361	0.76	46.5	D	222/#394
Cypress Street NB L	0.50	44.8	D	89/162	0.55	47.5	D	100/172
Cypress Street NB TR	0.82	36.1	D	310/475	0.85	39.4	D	340/522
School Street SB LTR	0.55	38.4	D	123/179	0.58	39.1	D	132/193
Overall	**0.75**	**40.5**	**D**		**0.79**	**43.9**	**D**	
Weekday Evening Peak Hour:								
Washington Street EB L	0.51	39.6	D	47/110	0.62	47.7	D	54/#137
Washington Street EB TR	0.86	56.3	E	271/#490	0.92	66.3	E	307/#534
Washington Street WB L	0.42	38.4	D	28/75	0.55	44.9	D	31/#93
Washington Street WB TR	0.81	51.1	D	232/#420	0.86	57.9	E	261/#459
Cypress Street NB L	0.61	49.8	D	114/195	0.65	52.7	D	126/207
Cypress Street NB TR	0.63	27.8	C	225/347	0.67	29.0	C	250/376
School Street SB LTR	0.71	41.9	D	194/267	0.73	42.8	D	212/287
Overall	**0.72**	**43.6**	**D**		**0.76**	**47.9**	**D**	
Washington Street at Holden Street								
Weekday Morning Peak Hour:								
Washington Street EB LT	0.10	3.4	A	--/8	0.10	3.5	A	--/9
Holden Street SB LR	0.20	12.7	B	--/19	0.22	13.2	B	--/21
Weekday Evening Peak Hour:								
Washington Street EB LT	0.04	1.5	A	--/3	0.04	1.5	A	--/3
Holden Street SB LR	0.32	12.7	B	--/35	0.35	13.3	B	--/40

Table 10 - Intersection Level of Service Summary (Cont'd)

Intersection/ Peak Period/Movement	2020 Existing Conditions				2032 No-Build Conditions			
	v/c[a]	Delay[b]	LOS[c]	Queue[d] 95th	v/c	Delay	LOS	Queue[d] 95th
Kent Street at Harvard Street								
Weekday Morning Peak Hour:								
Kent Street WB LR	0.70	58.3	E	119/#232	0.75	65.9	E	128/#248
Harvard Street NB T	0.39	1.1	A	19/30	0.41	1.3	A	23/33
Harvard Street SB T	0.74	45.2	D	259/391	0.78	49.6	D	281/#438
Overall	**0.51**	**27.6**	**C**		**0.53**	**30.7**	**C**	
Weekday Evening Peak Hour:								
Kent Street WB LR	1.10	138.0	F	~312/#522	1.20	174.6	F	~356/#568
Harvard Street NB T	0.32	1.8	A	24/40	0.34	1.8	A	27/43
Harvard Street SB T	0.86	58.3	E	336/#565	0.93	71.6	E	~381/#619
Overall	**0.63**	**64.9**	E		**0.67**	**81.1**	**F**	
Washington Street at Davis Avenue & Andem Place								
Weekday Morning Peak Hour:								
Davis Avenue EB LTR	0.61	55.9	E	65/167	0.72	66.7	E	91/#217
Andem Place WB TR	0.01	45.7	D	1/7	0.01	47.6	D	1/7
Washington Street NB L	0.59	35.1	D	210/326	0.62	38.0	D	231/349
Washington Street NB TR	0.76	42.8	D	272/416	0.80	47.8	D	299/#473
Harvard Street SB LT	0.48	1.8	A	4/22	0.51	2.1	A	5/23
Harvard Street SB R	0.07	0.2	A	0/m0	0.07	0.3	A	0/m0
Washington Street SE TR	0.54	34.3	C	142/251	0.58	37.2	D	160/273
Overall	**0.62**	**30.5**	**C**		**0.67**	**34.4**	**C**	
Weekday Evening Peak Hour:								
Davis Avenue EB LTR	0.48	56.4	E	47/121	0.53	58.5	E	54/130
Andem Place WB TR	0.02	51.1	D	2/11	0.02	52.0	D	2/11
Washington Street NB L	0.72	46.5	D	221/334	0.77	50.3	D	242/370
Washington Street NB TR	0.63	42.1	D	192/294	0.64	42.6	D	207/317
Harvard Street SB LT	0.62	3.2	A	32/m36	0.68	3.4	A	35/m36
Harvard Street SB R	0.11	0.5	A	0/m0	0.12	0.6	A	0/m0
Washington Street SE TR	0.81	55.2	E	222/360	0.84	58.4	E	246/#427
Overall	**0.69**	**31.8**	**C**		**0.74**	**33.4**	**C**	
Washington Street at Station Street								
Weekday Morning Peak Hour:								
Washington Street NB TR	0.70	18.2	B	136/198	0.73	18.9	B	154/220
Washington Street SB LT	0.78	15.2	B	79/109	0.81	16.0	B	86/118
Overall	**0.51**	**16.8**	**B**		**0.55**	**17.6**	**B**	
Weekday Evening Peak Hour:								
Washington Street NB TR	0.65	18.7	B	98/147	0.67	18.8	B	107/157
Washington Street SB LT	0.80	15.8	B	100/144	0.84	17.7	B	110/157
Overall	**0.48**	**17.0**	**B**		**0.52**	**18.1**	**B**	

*[a] Volume to Capacity Ratio; [b] Average Delay per vehicle (sec); [c] Level of Service; [d] 95th Percentile Queue Length (veh); [e] Percentile Queue Length (ft); NB = Northbound; SB = Southbound; EB = Eastbound; WB = Westbound; L = Left Turn; T = Through; R = Right Turn; LT = Shared Left/Through; TR Shared Through/Right; LR = Shared Left/Right; LTR = Shared Left/Through/Right; * - Demand greatly exceeds capacity; v/c Ratio, Delay, and Queue not calculated; # - 95th percentile volume exceeds capacity; queues are calculated for two signal cycles and may extend longer; ~ - Volume exceeds capacity, queue is theoretically infinite*

4.0 Proposed Alternatives

With the objectives of improving pedestrian and bicycle mobility, traffic operations and safety along the Washington Street corridor, design alternatives were developed in the preparation of this report. Several alternatives were considered for different segments of the corridor as well as the different intersections depending on width, geometry, and accommodations for different users. Alternatives will be developed following the principals outlined in MassDOT's new Healthy Transportation Policy Directive and the City's Complete Streets Policy.

4.1 Applicable Design Standards

The 2006 MassDOT Project Development and Design Guide provides the applicable design standards for roadways based on their functional classification and the area type in which they are located. The Healthy Transportation Policy Directive formalized the policy to address other modes of transportation such as walking, bicycling, and taking transit.

The MassDOT Project Development and Design Guide requires a minimum travel lane width of 11 feet.

According to the Healthy Transportation Policy Directive, pedestrian facilities may include sidewalks, shared use paths or side paths and shall be provided on both sides of a roadway if located in an urban area. The minimum pedestrian facility width is 5'-0". Marked crosswalks shall be provided across every leg of a signalized intersection. Bicycle facilities shall be provided on roadways in each direction except roadways classified as local. The bicycle facility shall consist of a shared-use path, side path, separated bicycle lane or buffered bike lane for roadways with a volume greater than 10,000 vehicles per day.

For projects that are located within the service district of the MBTA, crosswalks shall be provided to facilitate accessible pedestrian access between both sides of a roadway within 250 feet of a transit stop. A shelter or bench shall be provided at all transit stops with 100 or more boarding's per day. Transit priority treatments shall be provided along Transit routes with headways of 15 minutes or less.

Roadway Context

The three main elements of roadway context considered for design include roadway type, area type, and access control. The roadway type for Washington Street is an Urban Minor Arterial. The area type that best describes the project area is suburban High density, the area is Central Business District at the end of the project locations.

City of Brookline

The City of Brookline recently prepared an update to their bicycle network plan.[2] The Washington Street corridor has been identified as one of Brookline's major connectors for cyclists travelling from Brookline and Newton to Kenmore Square and downtown Boston. The groundwork for a significant improvement in a "Complete Streets" solution for the corridor has been completed with concrete recommendations for improved cycling and pedestrian amenities laid out. We will strive to incorporate as many of these Complete Streets recommendations as feasible in our design solution for Washington Street.

Roadway Users

Roadway users of this facility include pedestrians, bicyclists, motor vehicles and transit.

Transportation Demand

The design year for the project is 2032. Traffic volumes generally increase as we move from the southern limits of the project toward Cypress Street and then level off approaching Beacon Street at the northern project limits. Motor vehicle traffic volumes for this project is as follows:

		Washington Street, northwest of Harvard Street	Washington Street, northwest of Cypress Street	Washington Street, southeast of Beacon Street
ADT (2020)		8,300	13,400	12,200
ADT (2032)		8,900	14,200	12,900
K	AM:	7.3 %	6.6 %	7.3 %
	PM:	8.4 %	7.7 %	7.4 %
D	AM:	51.8% SB	51.5% NB	51.8% SB
	PM:	54.7% NB	58.1% NB	53.8% NB
T (Peak hour)	AM:	3.35%	3.5%	3.6%
	PM:	3.65%	2.5%	3.9%
PHF	AM:	89%	96%	91%
	PM:	87%	91%	96%
DHV	AM:	608	884	887
	PM:	700	1,032	899
DDHV	AM:	315 vph	455 vph	460 vph
	PM:	383 vph	599 vph	484 vph

Measures of effectiveness

The following measures of effectiveness related specifically to transportation function have been incorporated into the design:

- Existing deficiencies are being eliminated or improved

[2] Green Routes Bicycle Network Plan, Brookline Advisory Committee, January 2019

- Addressing know safety problems especially at high crash locations
- Increasing pedestrian/bicycle accommodations in the project area
- Improving or maintaining an acceptable Level of Service

4.2 Development of Alternatives

Each roadway segment may require a different configuration depending on type of user, roadway speed, roadway traffic volumes, roadway geometry and any site constraints that may be in place. After completing the upcoming Road Safety Audit (RSA) for Washington Street, the recommendations that will be presented during the RSA process will be incorporated into the design alternatives.

The project can be divided into two cross sections elements due to varying widths of the roadway. The existing roadway width is approximately 40 feet wide south of Gardner Road and provides a bike lane in the northbound direction only. North of Gardner Road, the roadway widens slightly to 43.5 feet and includes a bike lane in each direction.

As discussed in the deficiency section, the roadway pavement condition is poor and needs rehabilitation. In addition, sidewalks are not ADA compliant. Curb reveal in many areas is substandard, leaving little delineation between the travel way and the sidewalk.

Work also consists of providing traffic signal reconstruction at:

- *Washington Street at Beacon Street – Westbound*
- *Washington Street at Beacon Street – Eastbound*
- *Washington Street at Park Street*
- *Washington Street at School Street and Cypress Street*
- *Washington Street at Davis Avenue/Andem Place*
- *Harvard Street and Kent Street*
- *Washington Street at Station Street*

For the Washington Street corridor, alternatives were considered both for the entire corridor, which consist of modifying the lane configuration as well as spot improvements at specific locations. These are discussed further in the next section.

4.2.1 Corridor Wide Improvement – Beacon Street to Harvard Street

Alternative 1

Alternative 1 was developed as the alternative to accommodate bike lanes throughout the corridor without impacting sidewalk width, while retaining parking on one side of the road. The on-street parking along the southbound direction of Washington Street would be removed.

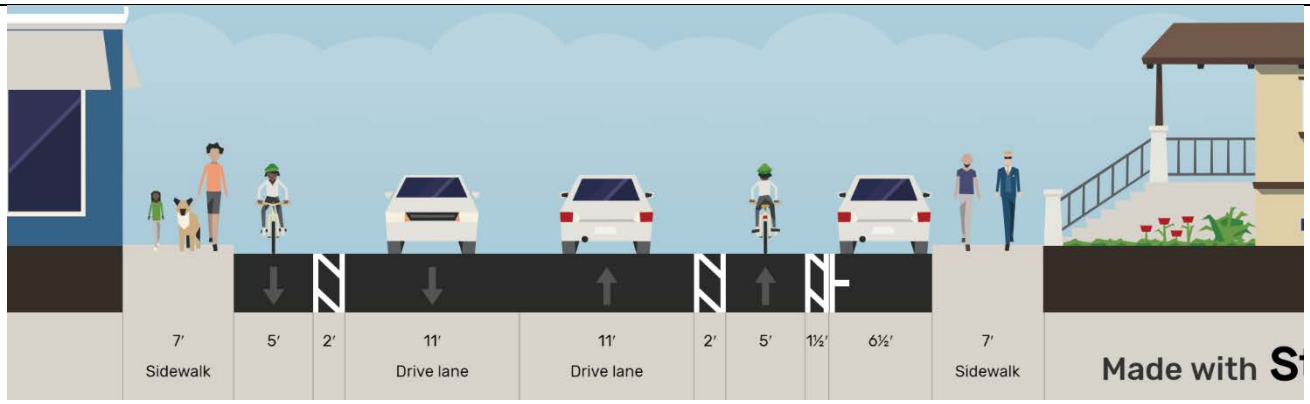
Improvements would consist of reconstruction of the roadway throughout the corridor, reconstruction of the curbing and reconstruction of the sidewalks and curb ramps. Intersection improvements would be incorporated as discussed in the following sections.

The graphic below shows the cross section of Alternative 1. This alternative maintains the existing width of the roadway while reconfiguring the uses.

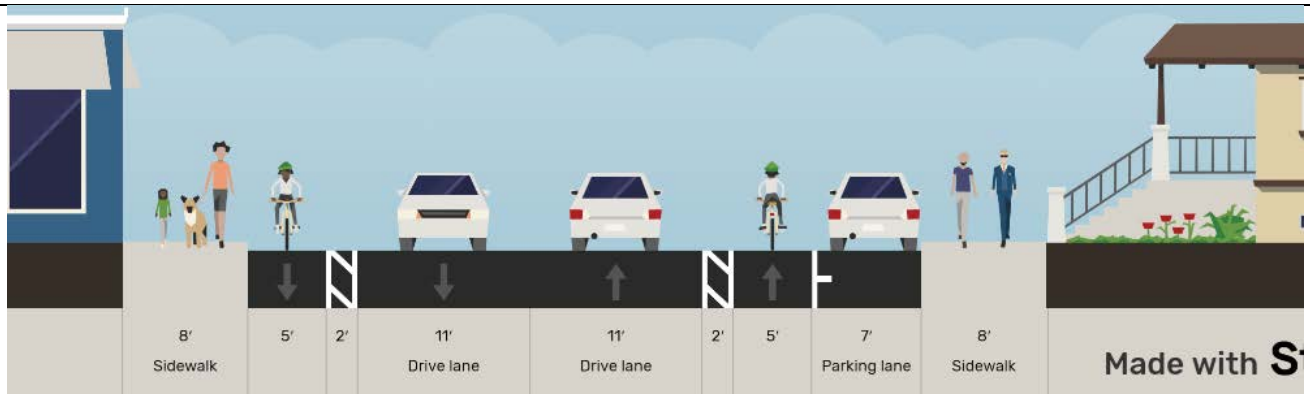
North of Gardner Road the cross section would consist of a 7-foot sidewalk on the west side of Washington Street. A 5-foot-wide southbound bike lane would be adjacent to the sidewalk. The bike lane could be street level or raised depending on drainage needs. A 2-foot-wide buffer would be provided between the southbound bike lane and the southbound travel lane. One 11-foot southbound and one 11-foot-wide northbound travel lane would be provided. A 2-foot-wide buffer would be provided between the northbound travel lane and the 5-foot-wide northbound bike lane. A parking lane is provided on the eastern (northbound) side of the roadway. A seven-foot-wide parking lane is provided on the eastern (northbound) side of the roadway.

South of Gardner Road the cross section would consist of an 8-foot sidewalk on the west side of Washington Street. A 5-foot-wide southbound bike lane would be adjacent to the sidewalk. The bike lane could be street level or raised depending on drainage needs. A 2-foot-wide buffer would be provided between the southbound bike lane and the southbound travel lane. One 11-foot southbound and one 11-foot-wide northbound travel lane would be provided. A 2-foot-wide buffer would be provided between the northbound travel lane and the 5-foot-wide northbound bike lane. A seven-foot-wide parking lane is provided on the eastern (northbound) side of the roadway.

This alternative does meet the requirements of the Healthy Transportation Policy.



Alternative 1 – North of Gardner Road



Alternative 1 – South of Gardner Road

Figure 5 - Proposed Cross Section - Alternative 1

Benefits/Issues

Bicyclist Comfort/ Safety – Alternative 1 is a significant improvement over existing conditions for bicyclists. With buffered bike lanes in both directions, bicycle accommodations are provided throughout the corridor. Alternative 1 does not provide a vertical separation between drivers and cyclists. Flexible delineator posts can be used in the buffer in the southbound direction. However due to the on-street parking, delineator posts are not applicable in the northbound direction. In the northbound direction, the bicyclists are adjacent to the parking lane.

Vehicular Operations. – All corridor wide alternatives generally have similar vehicular operations, except for the possibility of parallel parkers, and transit vehicles blocking traffic.

Pedestrian Accommodations – The existing sidewalk width remains the same as existing, conditions, between 7 and 8 feet wide. The sidewalk condition will be upgraded to meet ADA guidelines.

Transit Impacts – Under existing conditions, in the northbound direction stopped busses currently block the bike lane and use portions of the parking lane. With

Alternative 1, sufficient room exist to allow northbound bicycles to bypass a parked MBTA bus. In the southbound direction, buses will block traffic. Alternatively, a bus stop could be cut out of the bike lane and buffer. However, that creates a significant conflict for bicyclists.

Emergency Response – If emergency vehicles need to bypass traffic along the corridor, they can cross into the opposing lanes. In addition, drivers can pull over into the bike lane /buffer to allow emergency vehicles to pass.

Street Cleaning/ Snow removal. Alternative 1 would require very little special accommodation for street sweeping and snow removal. If flexible delineator posts are used in the southbound direction, the Town may choose to remove the delineator posts during the winter for snow clearing. Flexible delineator posts would present an obstacle to street sweepers.

Parking Impacts – Alternative 1 removes all of the parking on one side of the roadway, thereby reducing the on-street parking supply by half.

Drainage Impacts – Since the curb line is not changing, no significant change is needed to the drainage system.

Alternative 2

Alternative 2 was developed as an alternative to accommodate separated bike lanes, while also retaining some on-street parking. This alternative does slightly impact the width of the sidewalk. The on-street parking along the southbound direction of Washington Street would be removed.

Improvements would consist of reconstruction of the roadway throughout the corridor, reconstruction of the curbing and reconstruction of the sidewalks and curb ramps. Intersection improvements would be incorporated as discussed in the following sections.

The graphic below shows the cross section of Alternative 2. This alternative modifies the existing width of the roadway.

North of Gardner Road the cross section would consist of a 6.5-foot sidewalk on the west side of Washington Street. A 5-foot-wide separated southbound bike lane would be adjacent to the sidewalk. The bike lane could be street level or raised depending on drainage and maintenance needs. A 2-foot-wide curbed buffer would be provided adjacent to the southbound bike lane. A 1 ½ foot wide roadway shoulder would be provided on the west side of the roadway to accommodate roadway drainage. One 11-foot southbound and one 11-foot-wide northbound travel lane would be provided. A seven-foot-wide parking lane is provided on the eastern (northbound) side of the roadway. A 3-foot-wide buffer is provided

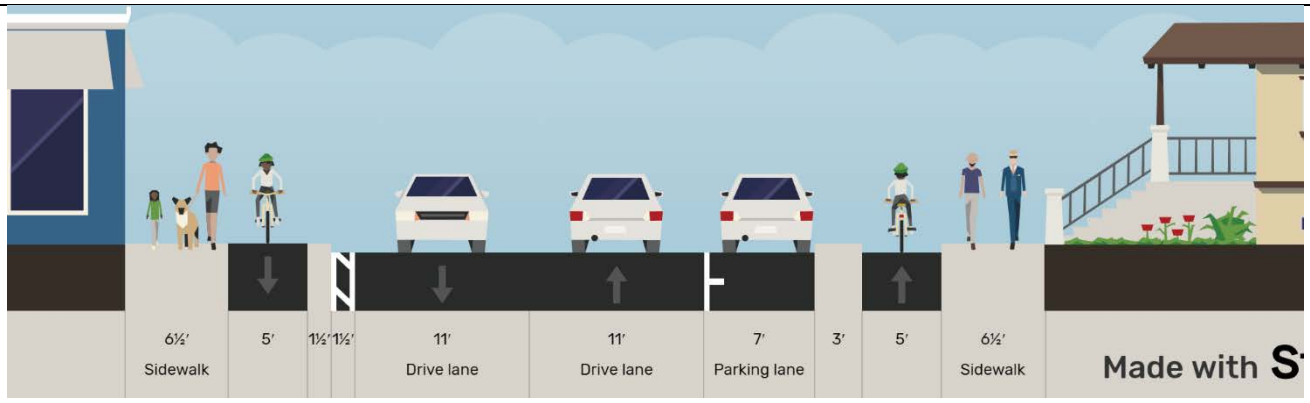
between the parking and the 5-foot-wide northbound separated bike lane. The sidewalk on the eastern side of the roadway will be 6.5 feet wide.

South of Gardner Road the cross section would consist of a 6.5-foot sidewalk on the west side of Washington Street. A 5-foot-wide separated southbound bike lane would be adjacent to the sidewalk. The bike lane could be street level or raised depending on drainage and maintenance needs. A 2-foot-wide curbed buffer would be provided adjacent to the southbound bike lane. A 2-foot-wide roadway shoulder would be provided on the west side of the roadway to accommodate roadway drainage. One 11-foot southbound and one 11-foot-wide northbound travel lane would be provided. A seven-foot-wide parking lane is provided on the eastern (northbound) side of the roadway. A 3-foot-wide buffer is provided between the parking and the 5-foot-wide northbound separated bike lane. The sidewalk on the eastern side of the roadway will be 7 feet wide.

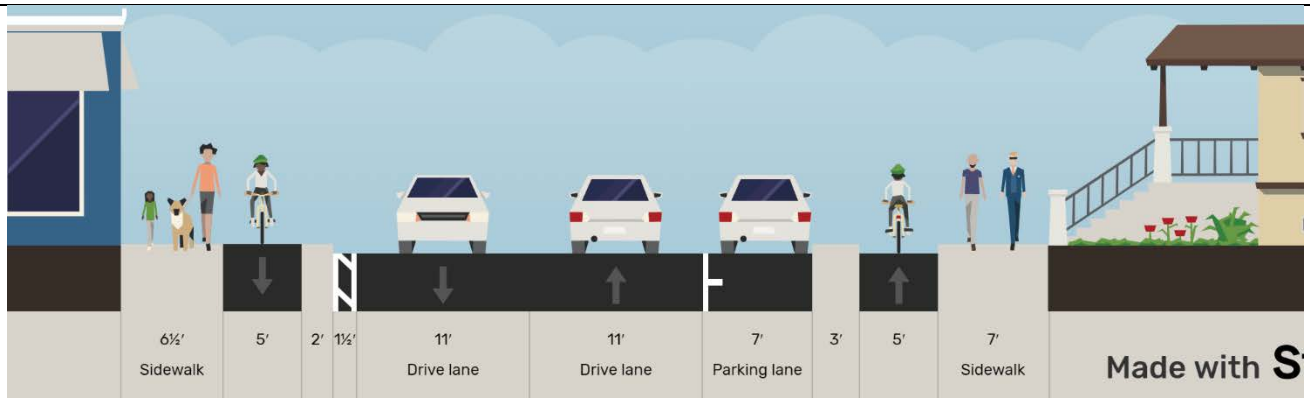
Due to the relatively narrow roadway, when drivers are parking the northbound traffic flow will be impacted.

Alternative 2 provides significantly improved operations for bicyclists. However, there is no room for a buffer between the sidewalk and the separated bike lane.

This alternative meets the requirements of the Healthy Transportation Policy.



Alternative 2 – North of Gardner Road



Alternative 2 – South of Gardner Road

Figure 6 - Proposed Cross Section - Alternative 2

Benefits/Issues

Bicyclist Comfort/ Safety – Alternative 2 is a significant improvement over existing conditions for bicyclists, as well as an improvement over Alternative 1. Separated bike lanes are provided in both directions throughout the corridor.

Vehicular Operations. – All corridor wide alternatives generally have similar vehicular operations, except for the possibility of parallel parkers, and transit vehicles blocking traffic.

Pedestrian Accommodations – The existing sidewalk width would be reduced slightly to 6.5 to 7 feet wide. The sidewalk condition will be upgraded to meet ADA guidelines.

Transit Impacts – Under existing conditions, in the northbound direction stopped busses currently block the bike lane and use portions of the parking lane. Under Alternative 2, northbound bus stops can be created out of the buffer space and parking area. The northbound bike lane will not be blocked. In the southbound

direction, buses will block traffic. Alternatively, a bus stop could be cut out of the bike lane and buffer. However, that creates a significant conflict for bicyclists.

Emergency Response – If emergency vehicles need to bypass traffic along the corridor, they would need to cross into the opposing lanes. Drivers are unable to pull into the bike lane .

Street Cleaning/ Snow removal. If sidewalk level bike lanes are constructed, very little special accommodation for street sweeping and snow removal. Bike lanes would be cleared at the same time as the sidewalks.

Parking Impacts – Alternative 2 removes all of the parking on one side of the roadway, thereby reducing the on-street parking supply by half. When cars are in the process of parallel parking, they will block through traffic.

Drainage Impacts – Since the curb line does change, the drainage will need modification. If the bike lane is sidewalk level, the drainage could be directed to the roadway butter. If the bike lane is not level with the sidewalk, separate drainage will be needed.

Alternative 3

Alternative 3 was developed to provide the best operations for vehicles, and well as the ideal configuration for bicyclists and pedestrians. Buffers can be provided between the sidewalk and separated bike lane. This alternative does not allow parking on either side of the roadway.

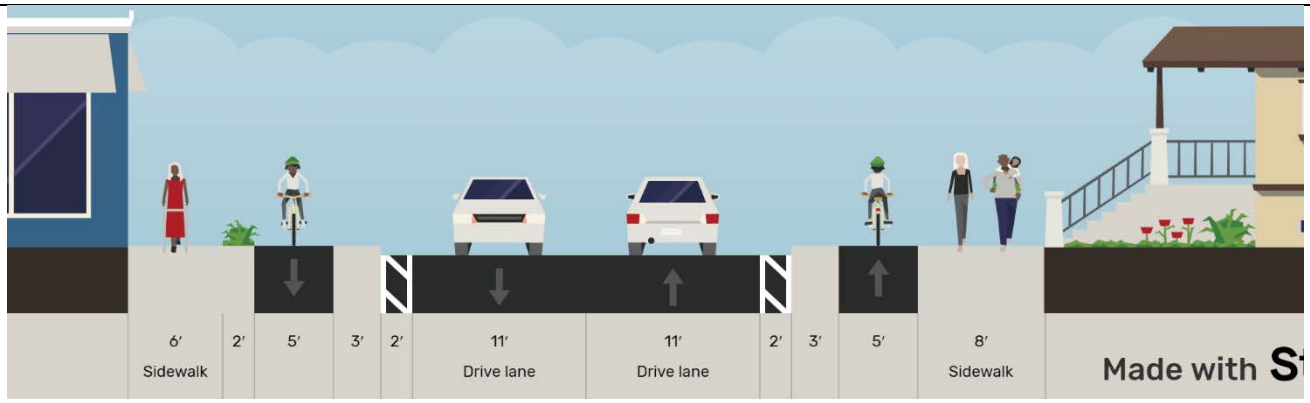
Improvements would consist of reconstruction of the roadway throughout the corridor, reconstruction of the curbing and reconstruction of the sidewalks and curb ramps. Intersection improvements would be incorporated as discussed in the following sections.

The graphic below shows the cross section of Alternative 3. This alternative modifies the existing width of the roadway.

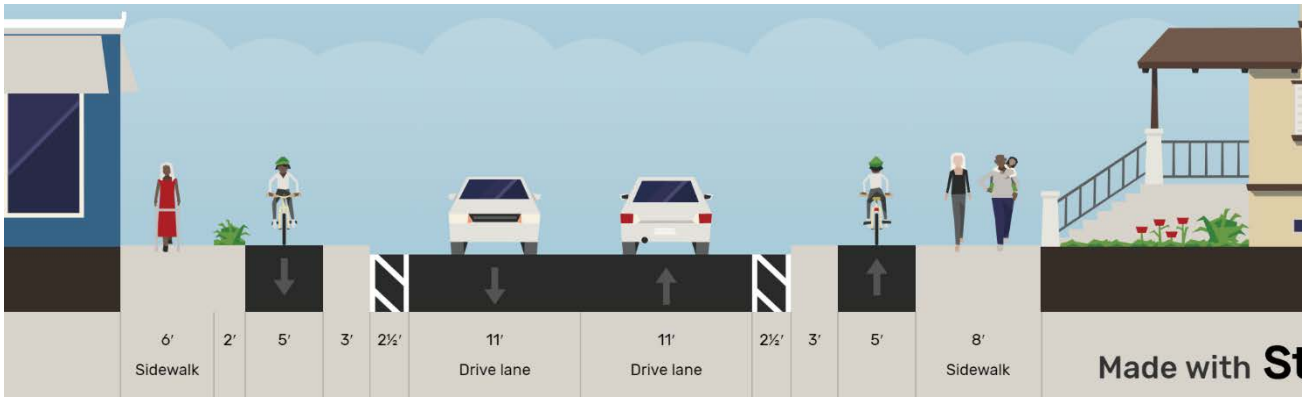
North of Gardner Road the cross section would consist of an 8-foot sidewalk on the west side of Washington Street. A portion of this 8-foot sidewalk can be used as a buffer between pedestrians and bicyclists. A 5-foot-wide separated southbound bike lane would be adjacent to the sidewalk. The bike lane could be street level or raised depending on drainage and maintenance needs. A 3-foot-wide curbed buffer would be provided adjacent to the southbound bike lane. A 2-foot-wide roadway shoulder would be provided on the west side of the roadway to accommodate roadway drainage. One 11-foot southbound and one 11-foot-wide northbound travel lane would be provided. A 2-foot-wide roadway shoulder would be provided on the east side of the roadway to accommodate roadway drainage. A 3-foot-wide buffer is provided between the roadway and the 5-foot-wide northbound

separated bike lane. The sidewalk on the eastern side of the roadway will be 8 feet wide. A portion of this 8-foot sidewalk can be used as a buffer between pedestrians and bicyclists.

This alternative does meet the requirements of the Healthy Transportation Policy.



Alternative 3 – North of Gardner Road



Alternative 3 – South of Gardner Road

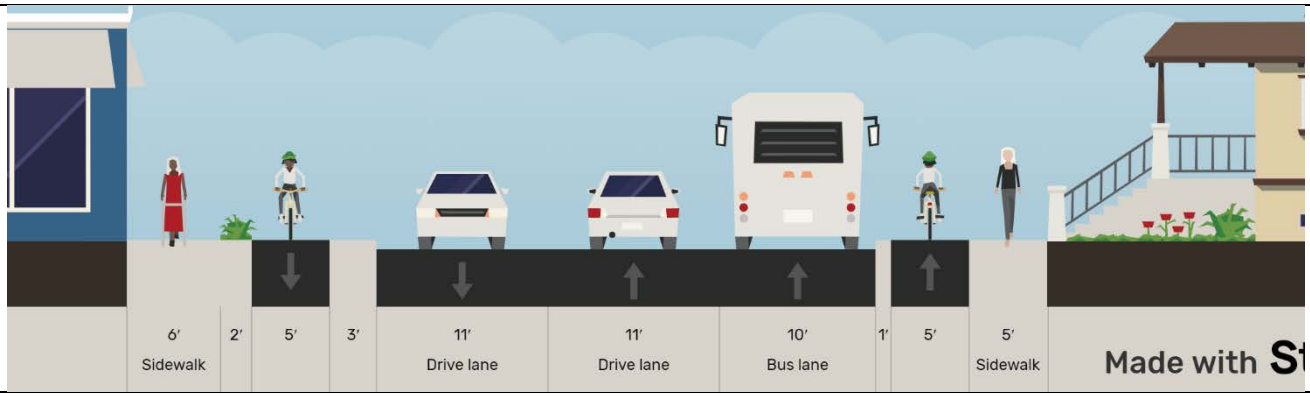


Figure 7 - Proposed Cross Section - Alternative 3

Benefits/Issues

Bicyclist Comfort/ Safety – Alternative 3 is a significant improvement over existing conditions for bicyclists, as well as an improvement over Alternative 1. Separated bike lanes are provided in both directions throughout the corridor.

Vehicular Operations. – All corridor wide alternatives generally have similar vehicular operations, except for the possibility of parallel parkers, and transit vehicles blocking traffic. Under Alternative 3, there is no parallel parking between Beacon Street and Harvard Street.

Pedestrian Accommodations – The sidewalks would be 8 feet wide. In areas with bus stops, the sidewalk may need to be narrowed to 5 feet wide. The sidewalk condition will be upgraded to meet ADA guidelines.

Transit Impacts – Under existing conditions, in the northbound direction stopped busses currently block the bike lane and use portions of the parking lane. Under Alternative 3, bus stops can be created out of the roadway width by narrowing sidewalk shoulders and buffer. Alternatively, the sidewalk can be kept full width by allowing buses to partially block traffic.

Emergency Response – If emergency vehicles need to bypass traffic along the corridor, they would need to cross into the opposing lanes. Drivers only have a 2-foot-wide shoulder.

Street Cleaning/ Snow removal. If sidewalk level bike lanes are constructed, very little special accommodation for street sweeping and snow removal. Bike lanes would be cleared at the same time as the sidewalks.

Parking Impacts – Alternative 3 removes all of the parking between Beacon Street and Harvard Street.

Drainage Impacts – Since the curb line does change, the drainage will need modification. If the bike lane is sidewalk level, the drainage could be directed to the roadway butter. If the bike lane is not level with the sidewalk, separate drainage will be needed.

4.2.2 Corridor Wide Improvement – Harvard Street to Station Street

The section of Washington Street to Station Street is currently generally two lanes in each direction, with on-street parking and bike lanes in each direction, separated by a raised median. Immediately south of Harvard Street, the right-of-way is the narrowest (with only a single southbound lane, before widening out.

Both Alternative A and Alternative B improve safety and comfort for bicyclists. Neither alternative change the sidewalk curb location. Alternative A removes the southbound parking lane while Alternative B removes the median island.

Alternative A

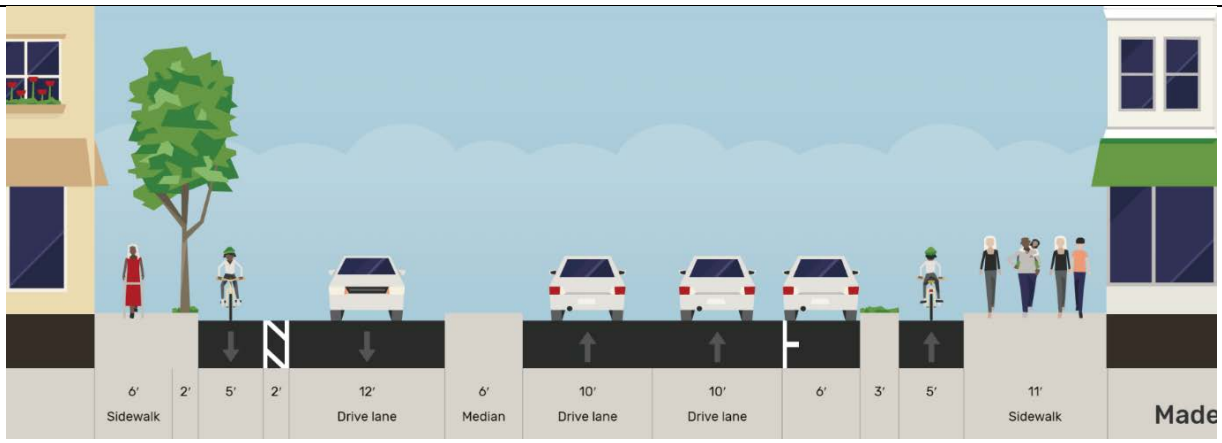
Alternative A provides an on-road buffered bike lane in the southbound direction and a separated bike lane in the northbound direction. The on-street parking along the southbound direction of Washington Street would be removed. This would result in removing 5 parking spaces in this segment.

The graphic below shows the cross section of Alternative A. This alternative maintains the existing width of the roadway while reconfiguring the uses.

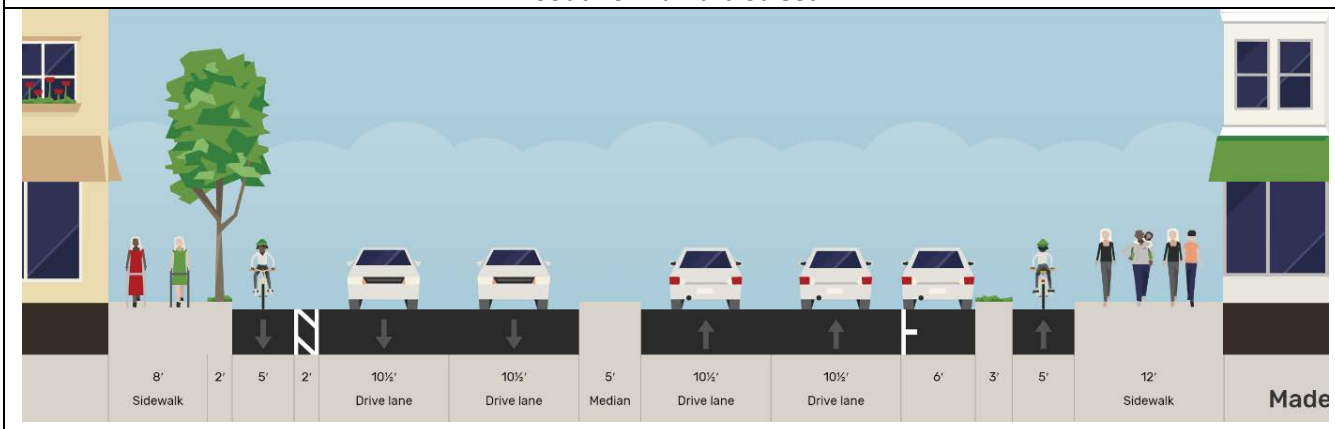
North of Station Street, the cross section would consist of a 6-foot sidewalk and 2-foot planting strip, similar to existing conditions. A 5-foot-wide on-road southbound bike lane would be adjacent to the curb, as well as a 2-foot-wide striped buffer. Two southbound lanes and two northbound lanes would be provided similar to existing conditions. The 5-6-foot-wide raised median would be shifted under this configuration. A parking lane is provided on the eastern (northbound) side of the roadway. A separated bike lane would be provided on the sidewalk side of the parking lane, separated by a three-foot-wide buffer.

The area south of Harvard Street is transitioning from the signalized intersection and widening to accommodate the two southbound lanes at Station Street.

This alternative does meet the requirements of the Healthy Transportation Policy.



South of Harvard Street



North of Station Street

Figure 8 - Proposed Cross Section - Alternative A

Alternative B

Alternative B provides on-road bike lane in the southbound direction and a separated bike lane in the northbound direction. The raised median on Washington Street would be removed.

The graphic below shows the cross section of Alternative B. This alternative maintains the existing width of the roadway while reconfiguring the uses.

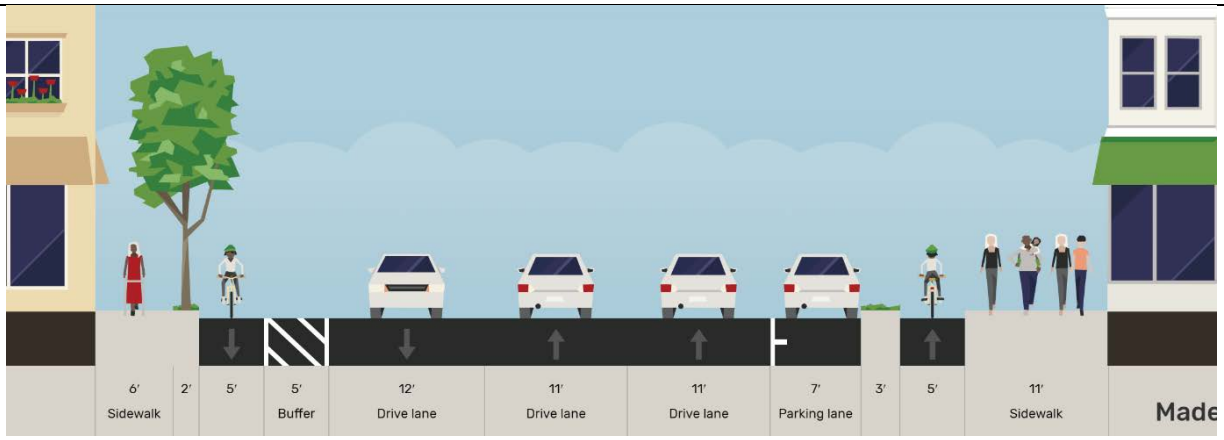
North of Station Street, the cross section would consist of a 6-foot sidewalk and 2-foot planting strip, similar to existing conditions. A 5-foot-wide on-road southbound bike lane would be adjacent to the on-street parking. The parking width was increased by 1 foot to reduce the likelihood of dooring.

Two southbound lanes and two northbound lanes would be provided similar to existing conditions. The 5-6-foot-wide raised median would be removed. A parking

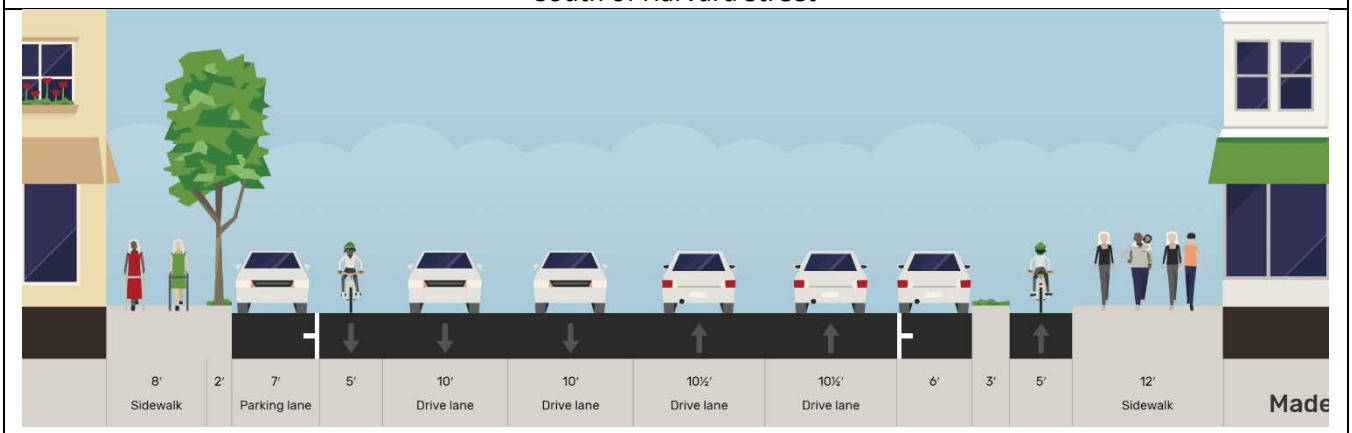
lane is provided on the eastern (northbound) side of the roadway. A separated bike lane would be provided on the sidewalk side of the parking lane, separated by a three-foot-wide buffer.

The area south of Harvard Street is transitioning from the signalized intersection and widening to accommodate the two southbound lanes at Station Street.

The section without the buffer does not meet the requirements of the Healthy Transportation Policy.



South of Harvard Street



North of Station Street

Figure 9 - Proposed Cross Section - Alternative B

4.2.1 Intersection Improvement

The following improvements are recommended at specific intersections along the corridor. These improvements are independent of the corridor wide improvements and can match any of the three alternatives.

In addition to the corridor wide roadway improvements, we recommend corridor wide signal improvements throughout the Washington Street corridor. These include replacing the

existing signal equipment. The new signal equipment will be equipped with adaptive traffic signal control, to better manage peak hour traffic flows. In addition, transit signal propriety will be incorporated into the traffic signal phasing.

Washington Street at Beacon Street

The intersection of Washington Street and Beacon Street is currently signalized on both sides of the MBTA Green Line tracks. The green line trolley movements are included in the signal system.

The proposed improvements at this intersection will consist of extending the northbound Washington Street left turn lane and smoothing the alignment of the through lanes slightly. In addition, new traffic signal equipment would be implemented at the two intersections. The new traffic signal equipment will be incorporated with coordination with the MBTA due to the MBTA Green line. Adaptive traffic signal system and transit signal priority will be incorporated into the traffic signal.

Washington Street at Fairbanks Street

There is an unsignalized crosswalk across Washington Street at this intersection. Improvements at this location consist of the installation of a Rectangular Rapid Flashing Beacon.

Washington Street at Garner Road

This intersection is wide and features a median island. While the median island does provide some pedestrian refuge, the width of the islands preclude the installation of a southbound bike lane. We recommend tightening the geometry of the intersection, removing the islands and modifying the curb ramps to eliminate the existing apex curb ramps.

Washington Street at Park Street

The intersection of Washington Street and Park Street is currently signalized. The traffic signal hardware is outdated and needs to be updated to include a new fully actuated intersection. A crosswalk is proposed to be added to the northern leg of the intersection.

Adaptive traffic signal system and transit signal priority will be incorporated into the traffic signal. The timing plan for the intersection would be optimized.

Washington Street at Weybridge Road

The curb alignment on the northwestern corner of the intersection was modified. The realignment will shorten the pedestrian crossing across Weybridge Street, and slow right turning traffic from Washington Street to Weybridge Road.

Washington Street at Greenough Street

There is an unsignalized crosswalk across Washington Street at this intersection. Improvements at this location consist of the installation of a Rectangular Rapid Flashing Beacon.

Washington Street at Cypress Street & School Street

The intersection of Washington Street and Cypress Street/School Street is currently signalized. The traffic signal hardware is outdated and needs to be updated to include a new fully actuated intersection. Adaptive traffic signal system and transit signal priority will be incorporated into the traffic signal.

The School Street approach can be modified slightly. Currently, the two lanes are both allowed as through movements. This requires two receiving lanes on Cypress Street. If the rightmost lane on School Street is converted to an exclusive right turn lane, the departure can be narrowed, providing a shorter crossing for pedestrians.

The intersection is currently set on pedestrian recall. Due to the high volume of pedestrians, keeping the pedestrian recall can be continued.

Washington Street at Thayer Street

There is an unsignalized crosswalk across Washington Street at this intersection. Improvements at this location consist of the installation of a Rectangular Rapid Flashing Beacon.

Washington Street at Harvard Street, Harvard Street at Kent Street and Washington at Davis Avenue/Andem Place

Two Alternatives have been identified at this location

Signalized Alternative

The intersection of Washington Street and Kent Street is currently signalized and functions with a single controller that operates the Davis Avenue/Andem Place intersection. The traffic signal hardware is outdated and needs to be updated to include a new fully actuated intersection. Adaptive traffic signal system and transit signal priority will be incorporated into the traffic signal.

Roundabout Alternative

A roundabout alternative was reviewed at this location. A graphic showing the potential linework is shown below. Full concepts have not been developed since there are issues associated with the roundabout.

For the concept for the roundabout, a 100-foot diameter roundabout was used. This diameter was selected to accommodate turning trucks. As shown, this diameter uses a large amount of the right-of-way, including the triangular plaza

area. The Davis Street and Andem Place approaches would not be included in the roundabout and would likely be limited to right-in/right-out.

One of the primary concerns about the roundabout is how it fits with the current roadway system. The Washington Street northbound movement to Harvard Street has very little deflection. The horizontal deflection within a roundabout is what slows drivers entering and circulating through a roundabout. The other concern is the close proximity of the Kent Street and Harvard Street approaches, which can lead to conflicts.

Pedestrian crosswalks would need to be incorporated using rectangular rapid flashing beacons (RRFB's). Based on the roadway geometry, a roundabout is not recommended.

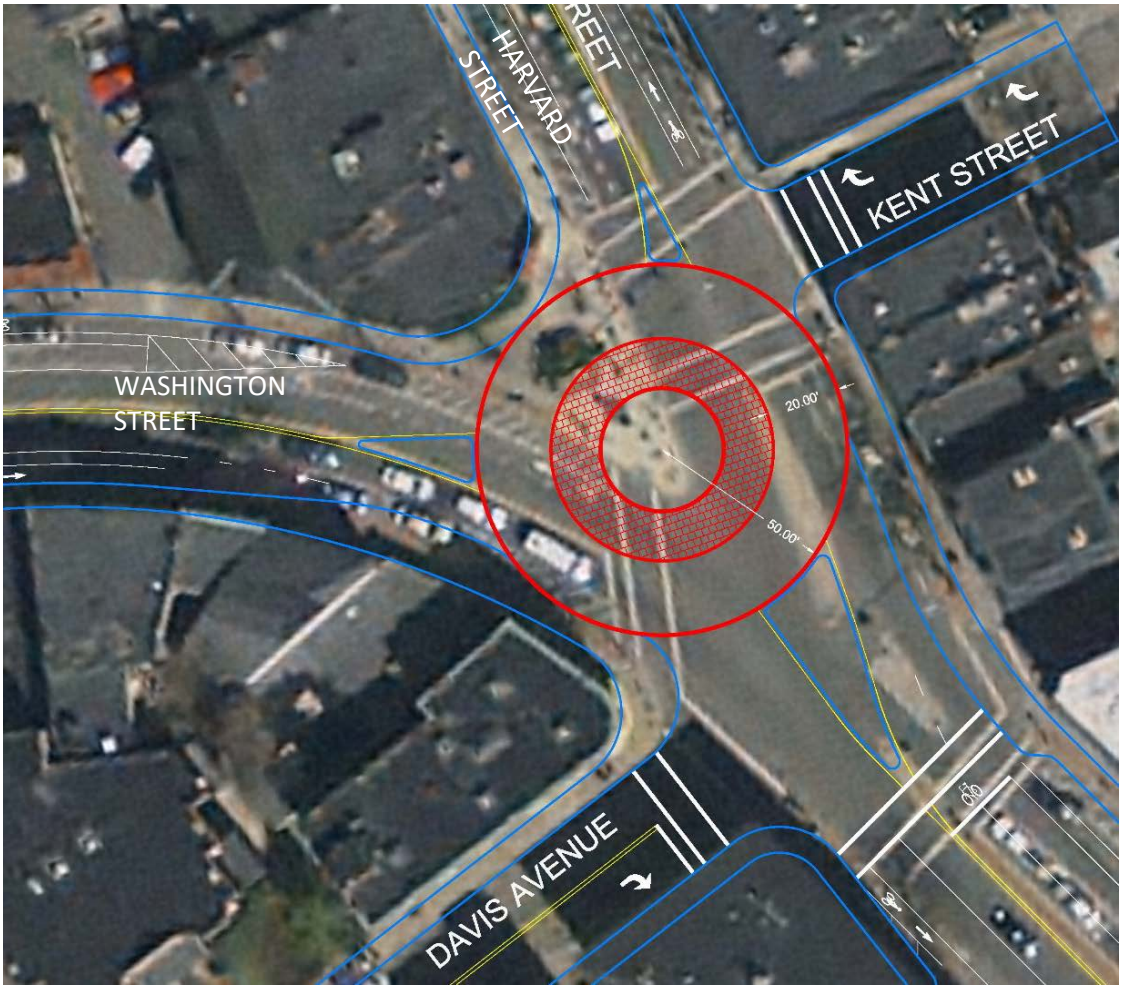


Figure 10 – Potential Roundabout Impacts

Washington Street at Station Street

The intersection of Washington Street and Station Street is currently signalized. The improvements proposed at this location consists of the installation of new traffic signal hardware, including controller, video detection and APS pedestrian equipment.

4.3 Traffic Operations with Proposed Improvements

To effectively assess the operations of the proposed improvements, the Synchro capacity analyses previously outlined for existing and Future No-Build conditions were updated to reflect the work mentioned in Section 4.1. The results are shown in Table 12. To provide a comparison between the alternatives, the results of Alternative 1 and 2 were compared with Alternative 3 in Table 12. As shown in the analysis, there is very little difference to vehicular operation between the Alternatives.

4.3.1 Future Build Analysis

Table 12 includes the v/c ratios, delays, and queues for the four intersections on the Washington Street corridor. Included are results for the AM Peak Hour and PM Peak Hour during future 2032 Build traffic conditions.

Washington Street at Beacon Street

The intersection of Washington Street and Beacon Street is currently signalized.

The capacity analyses indicate that with the 2032 No-Build LOS is a “C” in both the AM and PM peak hours. Under all three alternatives, the overall intersection LOS remains the same with little or no change in the delays.

Washington Street Park Street

For this intersection, the timing was updated slightly.

The capacity analyses indicate that with the 2032 No-Build LOS is a “C” in both the AM and PM peak hours. Under all Alternatives 1 and 2, the overall intersection remains at LOS C. Under Alternative 3, the LOS improves to LOS B during the PM peak. It should be noted that there is little difference in delay between the alternatives.

Washington Street at Cypress Street & School Street

The intersection of Washington Street and Cypress Street/School Street is currently signalized. The capacity analyses indicate that with the 2032 No-Build LOS is a “D” in both the AM and PM peak hours. Under all three alternatives, the overall intersection LOS remains the same with little or no change in the delays.

Washington Street at Davis Avenue/Andem Place Street & Harvard Street at Kent Street

The intersection of Washington Street and Kent Street currently functions as a single controller that operates the Davis Avenue/Andem Place intersection as well. The capacity analysis indicates that under 2032 No-Build case the Davis Avenue/Andem Place portion of the intersection is a "C" in both the AM and PM peak hours. Under all three alternatives, the overall intersection LOS remains the same with little or no change in the delays.

The Kent Street approach to the intersection was found to operate at LOS C during the morning peak, but LOS F during the evening peak hour.

ROUNDABOUT

A roundabout was evaluated at the intersection of Washington Street/ Harvard Street/ Kent Street. The results are shown in Table 11 below. Based on the capacity analysis, a roundabout would function well at this location.

Table 11 - Intersection Level of Service Summary

Intersection/ Peak Period/Movement	2032 Roundabout Alternative			
	Sat[a]	Delay[b]	LOS[c]	Queue[e] 95th
Washington Street at Harvard Street				
Weekday Morning Peak Hour:				
Washington Street NB	0.49	6.1	A	126
Kent Street SWB	0.20	12.0	B	29
Harvard Street SB	0.50	8.0	A	93
Washington Street EB	0.38	8.4	A	65
Overall	**0.38**	**7.6**	**A**	
Weekday Evening Peak Hour:				
Washington Street NB	0.42	6.3	A	97
Kent Street SWB	0.38	11.7	B	59
Harvard Street SB	0.50	9.3	A	96
Washington Street EB	0.52	11.1	B	108
Overall	**0.52**	**9.1**	**A**	

[a] Degree of Saturation; [b] Average Delay per vehicle (sec); [c] Level of Service;
[d] 95th Percentile Queue Length (veh); [e] Percentile Queue Length (ft);

Washington Street at Station Street

There were no changes proposed at this intersection that will impact capacity

Washington Street at Minor Side Street Intersections

The following minor intersections were reviewed and their operation with stop sign control evaluated under 2032 No-Build and Build conditions. The following intersections were analyzed:

- Washington Street at Gardner,
- Washington Street at Holden Street

Both intersections resulted in adequate LOS for both No Build and Build conditions and required no additional improvements.

Table 12 - Intersection Level of Service Summary with Improvements

Intersection/ Peak Period/Movement	Alternative 1 or 2 Build Conditions				Alternative 3 Build Conditions			
	v/c[a]	Delay[b]	LOS[c]	Queue[e] 50th/95th	v/c	Delay	LOS	Queue 50th/95th
Washington Street at Beacon Street WB								
Weekday Morning Peak Hour:								
Beacon Street WB TR	0.64	28.8	C	170/231	0.64	28.8	C	170/231
Washington Street NB L	0.52	8.3	A	18/m29	0.52	8.5	A	18/m127
Washington Street NB T	0.47	5.5	A	46/m59	0.47	5.7	A	46/m59
Washington Street SB TR	0.60	27.3	C	150/203	0.60	27.3	C	150/203
Overall	**0.63**	**21.0**	**C**		**0.63**	**21.1**	**C**	
Weekday Evening Peak Hour:								
Beacon Street WB TR	0.93	44.5	D	280/#412	0.93	44.5	D	280/#412
Washington Street NB L	0.63	9.8	B	18/m174	0.63	9.8	B	18/m174
Washington Street NB T	0.44	4.3	A	34/m44	0.44	4.3	A	34/m44
Washington Street SB TR	0.57	26.7	C	137/188	0.57	26.7	C	137/188
Overall	**0.84**	**28.3**	**C**		**0.84**	**28.3**	**C**	
Washington Street at Beacon Street EB								
Weekday Morning Peak Hour:								
Beacon Street EB L	0.84	64.7	E	99/#228	0.84	64.7	E	99/#228
Beacon Street EB TR	0.95	31.7	C	~475/#646	0.95	31.7	C	~475/#646
Washington Street NB TR	0.56	27.3	C	117/166	0.58	26.8	C	115/164
Washington Street SB L	0.84	28.5	C	26/#217	0.84	28.5	C	26/#217
Washington Street SB TR	0.62	5.6	A	13/18	0.62	5.6	A	13/18
Overall	**1.03**	**29.3**	**C**		**1.03**	**29.3**	**C**	
Weekday Evening Peak Hour:								
Beacon Street EB L	0.82	59.9	E	99/#228	0.82	59.9	E	99/#228
Beacon Street EB TR	0.55	14.2	B	190/250	0.55	14.2	B	190/250
Washington Street NB TR	0.64	28.9	C	137/191	0.61	28.2	C	137/191
Washington Street SB L	0.71	16.5	B	11/#75	0.72	16.7	B	11/#75
Washington Street SB TR	0.58	4.7	A	11/15	0.59	4.7	A	11/15
Overall	**0.69**	**20.3**	**C**		**0.69**	**20.2**	**C**	
Washington Street at Gardner Road								
Weekday Morning Peak Hour:								
Washington Street WB LT	0.05	1.4	A	4	0.05	1.4	A	4
Gardner Road NB LR	0.44	22.7	C	53	0.44	22.9	C	54
Weekday Evening Peak Hour:								
Washington Street WB LT	0.06	1.7	A	5	0.06	1.7	A	5
Gardner Road NB LR	0.27	19.1	C	26	0.27	19.2	C	26

Table 12 - Intersection Level of Service Summary (Cont'd)

Intersection/ Peak Period/Movement	Alternative 1 or 2 Build Conditions				Alternative 3 Build Conditions			
	v/c[a]	Delay[b]	LOS[c]	Queue[d] 95th	v/c	Delay	LOS	Queue[d] 95th
Washington Street at Park Street								
Weekday Morning Peak Hour:								
Washington Street EB L	0.51	11.4	B	21/86	0.56	12.8	B	21/86
Washington Street EB T	0.47	9.3	A	72/251	0.49	9.8	A	72/251
Washington Street WB TR	0.83	27.3	C	146/#461	0.82	26.0	C	139/#402
Park Street SB LR	0.69	31.1	C	77/#280	0.65	27.2	C	68/#280
Overall	**0.73**	**20.3**	**C**		**0.71**	**19.5**	**B**	
Weekday Evening Peak Hour:								
Washington Street EB L	0.28	12.6	B	9/42	0.32	13.8	B	9/42
Washington Street EB T	0.42	9.9	A	65/227	0.44	10.7	B	65/227
Washington Street WB TR	0.88	31.3	C	231/#679	0.85	28.7	C	231/#679
Park Street SB LR	0.83	46.5	D	117/#377	0.76	36.8	D	117/#377
Overall	**0.81**	**27.7**	**C**		**0.78**	**24.7**	**C**	
Washington Street at Cypress Street & School Street								
Weekday Morning Peak Hour:								
Washington Street EB L	0.79	61.0	E	91/#220	0.79	61.0	E	91/#220
Washington Street EB TR	0.83	52.0	D	256/#458	0.83	52.0	D	256/#458
Washington Street WB L	0.16	33.4	C	12/38	0.16	33.4	C	12/38
Washington Street WB TR	0.76	47.1	D	222/#349	0.76	42.3	D	217/#349
Cypress Street NB L	0.55	47.8	D	100/172	0.55	47.8	D	100/172
Cypress Street NB TR	0.85	38.8	D	340/522	0.85	38.8	D	340/522
School Street SB LT	0.76	48.3	D	189/303	0.76	48.3	D	189/303
School Street SB TR	0.33	35.8	D	69/128	0.33	35.8	D	69/128
Overall	**0.80**	**45.8**	**D**		**0.80**	**45.0**	**D**	
Weekday Evening Peak Hour:								
Washington Street EB L	0.60	46.1	D	56/#135	0.60	46.1	D	56/#135
Washington Street EB TR	0.94	72.4	E	321/#549	0.94	72.4	E	321/#549
Washington Street WB L	0.52	42.5	D	32/#90	0.52	42.5	D	32/#90
Washington Street WB TR	0.85	56.1	E	269/#459	0.76	47.8	D	269/#459
Cypress Street NB L	0.66	53.4	D	129/207	0.66	53.4	D	129/207
Cypress Street NB TR	0.67	29.4	C	251/376	0.67	29.4	C	251/376
School Street SB LT	0.79	49.8	D	264/392	0.79	49.8	D	264/392
School Street SB TR	0.59	40.9	D	140/230	0.59	40.9	D	140/230
Overall	**0.79**	**49.8**	**D**		**0.79**	**48.4**	**D**	
Washington Street at Holden Street								
Weekday Morning Peak Hour:								
Washington Street EB LT	0.10	3.5	A	--/9	0.10	3.5	A	--/9
Holden Street SB LR	0.22	13.2	B	--/21	0.22	13.2	B	--/21
Weekday Evening Peak Hour:								
Washington Street EB LT	0.04	1.5	A	--/3	0.04	1.5	A	--/3
Holden Street SB LR	0.35	13.3	B	--/40	0.35	13.3	B	--/40

Table 12 - Intersection Level of Service Summary (Cont'd)

Intersection/ Peak Period/Movement	Alternative 1 or 2 Build Conditions				Alternative 3 Build Conditions			
	v/c[a]	Delay[b]	LOS[c]	Queue[d] 95th	v/c	Delay	LOS	Queue[d] 95th
Kent Street at Harvard Street								
Weekday Morning Peak Hour:								
Kent Street WB LR	0.75	65.9	E	128/#248	0.75	65.9	E	128/#248
Harvard Street NB T	0.41	1.3	A	23/33	0.41	1.3	A	23/33
Harvard Street SB T	0.78	49.6	D	281/#438	0.78	49.6	D	281/#438
Overall	**0.53**	**30.7**	**C**		**0.53**	**30.7**	**C**	
Weekday Evening Peak Hour:								
Kent Street WB LR	1.20	174.6	F	~356/#568	1.20	174.6	F	~356/#568
Harvard Street NB T	0.34	1.8	A	27/43	0.34	1.8	A	27/43
Harvard Street SB T	0.93	71.6	E	~381/#619	0.93	71.6	E	~381/#619
Overall	**0.67**	**81.1**	**F**		**0.67**	**81.1**	**F**	
Washington Street at Davis Avenue & Andem Place								
Weekday Morning Peak Hour:								
Davis Avenue EB LTR	0.72	66.7	E	91/#217	0.72	66.7	E	91/#217
Andem Place WB TR	0.01	47.6	D	1/7	0.01	47.6	D	1/7
Washington Street NB L	0.62	38.0	D	231/349	0.62	38.0	D	231/349
Washington Street NB TR	0.80	47.8	D	299/#473	0.80	47.8	D	299/#473
Harvard Street SB LT	0.51	2.1	A	5/23	0.51	2.1	A	5/23
Harvard Street SB R	0.07	0.3	A	0/m0	0.07	0.3	A	0/m0
Washington Street SE TR	0.58	37.2	D	160/273	0.58	37.2	D	160/273
Overall	**0.67**	**34.4**	**C**		**0.67**	**34.4**	**C**	
Weekday Evening Peak Hour:								
Davis Avenue EB LTR	0.53	58.5	E	54/130	0.53	58.5	E	54/130
Andem Place WB TR	0.02	52.0	D	2/11	0.02	52.0	D	2/11
Washington Street NB L	0.77	50.3	D	242/370	0.77	50.3	D	242/370
Washington Street NB TR	0.64	42.6	D	207/317	0.64	42.6	D	207/317
Harvard Street SB LT	0.68	3.4	A	35/m36	0.68	3.4	A	35/m36
Harvard Street SB R	0.12	0.6	A	0/m0	0.12	0.6	A	0/m0
Washington Street SE TR	0.84	58.4	E	246/#427	0.84	58.4	E	246/#427
Overall	**0.74**	**33.4**	**C**		**0.74**	**33.4**	**C**	
Washington Street at Station Street								
Weekday Morning Peak Hour:								
Washington Street NB TR	0.73	18.9	B	154/220	0.73	18.9	B	154/220
Washington Street SB LT	0.81	16.0	B	86/118	0.81	16.0	B	86/118
Overall	**0.55**	**17.6**	**B**		**0.55**	**17.6**	**B**	
Weekday Evening Peak Hour:								
Washington Street NB TR	0.67	18.8	B	107/157	0.67	18.8	B	107/157
Washington Street SB LT	0.84	17.7	B	110/157	0.84	17.7	B	110/157
Overall	**0.52**	**18.1**	**B**		**0.52**	**18.1**	**B**	

*[a] Volume to Capacity Ratio; [b] Average Delay per vehicle (sec); [c] Level of Service; [d] 95th Percentile Queue Length (veh); [e] Percentile Queue Length (ft); NB = Northbound; SB = Southbound; EB = Eastbound; WB = Westbound; L = Left Turn; T = Through; R = Right Turn; LT = Shared Left/Through; TR Shared Through/Right; LR = Shared Left/Right; LTR = Shared Left/Through/Right; * - Demand greatly exceeds capacity; v/c Ratio, Delay, and Queue not calculated; # - 95th percentile volume exceeds capacity; queues are calculated for two signal cycles and may extend longer; ~ - Volume exceeds capacity, queue is theoretically infinite*

5.0 Conclusion

The Washington Street roadway and sidewalk are currently in poor condition. The roadway does not properly service drivers, pedestrians or bicyclists. The following locations have been identified as being high crash clusters and are eligible for funding -assistance through the Highway Safety Improvement Program (HSIP):

- Washington Street from Boylston Street to Holden Street (2007-2016 HSIP Bicycle & Pedestrian Cluster);
- Harvard Street from Washington Street to School Street (2007-2016 HSIP Bicycle & Pedestrian Cluster);
- Washington Street at Beacon Street (Washington Square) is (2007-2016 HSIP Bicycle Cluster)

Three corridor wide alternatives were identified for the main portion of the corridor, (from Beacon Street to Harvard Street) while two alternatives were identified for the shorter portion of Washington Street south of Harvard Street. All alternatives would greatly improve safety and comfort for bicyclists and pedestrians, while providing efficient operations for drivers. The most significant difference between alternatives is the treatment of bicycle facilities. They range in scope from buffered on-street bicycle lanes to off-road separated bicycle facilities. Alternatives 1 & 2 utilize the existing roadway width and do not require significant Right-of-Way to construct. Sidewalks and crossings will be upgraded to provide ADA compliant facilities.

For all of the recommended alternatives, the existing signalized intersections along the corridor will have all of the traffic signal equipment replaced.

Alternative 2 is the recommended alternative.

6.0 Appendices

6.1 Traffic Volume Counts

6.2 Crash Data

6.3 Traffic Background Growth

6.4 Signal Warrants

6.5 Level of Service Analyses – Existing Traffic Volumes with Existing Geometry

6.6 Level of Service Analyses – Future Traffic Volumes with Existing Geometry

6.7 Level of Service Analyses – Future Traffic Volumes with Improvements

ROAD SAFETY AUDIT

Washington Street

Town of Brookline

December 2020

Prepared For:
MassDOT

Massachusetts Department of Transportation

Prepared By:
WorldTech Engineering
300 TradeCenter, Woburn, MA

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Background

The FHWA, Federal Highway Administration, defines a Road Safety Audit, RSA, as the formal safety examination of an existing or future road or intersection by an independent, multidisciplinary team. The purpose of an RSA is to identify potential safety issues and possible opportunities for safety improvements considering all roadway users. Portions of Washington Street have been identified as being high crash clusters and are eligible for funding assistance through the Highway Safety Improvement Program (HSIP):

- Washington Street from south of Boylston Street to Holden Street (2007-2016 HSIP Pedestrian Cluster).
- Washington Street from south of Boylston Street to Thayer Street (2008-2017 and 2007-2016 HSIP Bicycle Cluster)
- Harvard Street from Washington Street to Harvard Avenue (2008-2017 HSIP Bicycle & Pedestrian Cluster).
- Washington Street at Beacon Street (Washington Square) (2008-2017 and 2007-2016 HSIP Bicycle Cluster)

An HSIP-eligible location is a crash cluster that ranks within the top 5% of each Regional Planning Agency (in this case Metropolitan Area Planning Council), based on the Equivalent Property Damage Only (EPDO) index, where Property Damage Only crashes = 1 point; Fatal and Injury crashes = 21 points.

Project Data

The RSA for Washington Street was held on December 10, 2020. Due to COVID-19 restrictions, the meeting was held virtually on Zoom.

As indicated in Table 1, the safety audit team included a cross section of engineering, planning, advocacy, and emergency response expertise with representatives from the Town of Brookline Planning Staff, Town of Brookline Engineering Department, the Massachusetts Department of Transportation (MassDOT), the Town of Brookline Police Department, the Town of Brookline Fire Department, the MBTA, Boston MPO, WalkBoston, and WorldTech Engineering (WorldTech). WorldTech's role was to facilitate the RSA. Contact information for participating audit team members is included in Appendix B.

Background material including crash history, and videos of the corridor, were provided to audit team members prior to the RSA. The invitation and agenda are included in Appendix A. Crash records provided by the Town of Brookline Police Department were used to compile the collision diagrams and crash data summary information. Appendix C provides the detailed crash data for the study area.

Table 1: Participating Audit Team Members

Audit Team Member	Agency/Affiliation
Ana Fill	MassDOT Traffic Safety
Michelle Deng	MassDOT Traffic Safety
Amitai Lipton	MassDOT District 6 Traffic
Brian Levine	MassDOT District 6 Project
Jesus Bastardo	MassDOT District 6 Traffic
Thomas Hannon	MassDOT Traffic Safety Intern
Erin Kennihan	MassDOT District 6 Project
Chris Sarno	MassDOT District 6 Project
Courtney Worhunsky	MassDOT Highway Design
Robert Guptill	MBTA
Chen-Yuan Wang	CTPS (Boston Region MPO)
Robert Sloane	Walk Boston
Dan Martin	Town of Brookline Transportation
Dean Groves	Town of Brookline Engineering
Todd Kirrane	Town of Brookline Transportation
Cpt. Tom Ferris	Town of Brookline Police Department
Todd Cantor	Town of Brookline Fire Department
Alan Cloutier	WorldTech Engineering
Christian Poste	WorldTech Engineering
Tim McGrath	WorldTech Engineering – On Washington Street

The RSA group identified existing safety issues and potential safety enhancements, both short and long term for the Washington Street corridor. The RSA included a pre-site visit, virtual site visit and post-site visit. Safety issues were discussed during the pre-site visit both from member's knowledge of the intersection and based on collision diagram materials. Audit members then conducted a virtual site visit as a group identifying actual roadway conditions as well as issues that were not mentioned during the pre-site visit session. The site visit was accomplished virtually using pre-recorded videos due to Covid-19 restrictions. In addition, WorldTech had an engineer on-site to check on site conditions during the virtual RSA meeting.

Finally, during the post-site visit members identified potential safety enhancements considering both short and long term improvements for each issue.

Crash Data

During the three-year study period from January 1, 2015 to December 31, 2017, the Brookline Police Department (BPD) reported a total of 27 crashes at the intersection of Washington Street/ Beacon Street. Of these crashes, 63 % occurred during the hours of 2 PM -8PM.

Of the 27 crashes that occurred at this location, eight (30 %) were single vehicle crashes (six of which involved parked or parking vehicles), six (22 %) were angle crashes, three (11 %) were rear-end crashes (2 of which were drivers stopping for pedestrians crossing), three (11 %) were sideswipe crashes, three (11 %) were pedestrian crashes and four (15%) were bicyclist crashes. The majority of crashes occurred under

daylight conditions (20 crashes, 74 %), with clear weather (20 crashes, 74 %), and a dry road surface (20 crashes, 74 %). There were 10 crashes (37 %) that resulted in injury.

During the same time period 12 crashes were reported at the intersection of Washington Street/ Harvard Street and Kent Street. Of the 12 crashes that occurred at this location, six (50 %) were single vehicle crashes, three (25 %) were rear-end crashes, two (17 %) were sideswipe crashes and one (8%) was a pedestrian crash. Three (25 %) crashes occurred from 12 pm to 2 pm. The majority of crashes occurred under daylight conditions (8 crashes, 67 %), with clear weather (12 crashes, 100 %), and a dry road surface (11 crashes, 92 %). There were 3 crashes (25 %) that resulted in injury.

Pedestrian/ Bicycle

Pedestrian and Bicyclists crash data was also research for a ten-year study period from January 1, 2010 to December 31, 2019. During this time period, the Brookline Police Department (BPD) reported a total of 28 pedestrian or bicyclist crashes at the intersection of Washington Street/ Beacon Street and Washington Street/ Westbourne Terrace. Of these 28 crashes, 13 involved a pedestrian and 15 involved a bicycle. One noticeable trend was four crashes that involved a bicyclist and a westbound Beacon Street vehicle at Westbourne Terrace. Two (2) of the pedestrian crashes involved rear-end crashes due to drivers stopping for pedestrians on a marked crosswalk.

Most crashes happened between the hours of 6-8 AM (6 crashes -22%) followed by crashes between 8-10 AM (5 crashes - 19 %), 2-4 PM (5 crashes - 19 %) and 6-8 PM (5 crashes - 19 %).

It was reported that 7 (25 %) of crashes occurred outside daylight hours. Based on the crash reports 4 (14 %) of the crashes involved a wet roadway surface. Of the 28 crashes, 17 (61 %) involved an injury.

During this same time period, the Brookline Police Department (BPD) reported a total of 14 pedestrian or bicyclist crashes on Washington Street between Gardner Road and School Street. Of these 14 crashes, 9 involved a pedestrian and 5 involved a bicycle. One (1) of the pedestrian crashes involved rear-end crash due to the driver stopping for a pedestrian on a marked crosswalk.

Most crashes happened between the hours of 8-10 AM (4 crashes -29 %) followed by crashes between 2-4 PM (3 crashes -21 %),4-6 AM (3 crashes -21 %) and 6-8 PM (2 crashes -14 %).

It was reported that 3 (21 %) of crashes occurred outside daylight hours. Based on the crash reports 2 (14 %) of the crashes involved a wet roadway surface. Of the 14 crashes, 6 (43 %) involved an injury.

The Brookline Police Department (BPD) reported a total of 12 pedestrian or bicyclist crashes on Washington Street between Thayer Road and Station Street. Of these 12 crashes, 8 involved a pedestrian, 3 involved a bicycle and one crash was a pedestrian/ bicyclist crash. Two (2) of the pedestrian crashes involved rear-end crashes due to drivers stopping for pedestrians on a marked crosswalk.

Most crashes happened between the hours of 12-2 PM (3 crashes - 25%) followed by crashes between 6-8 AM (2 crashes - 17%), 8-10 AM (2 crashes - 17%) and 2-4 PM (2 crashes - 17%).

It was reported that 2 (17%) of crashes occurred outside daylight hours. Based on the crash reports, none of the crashes involved a wet roadway surface. Of the 12 crashes, 7 (58%) involved an injury.

Project Location and Description

The study location is shown on the locus map in Figure 1.

Washington Street
Washington Street generally extends in a northwest/southeast direction between two commercial districts: Washington Square to the northwest and Brookline Village to the southeast. It provides a connection to Brookline High School via the recently improved Greenough Street. The project begins at the Washington Street/ Beacon Street intersection (MBTA Green Line C Branch Washington Square Station) and continues in southeasterly direction to Gardner Road where Washington Street becomes southbound heading toward Route 9. It also intersects with the Brookline Village Station stop on the MBTA Green Line D Branch and is served by the Route 65 MBTA bus. The Brookline Town Hall, the Public Library of Brookline, the Public Safety Building and Brookline Fire Station #7 are all located along Washington Street as well as a large residential neighborhood.

Washington Street is a two-lane urban minor arterial roadway with auxiliary turn lanes at major intersections. Well-marked crosswalks are generally present at major intersections with protected signal phases.

Sidewalks are provided on both sides of the Washington Street corridor. There are 5 unsignalized crosswalks across Washington Street between Beacon Street and Station Street. All side streets intersecting Washington Street have marked crosswalks.

All roadways and traffic control signals in the project area are under the jurisdiction of the Town of Brookline.

Existing Bicycle Accessibility

Existing bicycle accommodations consist of a 5-foot wide bike lane along portions of Washington Street adjacent to a 6-foot wide on street parking throughout. The northbound on-street bike lane is present for the entirety of the study area while the southbound on-street bike lane is present between Beacon Street and Gardner Road and Harvard Street and Station Street.

The Town of Brookline recently prepared an update to their bicycle network plan.[1] The Washington Street corridor has been identified as one of Brookline's major connectors for cyclists travelling from Brookline and Newton to Kenmore Square and downtown Boston. The groundwork for a significant improvement in a "Complete Streets" solution for the corridor has been completed with specific recommendations for improved cycling and pedestrian amenities.

Transit

The MBTA Green Line Branches C and D operate on the north and south ends of the corridor, respectively.

At the north end of the corridor, the C branch travels in the middle of Beacon Street. The Washington Square station on the Green Line C stop is located on the eastern side of the intersection

[1] Green Routes Bicycle Network Plan, Brookline Advisory Committee, January 2019

of Washington Street and Beacon Street. This line operates from 4:57 AM to 12:07 AM on weekdays and has peak hour headways of 6 minutes and off-peak headways of 9-11 minutes.

At the southern end of the corridor, the Green Line D branch runs south of Station Street and White Place.

The Brookline Village Station is located off Station Street approximately 250 feet east of Washington Street. This line operates from 4:56 AM to 12:05 AM on weekdays and has peak hour headways of 6-8 minutes and off-peak headways of 8-11 minutes.

The MBTA bus route 65 operates along the entire Washington Street corridor, connecting the Town Hall, library , residential neighborhoods and the two MBTA Green line Stations to Kenmore Square to the east and Brighton Center to the west. None of the bus stops along the corridor have shelters. The 2020 summer schedule operates from 5:58 AM to 8:28 PM on weekdays, with headways of 8 minutes or less during the peak hours.

The MBTA bus Route 66 connects Harvard Square to Nubian Square and has one stop within the study limits, just north of Kent Street. The 2020 summer schedule operates from 5:00 AM to 1:00 PM on weekdays, with headways of 9-10 minutes or less during the peak hours.

Washington Street at Salisbury Road

This intersection is a three legged unsignalized intersection. Washington Street northbound and southbound consist of a single travel lane. Salisbury Road is a Stop controlled two-way residential roadway, which is approximately 21 feet wide. On-road parking is provided on both sides of Washington Street and on the south side of Salisbury Road. Curb extensions are provided at the intersection.

Sidewalks are provided on both sides of Washington Street and both sides of Salisbury Street. Crosswalks are provided across Washington Street south of the intersection and across Salisbury Road. Curb ramps are provided, but there are no tactile warning panels. An on-road bike lane is provided on Washington Street northbound.

Washington Street at Beacon Street

This location is commonly known as Washington Square. Washington Street intersects Beacon Street to form a 4-way signalized intersection, bisected by the Green Line Rail. Beacon Street is an east-west major roadway and is functionally classified as an urban principal arterial. Beacon Street westbound has one through lane and one shared through/right lane, while Beacon Street eastbound has a left turn lane, one through lane and one shared through/right lane. Left turns are prohibited on Beacon Street westbound, with vehicles allowed the maneuver farther west at the Winthrop Road intersection. Both Washington northbound and southbound have a left turn lane and a shared through/right lane. The Washington Square Green Line stop is adjacent to this intersection. The MBTA also operates the Route 65 bus at this location, with stops on Washington Street south of the intersection. This location is designated as an HSIP high crash location for bicycles.

Sidewalks are provided on both sides of Beacon Street and both sides of Washington Street. There is a sidewalk within the Beacon Street median to access the on-street parking and the Washington Square MBTA Station. There are signalized crosswalks across Washington Street, north of the intersection, within the median (north of the Green Line) and south of the intersection. There are crosswalks across Beacon

Street westbound, east and west of the intersection and across Beacon Street eastbound east and west of the intersection. There are curb ramps at all of the crosswalks and tactile warning panels on all of the crossings except the southwestern corner. The crossings all include countdown pedestrian heads.

There is no bike accommodations on Washington Street at this location. On Beacon Street eastbound and westbound, there are shared lane markings approaching the intersection and on road bike lanes departing the intersection.

At the intersection of Beacon Street at Westbourne Terrace, there is an eastbound to westbound Beacon Street U-turn lane and a westbound to eastbound Beacon Street U-turn lane. North of Beacon Street, Westbourne Terrace is one-way northbound, departing the intersection. Drivers can access the northbound section of Westbourne Terrace from the Beacon Street eastbound to westbound U-turn. In the eastbound direction, the Beacon Street approach consists of a left turn lane and two through lanes. In the westbound direction, the Beacon Street approach consists of a left turn lane and two through lanes. A crosswalk is provided across Westbourne Terrace; mid-block crosswalks are provided across Beacon Street approximately 230 feet to the east of this location.

Washington Street at Brookline Fire Station #7

Washington Street is a bi-directional two-lane roadway consisting of one lane in each direction separated by a double yellow center line. The fire station driveway connects from the east to form a three legged intersection. There is an emergency signal that is only operational when activated by the fire department. Bike lanes are provided in each direction with parking allowed next to the curb except for directly in front of the Fire Station. Sidewalks are provided on both sides of Washington Street. There are no crosswalks present.

Washington Street at Fairbanks Street

Washington Street is a bi-directional two-lane roadway consisting of one lane in each direction separated by a double yellow center line. Fairbanks Street connects from the east to form a three legged intersection. Fairbanks Street is one-way westbound and is stop-controlled. Bike lanes are provided in each direction on Washington Street. Sidewalks are provided on both sides of Washington Street and both sides of Fairbanks Street. There is a crosswalk across Washington Street south of the intersection and a crosswalk across Fairbanks Street. The crosswalk across Washington Street does not provide ADA compliant ramps. Stops for the MBTA Route 65 bus are located on both sides of Washington Street north of the intersection for the southbound direction and south of the intersection for the northbound direction.

Washington Street at Gardner Road

Washington Street is a bi-directional two-lane roadway consisting of one lane in each direction separated by a median refuge island. Gardner Road connects from the west to form a three legged intersection. Gardner Road is a two-way roadway, separated at the intersection by a scored concrete median island and is stop-controlled at the intersection. Bike lanes are provided in each direction on Washington Street. Sidewalks are provided on both sides of Washington Street and both sides of Gardner Road. There is a crosswalk across all three legs of the intersection. Curb ramps and tactile warning panels are provided. The two ramps on the Gardner Road side are Apex ramps. Stops for the MBTA Route 65 bus are located on both sides of Washington Street north of the intersection.

Washington Street at Park Street

Park Street intersects with Washington Street to form a 3-legged signalized intersection. Park Street is functionally classified as an urban collector. Park Street provides a shared left/right approach lane. Washington northbound provides a shared through/right lane and a bike lane with parking. Washington southbound provides an exclusive left turn lane and a through lane with sharrows. Stops for the MBTA Route 65 bus are located on both sides of Washington Street north of the intersection. The intersection provides signal heads, but countdown heads are not present and the pushbuttons are not equipped with APS. There is a crosswalk across Washington Street south of the intersection and across Park Street east of the intersection.

Washington Street at Greenough Street

Washington Street is a bi-directional two-lane roadway consisting of one lane in each direction separated by a double yellow center line. Greenough Street connects from the southwest to form a three legged intersection. Greenough Street is a two-way roadway and provides access to the Brookline High School. Greenough Street is stop-controlled at the intersection. Bike lanes are provided in the northbound direction only. Shared Lane Markings are provided on Greenough Street and Washington Street in the southbound direction. Sidewalks are provided on both sides of Washington Street and both sides of Greenough Street. There is a crosswalk across Washington Street (with RRFB's present) and Greenough Street. Curb ramps are provided, but there are no tactile warning panels. Stops for the MBTA Route 65 bus are located on both sides of Washington Street slightly south of the intersection.

Washington Street at Cypress Street/ School Street

School Street and Cypress Street meet with Washington Street to form a skewed 4-way signalized intersection. All roadways at this location are classified as urban minor arterials. Washington Street southbound provides an exclusive left turn lane, a through lane with sharrows, and a channelized right turn lane. Washington Street northbound provides an exclusive left turn lane, a through lane with sharrows, and a channelized right turn lane. School Street provides two lanes: a shared left/through lane and a shared through /right lane. Cypress Street provides an exclusive left turn lane and a shared through/right lane. Stops for the MBTA Route 65 bus are located on both sides of Washington Street south of the intersection.

The intersection provides marked crosswalks, across all legs of the intersection. Due to the atypical geometry of this intersection, an additional crosswalk connecting the northeast corner of School Street with the southwest corner of Cypress Street is present. The intersection also provides pedestrian signal heads, and pushbuttons equipped with APS. Crosswalks have brick treatment.

All crosswalk ramps have tactile warning panels. All signals have countdown displays.

Washington Street at Thayer Street

Washington Street is a bi-directional two-lane roadway consisting of one lane in each direction separated by a double yellow center line. Thayer Street connects from the west to form a three legged intersection. Thayer Street is a two-way roadway and is stop-controlled at the intersection. Bike lanes are provided in the northbound direction only.

Sidewalks are provided on both sides of Washington Street and both sides of Thayer Street. There is a crosswalk across Washington Street south of the intersection and across Thayer Street. Curb ramps and

tactile warning panels are provided. The MBTA also operates the Route 65 bus at this location, with stops on both sides of Washington Street.

Washington Street at Holden Street

Washington Street is a bi-directional two-lane roadway consisting of one lane in each direction separated by a double yellow center line. Holden Street connects from the northeast to form a three legged intersection. Holden Street is a two-way roadway and is stop-controlled at the intersection. Bike lanes are provided in the northbound direction only. Sidewalks are provided on both sides of Washington Street and both sides of Holden Street. There is a crosswalk across Holden Street. Curb ramps are provided, but there are no tactile warning panels.

Washington Street at Harvard Street/Davis Avenue/Andem Place and

Harvard Street at Kent Street

Washington Street intersects Harvard Street, Davis Avenue and Andem Place while Harvard Street intersects Kent Street to form two very closely spaced signalized intersections. Washington Street is a northwest-southeast roadway and Harvard Street is a north-south roadways: both roadways are functionally classified as urban minor arterials. Davis Avenue and Andem Place are east-west local roads. Kent Street is an east-west urban collector.

Washington Street northbound provides a left turn/ bear left lane to access Washington Street and Davis Avenue and a through/bear right lane to access Harvard Street; the left lane is separated from southbound traffic by a median while scored concrete separates the northbound lanes just to the north of the intersection.

Harvard Street has one lane approaching Washington Street. Washington Street southbound provides a through/right turn lane, as left turns are prohibited. Davis Avenue has one general purpose lane approaching the intersection, while Andem Place provides a very narrow general purpose lane.

Kent Street is one way towards the intersection of Harvard Street providing one general purpose lane. Harvard Street northbound and southbound approaches consist of one through lane.

Parking is allowed on both sides of Washington Street, both sides of Harvard Street, along the south side of Kent Street, the north side of Davis Avenue and the south side of Andem Place.

MBTA Routes 65 and 66 operate through this location with bus stops near the intersection. Route 65 has northbound and southbound stops on Washington Street north of the intersection. Route 66 has northbound and southbound stops on Harvard Street north of Kent Street. The intersection provides marked crosswalks across all legs of both intersection, curb ramps, pedestrian signal heads, and pushbuttons.

Bike lanes are present on both sides of Harvard Street, both sides of Washington Street south of the intersection and on the northwest direction of Washington Street north of the intersection.

Tactile warning panels are not provided at the ramps across Davis Avenue or Andem Place.

Washington Street at Station Street

Station Street meets Washington Street to form a 3-legged signalized intersection that essentially functions as a signalized pedestrian crossing since Station Street is a one-way roadway away from the intersection. Station Street is an east-west roadway that is classified as an urban collector. The Washington Street

southbound approach provides a shared left/through lane and a through lane. Washington Street northbound approach provides a through lane and a shared through/right-turn lane.

Parking is provided on both sides of the street along Station Street as well as on Washington Street north of the intersection.

Washington Street provides a bike lane in each direction. The Brookline Village Green line stop is just to the east of the intersection along Station Street. The intersection provides marked crosswalks, across Station Street as well as across the northern leg of Washington Street.

Pedestrian signal heads, and pushbuttons are present. Tactile warning panels are not provided at three of the wheelchair ramps.

PREPARED FOR:	TITLE:		DATE: 9/3/21	SCALE: N.T.S.
	Rehabilitation of Washington Street Brookline, Massachusetts	N	PREPARED BY: WORLDTECH ENGINEERING 300 TRADE CENTER, SUITE 5580 WOBURN, MASSACHUSETTS 01801 PHONE: 781.933.4800	Figure 1
	Locus Map			

Audit Observations and Potential Safety Enhancements

Audit team members were solicited for their observations during the meetings before and after the field visit, as well as during the field visit. The team members offered the following observations on roadway and intersection issues as they relate to safety. The team members also discussed potential safety enhancements that could be implemented to mitigate the safety-related observations. Team members were encouraged to consider short-, medium-, and long-term safety enhancements.

Safety Issue #1: Substandard Pedestrian Facilities

Washington Street experiences high volumes of pedestrian activity, especially at the two ends, near Beacon Street (Washington Square) and Station Street (Brookline Village). Along the corridor, there are many uncontrolled pedestrian crossings.

The crosswalks along the corridor are different styles. At signalized intersections, the Town uses transverse lines. At unsignalized midblock crossings ladders markings are used. Within the business districts, brick style is used. While no crashes can be directly attributed to this, constancy would help drivers more easily identify crosswalks.

The curb reveal along the corridor is low, providing poor delineation between the roadway and sidewalk. No crashes involved vehicles driving onto the sidewalk.

Some of the intersections within the study area include Apex pedestrian ramps. Apex ramps do not give clear directions to pedestrians, especially for visually impaired pedestrians.

On-street parking is located close to crosswalks along the corridor on both sides of the road. Because of the parking, it is difficult to see pedestrians using the crosswalk. This is especially pronounced in the area of the Brookline Village Library. Two rear end crashes were specifically tied to vehicles stopping for pedestrians at marked crosswalks.

The conditions of the sidewalks along many portions of the corridor are poor, with root damage causing raised panels and overgrowth vegetation blocking the path on sidewalk and parts of the sidewalk which can cause tripping. Additionally, some portions of the sidewalk do not provide the minimum 3 feet of clearance. In locations where sidewalks are difficult to navigate, due to poor pavement or obstructions, people may choose to walk on the street, particularly if pushing strollers or using equipment to assist with walking such as walkers and wheelchairs.

<u>Washington Street/ Salisbury Road</u>
This intersection may soon see increased pedestrian volume, due to nearby school construction at the Driscoll School. Tactile warning panels are currently missing on all ramps.

Even though curb extensions are present at this location, visibility issues remain as indicated on 2 pedestrian crashes recorded at the crosswalk that mentioned drivers not seeing the pedestrians.
RRFB's are proposed to be installed at this location as part of the school project.

Washington Street / Beacon Street
The R10-15 (Right turns yield to pedestrians) signs facing northbound Washington Street and eastbound Beacon Street are text based and not as easy to understand as the graphical version of the sign. One reported crash involved an eastbound vehicle making a right turn striking a bicycle on the crosswalk.

The pedestrian crossings have concurrent phasing which required pushing the button to activate prior to Covid 19. This intersection is the only location within the corridor with a leading pedestrian interval (LPI) at the crosswalk across Beacon Street eastbound, east of Washington Street. The crosswalks are set back from the intersection making it more difficult for turning vehicles to see the pedestrians in the crosswalk. Two crashes involving southbound left turns and crossing pedestrians may be related to this condition. In addition, a westbound Beacon Street driver struck a pedestrian at the northern leg intersection and an eastbound Beacon Street driver struck a cyclist in the crosswalk across the southern leg.

The intersection is a very wide intersection with lots of activity - pedestrians, bicyclists, green line, etc. - which may make it difficult for drivers to navigate and may make it harder to see pedestrians and bicyclists. Two pedestrian crashes occurred when pedestrians were not in marked crossings.

The two curb ramps on the northeast corner do not have tactile warning panels. The intersection does not include countdown pedestrian signals however the push buttons do include APS signals.

Beacon Street/ Westbourne Terrace
This intersection may soon see increased pedestrian volume, due to nearby school construction at the Driscoll School which will increase student numbers.

A crosswalk is not present across Beacon Street at this intersection although desire lines are present due to the location of the Green Line Washington Square station while Two crashes involved pedestrians crossing Beacon Street at this location while two crashes occurred at the crosswalk just east of intersection. Although it has warning signage (including advanced), due to the location of the crosswalk and existing vegetation including foliage and a large tree it may be difficult to see. There is parking on both sides of the street (including angle parking) near the crosswalk across Beacon Street eastbound which may also impede visibility as well as provide additional distractions to the drivers. Overhead lighting also appears to be insufficient.

Washington Street/ Fairbanks Road
The crosswalk across Washington Street is missing curb ramps. The ramps on the crosswalk across Fairbanks Road do not align well with the crosswalk as they are apex style ramps, although they only serve one crosswalk. The crosswalk at Fairbanks Road does not have warning signage. There were two pedestrian crashes at this crosswalks one of which involved a vehicle stopping to allow a pedestrian to cross and got rear -ended.

Washington Street/ Brookline Fire Station #7
It was noted that there have been issues with pedestrian on the sidewalk in front of the fire station seemingly unaware when firetrucks are pulling in or out. No reported crashes were attributed to this condition.

Washington Street/ Gardner Road

The Town has recently installed a rectangular rapid flashing beacon (RRFB) at the intersection of Washington Street and Gardner Road. However, it was not yet active at the time of the RSA. One pedestrian crash occurred at the crosswalk across Washington Street north, while another pedestrian crash occurred at the Gardner Road crosswalk. A third pedestrian crash occurred south of the intersection, when a person crossed behind a bus (since this is not at a bus stop, it is presumed the bus was either not stopped or stopped in traffic).

It was noted during the audit that it is difficult to see pedestrians on the crosswalk possible due to the road curvature as well as the presence of trees.

The pedestrian warning sign northbound (prior to Gardner) is faded and missing the AHEAD plaque which can cause confusion regarding location of crosswalk. Also, the crosswalk sign is partially blocked in the northbound direction by a tree.

Washington Street / Park Street

The intersection of Washington Street/ Park Street does not have a crosswalk across the northern Washington Street leg of the intersection.

The intersection does not include countdown pedestrian signals, or accessible pedestrian signals. The pedestrian phasing is exclusive phasing. Tactile warning panels are missing at a few of the ramps at the Park Street intersection. There were no reported pedestrian crashes.

Washington Street/ Greenough Street

The Town has recently installed a curb extension on Washington Street near Greenough Street to shorten the pedestrian crossing across Washington Street. An RRFB was installed as well. This improvement was implemented in 2020 and is not reflected in the crash data. One pedestrian was struck crossing the Greenough Street crosswalk. A rear-end crash was caused by a vehicle stopping for a pedestrian crossing at the Washington Street crosswalk was also reported.

The Greenough Street crossing is frequently used by high school students. The volume of students is expected to increase as well, due to the nearby construction at the high school. The crosswalk across Greenough Street is very long (approximately 45 feet long), which increases pedestrian exposure to vehicles. Additionally, the bus stop may block visibility of the crosswalk when buses are stopped. The ramps on the crosswalk across Greenough Street do not align well with the crosswalk as they are apex style ramps, although they only serve one crosswalk. One pedestrian crash noted dusk/dark condition, indicating overhead lighting may be an issue. There is only one overhead light provide on the east side of Washington Street at this intersection.

Washington Street/ Weybridge Road

The radius at Weybridge Road is very wide, resulting in a very long pedestrian crossing and higher speed right turning vehicles. The longer crosswalk requires more exposure of the pedestrian to motor vehicles. The curb ramps do not have tactile warning panels. Higher speed vehicles can increase injury levels, as well as making it harder to see and stop in time for pedestrians. No pedestrian crashes were reported at this location.

Washington Street/ School Street/ Cypress Street

The crossing across Cypress Street is long due to the intersection skew, which increases exposure of pedestrians and results in longer pedestrian crossing time and delays. The intersection has atypical

intersection geometry, and long distances for drivers to cross, making it difficult to see pedestrians. These issues are compounded by the presence of concurrent phasing with absence of LPI's. Three pedestrians were struck in the crosswalk across Cypress Street.

It was mentioned that southbound left turns cannot clear the intersection when turning which could create a conflict with pedestrians across the School Street and Washington Street crosswalks.

There is an alley for a rear parking lot associated to a business at 385-395 Washington Street. The entrance/ exit for the alley is not included in the traffic signal and it is the only driveway for the business. Due to nearby buildings, the driveway is difficult to be seen by pedestrians on the sidewalk while the drivers' visibility is also limited. One pedestrian was struck on the sidewalk at this location by a driver exiting the driveway.

Washington Street/ Holden Street
This intersection does not have ADA compliant curb ramps. There were 2 pedestrian crashes at this intersection, although they were not attributed to the lack of curb ramps.

Washington Street/ Thayer Street
Crosswalk visibility may be limited due to parked cars and vegetation. Lack of advanced warning signage may further contribute to difficulty seeing the crosswalk. Two rear end crashes occurred on Washington Street when vehicles stopped for crossing pedestrians. In addition, there was one bicyclist/ pedestrian crash, at the Washington Street crosswalk and one crash involving a bicycle on a marked crosswalk was also reported, although no information was available indicating which crosswalk.

Washington Street/ Harvard Street
This intersection has concurrent pedestrian phasing but does not include leading pedestrian intervals. Leading pedestrian intervals improve safety by giving pedestrians with concurrent phasing a 3-7 second head start. LPIs enhance the visibility of pedestrians in the intersection and reinforce their right-of-way over turning vehicles. Since the intersection has building close to the roadway, it is sometimes difficult for turning drivers to see pedestrians about to cross the adjacent crosswalk. For instance, it is difficult for Davis Road eastbound drivers to see pedestrians crossing Washington Street south of the intersection. It is difficult for southbound Washington Street drivers to see pedestrians in the Davis Road crosswalk.

The right turn from Davis Avenue onto Washington Street is heavy, and during the red phase, drivers may be looking left to see if there is a gap. Right turns on red are allowed on this approach; a sign stating, "Right Turn on Red After Stop" is present. Additionally, no pedestrian heads are provided to cross Davis Road. One pedestrian was struck crossing the Davis Avenue crosswalk by a right turning vehicle.

The curb ramps across Davis Avenue and Andem Place, the Washington Street south crosswalk and the western side of the Washington Street north crosswalk are all apex ramps and do not have tactile warning panels. The pedestrian signal heads at the intersection of Harvard Street are the older text based "Walk/Don't Walk' pedestrian signal face. The intersection does not include countdown pedestrian signals, or accessible pedestrian signals.

One pedestrian crash was reported at the Washington Street crosswalk south of the intersection.

Washington Street / Station Street
This intersection does not have ADA compliant curb ramps. This intersection provides older pedestrian signal heads, with no countdown signal or accessible pedestrian signals.

There were 2 pedestrian crashes at this intersection.

The traffic signal is effectively a pedestrian signal. The signal faces have poor visibility , with mostly post mounted signals, without backplates. Due to the poor visibility, drivers are more likely to drive through the red light.

Potential Enhancements

- Reconstruct the sidewalks along Washington Street to remove obstructions making it difficult for a pedestrian to traverse the corridor (brick, heaving panels, etc.).
- Reconstruct the curbing to provide better delineation between the roadway and sidewalk.
- Evaluate pedestrian clearance times at the signalized intersections.
- Restrict parking near crosswalks to improve visibility of pedestrians.
- Consider lowering speed limits on roadway in the vicinity of the school properties. These include Washington Street, Salisbury Road and Beacon Street.
- Evaluate curb extensions to improve pedestrian visibility at crosswalks.
- Trim vegetation to avoid sidewalk obstructions and improve crosswalk visibility.

Washington Street/ Beacon Street

- The R10-15 (Right turns yield to pedestrians) sign facing northbound Washington Street and eastbound Beacon Street traffic should be changed to the graphical version of the sign, to be more easily understood.
- Consider implementing leading pedestrian intervals (LPI's) at all crossings.
- Evaluate crosswalk locations to improve pedestrian visibility.
- Consider upgrading pedestrian signals to include countdown signal and APS.
- Install tactile warning panels where missing.

Beacon Street/ Westbourne Terrace

- Evaluate providing crosswalk across Beacon Street connecting to green line.
- Evaluate RRFBs at mid-block crosswalk to the south of Westbourne Terrace.
- Consider secondary access for the MBTA Washington Square Green Line Station at Westbourne Terrace.
- Trim vegetation to not obscure pedestrian warning signage.
- Evaluate lighting at the intersection, in particular pedestrian scale lighting.

Washington Street/ Fairbanks Road

- Install additional signage and improved pavement markings for crosswalk at Fairbanks Road. The signage would include W11-2 (Pedestrian Crossing), W16-7P (Diagonal Downward Pointing Arrow), and W16-9P (AHEAD) plaques. Inclusion of signage should conform with MUTCD compliance.
- Consider installing rectangular rapid flashing beacons (RRFB) at the Washington Street crosswalk at Fairbanks Road to improve visibility of pedestrian crossing.
- Install ADA compliant ramps at the crosswalk across Washington Street.
- Evaluate ramps alignment on crosswalk across Fairbanks Road and modify if feasible.
- Consider adding curb extensions to improve visibility.

Washington Street/ Brookline Fire Station #7

- Install signage warning pedestrians of the conflict area with emergency vehicles.

Washington Street/ Park Street

- Add an additional crosswalk across the northern leg of Washington Street at the signalized Park Street intersection.
- Replace curb ramps with ADA compliant ramps with tactile warning panels.
- Consider upgrading pedestrian signals to include countdown and APS.

Washington Street/ Weybridge Road

- Consider tightening the radius at Weybridge Road to reduce the crossing distance and to slow turning vehicles.
- Replace curb ramps with ADA compliant ramps with tactile warning panels.

Washington Street/ Greenough Street

- Consider signage identifying Greenough Street to alert drivers of its presence.
- Evaluate lighting at the intersection, in particular pedestrian scale lighting.
- Evaluate ramps alignment on crosswalk across Greenough Street and modify if feasible.
- Evaluate location of crosswalk across Greenough Street.

Washington Street/ School Street/ Cypress Street

- Review lane configuration for the two lane departure on Cypress Street. If one lane can be removed, a pedestrian refuge can be provided.
- Consider adding leading pedestrian intervals (LPI's)
- Provide signage, including potentially audible warning, for driveway at 385-395 Washington Street. Alternatively, include driveway into the signal and provide associated pedestrian infrastructure including crosswalk, pedestrian signal indications, etc.
- Evaluate signal timing including pedestrian clearance intervals.

Washington Street/ Harvard Street

- Replace the older pedestrian heads at the intersection of Harvard Street with new, countdown pedestrian heads and APS.
- Consider adding leading pedestrian intervals (LPI's)
- Review right turn on red at Davis Avenue. Consider prohibiting right turns on red or changing Davis Avenue to one way away from the intersection to eliminate conflicts.
- Provide signal heads across Davis Avenue.
- Replace curb ramps with ADA compliant ramps with tactile waning panels, as appropriate.

Washington Street/ Station Street

- Replace the older pedestrian heads with new, countdown pedestrian heads and APS.
- Install retroreflective backplates.
- Consider providing mast arm signal heads.
- Replace curb ramps with ADA compliant ramps with tactile waning panels.

Safety Issue #2: Substandard Bicycle Facilities

A total of 19 bicycle crashes were reported on the Washington Street corridor from Salisbury Street to Station Street between 2010 and 2019. Within the project area there is a northbound 5 foot wide bike lane, while a 5 foot wide bike lane is provided in the southbound direction between Beacon Street to Gardner Road and Harvard Street to Station Street which creates segments without bicycle accommodations. The bike lane is located between a six foot wide parking lane and a 10-11 foot wide travel lane. During the field visit, parked vehicles were observed partially encroaching on the bike lane due to the narrow width of the adjacent travel lane and parking lane. When car doors are opened, they block the bike lane and may collide with a bicyclist. Five of the crashes can be attributed to bicyclists being hit by a door or having to swerve to avoid a vehicle in the bike lane.

Beacon Street crash #7 involved a driver striking a bicyclists and pushing them into a parked car, Beacon Street crash #26 had a car parked in bike lane and hit the bike with door. At Washington Street southbound near Gardner Road crash # 2 involved a bicyclist striking a forklift blocking the bike lane, crash #4 on Cypress Street involved a vehicle opening the door. Crash #3 at Station Street involved a vehicle opening the door.

The bike lanes pavement markings are faded which makes it difficult for drivers to see the bike lanes. In addition, no pavement markings are provided within intersections to guide bicyclists.

The bike accommodations on Beacon Street vary. In the eastbound direction, bicyclists share a lane with drivers approaching Washington Street. A bike lane is provided in the eastbound direction east of Washington Street. In the westbound direction, there is a westbound bike lane. However, approaching Washington Street, there is a gap, where bicyclists share a vehicular lane. The Bike Advisory Committee has previously asked the MBTA about fitting of bike lanes in median of Beacon Street.

Pavement condition is also very poor, making it difficult for a bike to traverse the corridor. None of the bicyclist crashes were specifically attributed to the pavement conditions.

<u>Washington Street/ Beacon Street</u>
Washington Street at Beacon Street is a large intersection which increases exposure to conflicting vehicles. There were 10 bicycle crashes that occurred at this location.

There is a lack of dedicated facilities for bicycles at this intersection, especially crossing the tracks. There are no bike lanes approaching the intersection on Beacon Street or Washington Street. Six of the crashes involved bikes traveling outside of marked bike lanes.

There is a lack of colored bicycle lane conflict markings (green paint) across conflict areas. One crash involved a cyclist in the bike lane and a vehicle entering a driveway.

<u>Beacon Street/ Westbourne Terrace</u>
There is limited sight distance for Beacon Street westbound drivers approaching Westbourne Terrace. In addition, the overhead lighting may not be sufficient and contribute to visibility problems. Three of the five crashes reported at this location occurred outside daylight hours.

It was also mentioned during the audit that speeds are higher in the evening which, coupled with high volumes, may make it difficult for drivers to find gaps to cross. The speed differential between bicycles

and vehicles and the need of vehicles to accelerate quickly to cross Beacon Street may also have contributed to the four crashes involving westbound bicycles and drivers crossing into Westbourne Terrace. One additional crash occurred at the westbound to eastbound U-turn.

Washington Street/ School Street/ Cypress Street
It was noted during the audit that the northbound right turn on the Washington Street approach at Cypress Street/ School Street queues and blocks the bikes lane. No bicycle crashes were attributed to this.

Potential Enhancements

- Consider removing parking along the corridor to eliminate conflicts and provide sufficient spaces for bike accommodations.
- Add a bike lane in the southbound direction between Gardner Road to Davis Road. This would result in continuous bike lanes in both directions from Beacon Street to Station Street.
- Consider providing cycle tracks, separated bike lanes or parking separated bike lanes on Washington Street.
- Consider bike lane extensions with green pavement markings at intersections and conflict zones.
- Consider bike boxes or turn two-stage queue box at intersections.
- Improve the pavement condition along the corridor.
- Provide better delineation for the bike lanes.

Washington Street/ Beacon Street
- Consider implementing bike lanes on Beacon Street eastbound approaching Washington Street and Beacon Street westbound approaching Washington Street.
- Consider implementing bike lanes on Washington Street northbound and southbound through the intersection with Beacon Street.

Beacon Street/ Westbourne Terrace
- Review possible improvements to the sight distance on Beacon Street westbound approaching Westbourne Terrace.
- Evaluate prohibiting through movements from the Beacon Street U-turn onto Westbourne Terrace by revising travel patterns in area. This would need to be coordinated with school drop-off/pick-up patterns.
- Review overhead street lighting at the intersection of Beacon Street/ Westbourne Terrace.

Washington Street/ School Street/ Cypress Street
- At the intersection of Washington Street/ School Street/ Cypress Street, provide protection for the northbound bike lane.

Safety Issue #3: Intersection Geometry, Operations, Signage and Pavement Markings

Due to the Covid-19 Pandemic, Brookline has temporarily changed all Town owned signals to automatic pedestrian recall (do not need to push the button). Brookline is evaluating whether to keep signals on pedestrian recall afterwards. MassDOT added an LPI (Lead Pedestrian Interval – where pedestrian start crossing before the signal turns green for vehicles) for the Beacon Street crossing phase at the intersection of Washington Street/ Beacon Street in 2016.

Throughout the corridor, there are areas with overgrown vegetation that blocks the visibility of signage.

Washington Street/ Beacon Street
There is an R10-15 (Turning Traffic Yield to Pedestrians) Sign facing Washington Street northbound drivers at Beacon Street and Beacon Street eastbound at Washington Street. The sign is a strictly word based sign and may not be as easily understood as the newer sign featuring words and graphics. There was a crash with a bicyclists on the Washington Street south crosswalk. It was noted that there is sign clutter at the southwest corner of this intersection. There is a missing bus stop sign in the southbound direction.

All the signal heads have backplates at the Washington Street at Beacon Street Washington Street intersection, but none of them have retroreflective strips. Backplates improve the visibility of the traffic signals to motorists. The retroreflective strips further improve visibility, especially during nighttime or low light conditions. Seven of the crashes occurred during low light conditions (1 dawn, 6 dark – lighted roadway).

The length of the northbound Washington Street left turn lane is short and cannot accommodate the left turns queue. This can result in drivers jockeying for position, leading to sideswipe crashes. There was one crash where this occurred.

There is a significant amount of on-street parking adjacent to travel lanes. Several crashes involved parked vehicles.

Washington Street/ Brookline Fire Station #7
In front of Brookline Fire Station #7, the pavement makings are faded.

It is difficult to identify the location of fire station. The area lacks specific pavement markings identifying the station. In addition, on-street parking is allowed on the opposite side of Washington Street from the Brookline Fire Station #7.

The audit team stated that at Brookline Fire Station #7, there have been near miss crashes for fire trucks trying to get into/out of the station due to drivers not noticing the emergency signal. The signals at the fire station have poor visibility. The heads are post mounted and do not include backplates. Backplates improve the visibility of the traffic signals to motorists. The retroreflective strips further improve visibility, especially during nighttime or low light conditions. Vegetation and the angle of the signal heads also contribute to the poor visibility of the signals.

Washington Street/ Gardner Road

There are three Chevron Signs located on poles in the northbound direction south of Gardner Road due to the horizontal curve at the Gardner Street intersection. Based on the Town, the signs were in response to vehicles driving off the road into the condominium property. The spacing between signs appears to be larger than guidelines recommend.

Washington Street/ Park Street

The traffic signals have poor visibility and do not include backplates. Backplates improve the visibility of the traffic signals to motorists. The retroreflective strips further improve visibility, especially during nighttime or low light conditions. Poor signal visibility may contribute to rear-ends as well as angle crashes due to red light running.

Washington Street/ School Street/ Cypress Street

There is an alley for a rear parking lot associated to a business at 385-395 Washington Street. The alley is not included in the traffic signal. The alley, which is the only driveway for the business, exits into the intersection and has poor visibility due to nearby buildings. One pedestrian was struck on the sidewalk at this location by a driver exiting the driveway.

The alignment of the School Street / Cypress Street maneuver is awkward. Due to the intersection geometry, it is difficult for drivers to execute certain movements comfortably. These include the through movements between Cypress Street and School Street as well as left turns from School Street onto Washington Street southbound (this movement is prohibited during peak hours). School Street consists of a shared left-turn/through lane and a through/right lane; members of the RSA team indicated that this creates confusion for drivers due to the intersection alignment and associated large footprint.

On the northbound Washington Street approach, drivers commonly queue onto the bike lane. These drivers are often through vehicles, trying to get around left turning vehicles. Due to the short length of the northbound left turn lane, vehicles queue past it forming two lanes and blocking the bike lane. The skew of the intersection creates a large footprint, and northbound left turns need to wait at the middle of the intersection before making the turn. Two crashes involved pedestrians and northbound left-turning vehicles.

The Washington Street southbound left is a heavy turn but does not include a protected left turn phase. Similar to the northbound movement vehicles trying to turn left from Washington into School Street need to stop in the middle of the intersection which may create confusion as to where to wait to make the turn. The lack of a protected phase coupled with the intersection geometry may result in vehicles getting "stuck" in the middle of the intersection or having to proceed during the clearance interval.

Overhead signal heads for all approaches are placed on a single mast arm, precluding the presence of a signal head over each travel lane. In addition, the location of the mast arm in the context of this large intersection results in the signal head being far from the stop line for some approaches. Finally, no backplates are present. All these issues result in visibility issues for the signal, which could contribute to rear-end and red light running crashes.

Washington Street/ Harvard Street

Due to the two closely spaced intersections, large footprint, skewed alignment, prohibition of some movements, position of signals, lack of clear lane designation, this intersection is confusing to motorists.

Pavement markings do not clearly guide drivers at the intersection of Washington Street/ Harvard Street which results in drivers having trouble identifying where to stop or how to travel through the intersection. Audit team members mentioned that drivers pull past the stop line and wait in the middle of the intersection. This confusion may have contributed to 2 vehicles striking the median. In addition to pavement markings, there is a lack of guiding signage to help drivers navigate intersection. The pedestrian post on the median island does not include the necessary signage.

The traffic signals have poor visibility and do not include retroreflective backplates. Backplates improve the visibility of the traffic signals to motorists while the retroreflective strips further improve visibility, especially during nighttime or low light conditions. Four of the crashes at this locations were under dark conditions.

The southbound signal head is post mounted making it difficult for right-turning vehicles to see due to vegetation.

The traffic signals at this intersection use a mix of green balls and turn arrows, on different post mounted signal providing indications for different roads. As an example, on the northbound approach, the first post mounted signal at the north-east corner uses a through arrow for Washington Street northbound towards Harvard Street. However, the overhead signals for the same movement use a 45 degree right-thru angle arrow, which could confuse drivers.

Issues with parked vehicles contributed to 2 crashes.

Potential Enhancements

- Clear vegetation throughout the corridor to improve signage visibility.

Washington Street/ Beacon Street

- The R10-15(Turning Traffic Yield to Pedestrians) sign facing northbound Washington Street and eastbound Beacon Street traffic should be changed to the graphical version of the sign, to be more easily understood.
- Install a bus stop sign in the southbound direction, south of Beacon Street.
- Remove unnecessary signage at the intersection of Washington Street/ Beacon Street.
- Add retroreflective borders to improve visibility of the existing signal heads.
- Increase the length of the northbound Washington Street left turn lane.
- Consider eliminating eastbound Beacon Street left turn movements at the signal. Drivers can use the existing U-turns east and west of the intersection. This may require signalizing the Westbourne Street and Winthrop Street U-turns.
- Evaluate location of parking in the vicinity of the intersection.

Washington Street/ Brookline Fire Station #7

- Add dotted yellow extension line at Fire Station to make it clear that this is an intersection.
- Provide green bike lane pavement markings to make clear that this is a conflict area.
- Restrict parking within the Fire Station intersection.
- Evaluate providing crosshatch area (do not block the box marking) on roadway to make presence of the Fire Station clearer.
- Add retroreflective borders to improve visibility of the existing signal heads.

- Replace existing post mounted traffic signal equipment with overhead traffic signal heads to provide improved visibility.
- Provide an emergency hybrid beacon.

Washington Street/ Gardner Road

- Evaluate spacing of the Chevron signs at Gardner Road. Adjust if necessary.

Washington Street/ Park Street

- Add retroreflective borders to improve visibility of the existing signal heads.

Washington Street at School Street/ Cypress Street

- Modify the School Street lane configuration to provide an exclusive right turn lane. Reconfigure the Cypress Street departure to one lane. This reconfiguration can increase the size of the pedestrian refuge.
- Consider reconfiguring the driveway providing access to a business at 385-395 Washington Street to remove it from the intersection.
- Consider providing a signal head for the driveway providing access to a business at 385-395 Washington Street.
- Consider reconfiguring the intersection to realign School Street and Cypress Street possibly creating two off-set intersections.
- Evaluate alternative configurations such as a roundabout. Right-of-way restrictions would need to be considered.
- Evaluate adding a protected left turn phase for the Washington Street southbound left turn.
- Add retroreflective borders to improve visibility of the existing signal heads.
- Provide new overhead traffic signals facing each approach. Use retroreflective borders on new signals.

Washington Street/ Harvard Street

- Add dashed lines at the intersection of Washington Street/ Harvard Street to help guide drivers. Consider adding rumble strips to further help to delineate vehicle travel paths.
- Provide lane guide signage,
- Review object marker on island and replace if necessary.
- Reconfigure the intersection of Washington Street/ Harvard Street to simplify movements.
- Add retroreflective borders to improve visibility of the existing signal heads.
- Evaluate which approaches and lanes should have green arrows versus green balls.
- Evaluate location of signal heads, including alignment to the appropriate lane.
- Provide overhead signal heads at all approaches.

Safety Issue #4: Transit Facilities

Pedestrian desire lines are influenced by the location of the bus stops. Additionally, buses stopped at bus stops may impact visibility of crosswalks. The MBTA prefers crosswalks to be located behind bus stops for this reason. Bus stops can also indirectly cause sideswiping and/or rear-end crashes as vehicles may attempt to change lanes or stop suddenly due to a bus stopping to pick up/drop off passengers.

There are many bus stops located very close to each other throughout the corridor. In general, as part of any reconstruction effort, the MBTA would like to review the location of each bus stop through the corridor to eliminate conflicts with vehicles, bicycles and pedestrians as possible.

Washington Street/ Beacon Street
As discussed under the pedestrian section, the Washington Square Station, which spans from Washington Street to Westbourne Terrace, has access deficiencies, including desire to access platform from both ends and lack of crosswalks on Beacon Street near Westbourne Terrace. Two crashes involved pedestrians crossing Beacon Street outside of marked crosswalks.

The bus stops on Washington Street are near sided. The northbound bus stop on Washington Street conflicts with the through/ right turn lane. The southbound bus stop is set back from this intersection. Both bus stops appears to only have one sign.

There is an additional bus stop located approximately 200 feet south of the intersection, in front of #692 Washington Street. This stop only has one sign. Crash #13 involved a pedestrian crossing in vicinity of this bus stop where there were no marked crosswalk provided.

Washington Street/ Fairbanks Road
At Fairbanks Road, the northbound buses currently stop in the middle of the intersection.

The location of the bus stop may block the view of the crosswalk.

Washington Street/ Gardner Road
There is a curb extension for bus pull-out at this intersection in the southbound direction. The northbound bus stop is a far side stop, conflicting with the bike lane due to the limited lane width of the road. One of the bus signs is missing at Gardner Street on the Washington Street northbound approach.

One of the pedestrian crashes involved a pedestrian who crossed behind an MBTA bus outside a marked crosswalk.

Washington Street/ Griggs Road (South)
The bus stop at Griggs Road is approximately 780 feet from the bus stops at Gardner Road. Additionally, the southbound bus stop is approximately 200 feet south of the intersection where no marked crossing is provided. Desire lines for pedestrians to cross the street are typically present at bus stop locations.

The new crosswalk at Griggs Road may be blocked by the bus stop as it's a near side stop once the crosswalk is in place.

Washington Street/ Greenough Street
It was mentioned that the Greenough Street bus stop pairs might be too close to the School Street stops which are approximately 625 ft apart.

Washington Street/ Harvard Street
At the intersection of Washington Street and Harvard Road, there are four bus stops, all north of the intersection. Route 65 has northbound and southbound stops on Washington Street north of the intersection. Route 66 has northbound and southbound stops on Harvard Street north of Kent Street. If the stops were relocated south of the intersection, the four stops could be consolidated into two bus stops prior to when the routes diverge to travel on Washington Street and Harvard Street.

It was mentioned during the meeting that the SB bus sometimes have issue pulling into the stop located in-front of the Rockland Trust on Washington Street due to the queue. It's currently a near side stop.

Potential Enhancements

- Consider consolidating bus stops throughout the study corridor.
- Evaluate location of bus stops through the study area. If feasible, move all bus stops to far side of intersections.
- Evaluate providing a shared bus/right turn lane on Washington Street southbound between Station Street and Route 9.
- Ensure all bus stops and transit facilities meet current MBTA design guidelines and ADA compliance.

Washington Street/ Beacon Street

- Consider moving the northbound and southbound Washington Street bus stops from near side stops to far side stops on the opposite side of the intersection. If bus stops are moved, consolidate bus stop in front of #692 with a new stop.
- Provide two bus stop signs at each bus stop.

Washington Street/ Fairbanks Road

- At Fairbanks Road, move bus stop further north to avoid buses stopping in the intersection.
- Consider installing a floating bus stop.

Washington Street/ Griggs Road and Washington Street/ Gardner Road

- Consider consolidating the bus stops at Gardner Road and Griggs Road.
- Provide missing northbound bus stop sign at the Gardner Road intersection.

Washington Street/ Greenough Street

- Consolidate Greenough Street northbound stop with the School Street stop,
- Consider moving the Greenough southbound stop to the far side of the Washington Street/ Park Street intersection.

Washington Street/ Harvard Street

- Consider consolidating all four bus stops to a location south of Davis Avenue.
- Consider repurposing the existing southbound bus stop into a queue jump lane for buses. The near-bus stop may be converted into a queue jump by receiving an advance or extended green phase through the intersection, while general traffic is held. Street parking might need to be modified at this location to accommodate the queue jump lane.

Summary of Road Safety Audit

Each safety issue and potential safety enhancement discussed during the audit has been listed on the following Table 3. For each safety issue, the potential safety enhancement is described; its potential safety payoff is estimated based on groupings shown below, as are the estimated time frame for completion, the estimated construction cost, and the jurisdiction for implementing each improvement.

Safety payoff estimates are subjective and may be based on the relative percent of crashes that may be reduced by the enhancement based on known and documented crash reduction factors, if available, or estimated crash reduction based on a stated source [for example, low (less than 30%), medium (31% to 70%), and high (greater than 71%)]. The time frame is categorized as short-term (less than 1 year), mid-term (1 to 3 years), or long-term (greater than 3 years). The costs are categorized as low (less than $10,000), medium ($10,001 to $50,000), or high (greater than $50,001). The RSA is intended to identify potential safety improvements that can be evaluated and included as part of the design process for safety improvements.

Table 2: Estimated Time Frame and Costs Breakdown

Time Frame	
Short-Term	<1 Year
Mid-Term	1-3 Years
Long-Term	>3 Years

Costs	
Low	<$10,000
Medium	$10,001-$50,000
High	>$50,000

Table 3: Potential Safety Enhancement Summary

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Substandard Pedestrian Facilities	Reconstruct the sidewalks along Washington Street to remove obstructions making it difficult for a pedestrian to traverse the corridor (brick, heaving panels, etc.).	High	Long-term	High	Town of Brookline
Substandard Pedestrian Facilities	Reconstruct the curbing to provide better delineation between the roadway and sidewalk.	Low	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Evaluate pedestrian clearance times at the signalized intersections.	Medium	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Restrict parking near crosswalks to improve visibility of pedestrians.	High	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Evaluate curb extensions to improve pedestrian visibility at crosswalks.	High	Mid-term	High	Town of Brookline
Substandard Pedestrian Facilities	Trim vegetation to avoid sidewalk obstructions and improve crosswalk visibility.	Medium	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Consider lowering speed limits on roadway in the vicinity of the school properties. These include Washington Street, Salisbury Road and Beacon Street.	Low	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Beacon Street The R10-15 (right turns yield to pedestrians) sign facing northbound Washington Street traffic at Beacon Street and Beacon Street eastbound should be changed to the graphical version of the sign, to be more easily understood.	Medium	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Beacon Street Consider implementing leading pedestrian intervals (LPI's) at all crossings.	Medium	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Beacon Street Evaluate crosswalk locations to improve pedestrian visibility.	High	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Beacon Street Consider upgrading pedestrian signals to include countdown signal and APS.	Medium	Mid-term	Medium	Town of Brookline

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Substandard Pedestrian Facilities	Washington Street/ Beacon Street Install tactile warning panels where missing.	Medium	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Beacon Street/ Westbourne Terrace Evaluate providing crosswalk across Beacon Street connecting to the MBTA Washington Square green line station.	High	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Beacon Street/ Westbourne Terrace Consider secondary access for the MBTA Washington Square green line station at Westbourne Terrace.	Medium	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Beacon Street/ Westbourne Terrace Trim vegetation to not obscure pedestrian warning signage.	Medium	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Beacon Street/ Westbourne Terrace Evaluate lighting at the intersection, in particular pedestrian scale lighting.	Medium	Mid-term	Medium	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Fairbanks Road Install additional signage and improved pavement markings for crosswalk at Fairbanks Road. The signage would include W11-2 (Pedestrian Crossing), W16-7P (Diagonal Downward Pointing Arrow), and W16-9P (AHEAD) plaques. Inclusion of signage should conform with MUTCD compliance.	Medium	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Fairbanks Road Consider installing rectangular rapid flashing beacons (RRFB) at the Washington Street crosswalk at Fairbanks Road to improve visibility of pedestrian crossing.	High	Mid-term	Medium	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Fairbanks Road Consider adding curb extensions to improve visibility.	High	Mid-term	Medium	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Fairbanks Road Install ADA compliant ramps at the crosswalk across Washington Street.	Medium	Mid-term	Medium	Town of Brookline

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Substandard Pedestrian Facilities	Washington Street/ Fairbanks Road Evaluate ramp alignment on crosswalk across Fairbanks Road and modify if feasible.	Medium	Mid-term	Medium	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Brookline Fire Station #7 Install signage warning pedestrians of the conflict area with emergency vehicles.	Low	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Park Street Add an additional crosswalk across the northern leg of Washington Street at the signalized Park Street intersection.	Medium	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Park Street Replace curb ramps with ADA compliant ramps with detectable warning panels.	Medium	Mid-term	Medium	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Park Street Consider upgrading pedestrian signals to include countdown and APS.	Medium	Mid-term	Medium	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Weybridge Road Consider tightening the radius at Weybridge Road to reduce the crossing distance and to slow turning vehicles.	High	Mid-term	Medium	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Weybridge Road Replace curb ramps with ADA compliant ramps with detectable warning panels.	Medium	Mid-term	Medium	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Greenough Street Consider signage identifying Greenough Street to alert drivers of its presence.	Low	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Greenough Street Evaluate lighting at the intersection, in particular pedestrian scale lighting.	Medium	Mid-term	Medium	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Greenough Street Evaluate ramps alignment on crosswalk across Greenough Street and modify if feasible.	Medium	Mid-term	Low	Town of Brookline

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Substandard Pedestrian Facilities	Washington Street/ Greenough Street Evaluate location of crosswalk across Greenough Street.	Medium	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ School Street/ Cypress Street Review lane configuration for the two lane departure on Cypress Street. If one lane can be removed, a pedestrian refuge can be provided.	High	Mid-term	Medium	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ School Street/ Cypress Street Evaluate signal timing including pedestrian clearance intervals.	Medium	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ School Street/ Cypress Street Review lane configuration for the two lane departure on Cypress Street. If one lane can be removed, a pedestrian refuge can be provided.	High	Long-term	High	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ School Street/ Cypress Street Consider adding leading pedestrian intervals (LPI's)	Medium	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ School Street/ Cypress Street Provide signage, including potentially audible warning, for driveway at 385-395 Washington Street. Alternatively, include driveway into the signal and provide associated pedestrian infrastructure including crosswalk, pedestrian signal indications, etc.	Medium	Mid-term	Medium	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Harvard Street Replace the older pedestrian heads at the intersection of Harvard Street with new, countdown pedestrian heads and APS.	Medium	Mid-term	Medium	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Harvard Street Consider adding leading pedestrian intervals (LPI's)	Medium	Short-term	Low	Town of Brookline

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Substandard Pedestrian Facilities	Washington Street/ Harvard Street Review right turn on red at Davis Avenue. Consider prohibiting right turns on red or changing Davis Avenue to one way away from the intersection to eliminate conflicts.	Medium	Short/Mid-term	Low/ Medium	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Harvard Street Provide signal heads across Davis Avenue.	Medium	Mid-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/ Harvard Street Replace curb ramps with ADA compliant ramps with detectable warning panels, as appropriate.	Medium	Mid-term	Medium	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/Station Street Replace curb ramps with ADA compliant ramps	Medium	Mid-term	Medium	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/Station Street Consider providing mast arm signal heads	Medium	Long-term	High	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/Station Street Install retroreflective backplates	Medium	Short-term	Low	Town of Brookline
Substandard Pedestrian Facilities	Washington Street/Station Street Replace the older pedestrian heads with new, countdown pedestrian heads and APS.	Medium	Mid-term	Medium	Town of Brookline
Substandard Bicycle Facilities	Consider removing parking along the corridor to eliminate conflicts and provide sufficient spaces for bike accommodations.	High	Mid/Long-term	Low	Town of Brookline
Substandard Bicycle Facilities	Add a bike lane in the southbound direction between Gardner Road to Davis Road. This would result in continuous bike lanes in both directions from Beacon Street to Station Street.	High	Long-term	High	Town of Brookline
Substandard Bicycle Facilities	Consider providing cycle tracks, separated bike lanes or parking separated bike lanes on Washington Street.	High	Long-term	High	Town of Brookline

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Substandard Bicycle Facilities	Consider bike lane extensions with green pavement markings at intersections and conflict zones.	High	Short-term	Low	Town of Brookline
Substandard Bicycle Facilities	Consider bike boxes or turn two-stage queue box at intersections.	High	Short-term	Low	Town of Brookline
Substandard Bicycle Facilities	Improve the pavement condition along the corridor.	Medium	Long-term	High	Town of Brookline
Substandard Bicycle Facilities	Provide better delineation for the bike lanes.	Medium	Short-term	Low	Town of Brookline
Substandard Bicycle Facilities	Washington Street/ Beacon Street Consider implementing bike lanes on Beacon Street eastbound approaching Washington Street and Beacon Street westbound approaching Washington Street	High	Long-term	High	Town of Brookline
Substandard Bicycle Facilities	Washington Street/ Beacon Street Consider implementing bike lanes on Washington Street northbound and southbound through the intersection.	High	Long-term	High	Town of Brookline
Substandard Bicycle Facilities	Beacon Street/ Westbourne Terrace Review possible improvements to the sight distance on Beacon Street westbound approaching Westbourne Terrace.	High	Mid-term	Medium	Town of Brookline
Substandard Bicycle Facilities	Beacon Street/ Westbourne Terrace Evaluate prohibiting through movements from the Beacon Street U-turn onto Westbourne Terrace by revising travel patterns in area. This would need to be coordinated with school drop-off/pick-up patterns.	High	Mid-term	Medium	Town of Brookline
Substandard Bicycle Facilities	Beacon Street/ Westbourne Terrace Review overhead street lighting at the intersection of Beacon Street/ Westbourne Terrace.	Medium	Mid-term	Medium	Town of Brookline

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Substandard Bicycle Facilities	Washington Street/ School Street/ Cypress Street At the intersection of Washington Street/ School Street/ Cypress Street, provide protection for the northbound bike lane.	Medium	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Clear vegetation throughout the corridor to improve signage visibly.	Medium	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Beacon Street The R10-15(Turning Traffic Yield to Pedestrians) sign facing northbound Washington Street and eastbound Beacon Street traffic should be changed to the graphical version of the sign, to be more easily understood.	Medium	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Beacon Street Install a bus stop sign in the southbound direction, south of Beacon Street.	Low	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Beacon Street Remove unnecessary signage at the intersection of Washington Street/ Beacon Street.	Medium	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Beacon Street Add retroreflective borders to improve visibility of the existing signal heads.	Medium	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Beacon Street Increase the length of the northbound Washington Street left turn lane.	Medium	Mid-term	Medium	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Beacon Street Consider eliminating eastbound Beacon Street left turn movements at the signal. Drivers can use the existing U-turns east and west of the intersection. This may require signalizing the Westbourne Street and Winthrop Street U-turns.	Medium	Long-term	High	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Beacon Street Evaluate location of parking in the vicinity of the intersection.	Medium	Short-term	Low	Town of Brookline

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Brookline Fire Station #7 Add dotted yellow extension line at Fire Station to make it clear that this is an intersection.	Medium	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Brookline Fire Station #7 Provide green bike lane pavement markings to make clear that this is a conflict area.	High	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Brookline Fire Station #7 Restrict parking within the Fire Station intersection.	Medium	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Brookline Fire Station #7 Evaluate providing crosshatch area (do not block the box marking) on roadway to make presence of the Fire Station clearer.	Medium	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Brookline Fire Station #7 At the fire station signal – add retroreflective borders to improve visibility of the existing signal heads.	Medium	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Brookline Fire Station #7 Replace existing post mounted traffic signal equipment with overhead traffic signal heads to provide improved visibility.	High	Long-term	High	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Brookline Fire Station #7 Provide an emergency hybrid beacon.	High	Long-term	High	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Gardner Road Evaluate spacing of the Chevron signs at Gardner Road. Adjust if necessary.	Low	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Park Street Add retroreflective borders to improve visibility of the existing signal heads.	Medium	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street at School Street/ Cypress Street Modify the School Street lane configuration to provide an exclusive right turn lane. Reconfigure the Cypress Street departure to one lane. This reconfiguration can increase the size of the pedestrian refuge.	High	Long-term	High	Town of Brookline

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street at School Street/ Cypress Street Consider reconfiguring the driveway providing access to a business at 385-395 Washington Street to remove it from the intersection.	Medium	Long-term	High	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street at School Street/ Cypress Street Consider providing a signal head for the driveway providing access to a business at 385-395 Washington Street	Medium	Long-term	High	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street at School Street/ Cypress Street Consider reconfiguring the intersection to realign School Street and Cypress Street possibly creating two off-set intersections.	Medium	Long-term	High	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street at School Street/ Cypress Street Evaluate alternative configurations such as a roundabout. Right-of-way restrictions would need to be considered.	High	Long-term	High	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street at School Street/ Cypress Street Evaluate adding a protected left turn phase for the Washington Street southbound left turn.	Medium	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street at School Street/ Cypress Street Add retroreflective borders to improve visibility of the existing signal heads.	Medium	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street at School Street/ Cypress Street Provide new overhead traffic signals facing each approach. Use retroreflective borders on new signals.	High	Long-term	High	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Harvard Street Add dashed lines at the intersection of Washington Street/ Harvard Street to help guide drivers. Consider adding rumble strips to further help to delineate vehicle travel paths.	Medium	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Harvard Street Provide lane guide signage.	Medium	Short-term	Low	Town of Brookline

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Harvard Street Review object marker on island and replace if necessary.	Low	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Harvard Street Reconfigure the intersection of Washington Street/ Harvard Street to simplify movements.	High	Long-term	High	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Harvard Street Add retroreflective borders to improve visibility of the existing signal heads.	Medium	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Harvard Street Evaluate which approaches and lanes should have green arrows versus green balls.	High	Short-term	Low	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Harvard Street Evaluate location of signal heads, including alignment to the appropriate lane.	High	Long-term	High	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Harvard Street Provide overhead signal heads at all approaches.	High	Long-term	High	Town of Brookline
Intersection Geometry, Operations, Signage and Pavement Markings	Washington Street/ Harvard Street Trim vegetation obstructing visibility of signage or traffic signals.	Medium	Short-term	Low	Town of Brookline
Transit Facilities	Consider consolidating bus stops throughout the study corridor.	Medium	Short-term	Low	Town of Brookline/ MBTA
Transit Facilities	Evaluate location of bus stops through the study area. If feasible, move all bus stops to far side of intersections.	Medium	Short-term	Low	Town of Brookline/ MBTA
Transit Facilities	Evaluate providing a shared bus/right turn lane on Washington Street southbound between Station Street and Route 9.	Medium	Mid-term	Medium	Town of Brookline/ MBTA
Transit Facilities	Ensure all bus stops and transit facilities meet current MBTA design guidelines and ADA compliance.	Medium	Mid-term	Medium	Town of Brookline/ MBTA

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Transit Facilities	Washington Street/ Beacon Street Consider moving the northbound and southbound Washington Street bus stops from near side stops to far side stops on the opposite side of the intersection	Medium	Mid-term	Low	Town of Brookline/ MBTA
Transit Facilities	Washington Street/ Beacon Street Provide two bus stop signs at each bus stop.	Low	Short-term	Low	Town of Brookline/ MBTA
Transit Facilities	Washington Street/ Fairbanks Road At Fairbanks Road, move bus stop further north to avoid buses stopping in the intersection.	Medium	Short-term	Low	Town of Brookline/ MBTA
Transit Facilities	Washington Street/ Fairbanks Road Consider installing a floating bus stop.	Medium	Mid-term	Medium	Town of Brookline/ MBTA
Transit Facilities	Washington Street/ Griggs Road and Washington Street/ Gardner Road Consider consolidating the bus stops at Gardner Road and Griggs Road.	Medium	Short-term	Low	Town of Brookline/ MBTA
Transit Facilities	Washington Street/ Griggs Road and Washington Street/ Gardner Road Provide missing northbound bus stop sign at the Gardner Road intersection.	Medium	Short-term	Low	Town of Brookline/ MBTA
Transit Facilities	Washington Street/ Greenough Street Consolidate Greenough Street northbound stop with the School Street stop	Medium	Short-term	Low	Town of Brookline/ MBTA
Transit Facilities	Washington Street/ Greenough Street Consider moving the Greenough Street southbound stop to far side of Washington Street/ Park Street intersection.	Medium	Short-term	Low	Town of Brookline/ MBTA
Transit Facilities	Washington Street/ Harvard Street Consider consolidating all four bus stops to a location south of Davis Avenue.	Medium	Short-term	Low	Town of Brookline/ MBTA
Transit Facilities	Washington Street/ Harvard Street Consider repurposing the existing southbound nearside bus stop into a queue jump lane for buses.	Medium	Mid-term	Medium	Town of Brookline/ MBTA

Appendix A. RSA Meeting Agenda

Agenda

Road Safety Audit

Brookline, MA

Washington Street Corridor
Beacon Street to Station Street

Meeting Location:
Virtual

December 10, 2020

9:00 a.m. – 1:00 p.m.

Type of meeting:	**Bike High Crash Location – Road Safety Audit Invited**
Attendees:	**Participants to Comprise a Multidisciplinary Team**
Please bring:	**Thoughts and Enthusiasm!!**

9:00 AM	**Welcome and Introductions**
9:15 AM	**Review of Site Specific Material** • Crash, Speed & Volume Summaries • Existing Geometries and Conditions
10:00 AM	**Visit the Site (Virtually)** • Watch videos of the identified area. • As a group, identify areas for improvement
11:30 AM	**Post Visit Discussion / Completion of RSA** • Discuss observations and finalize findings • Discuss potential improvements and finalize recommendations
1:00 PM	**Adjourn for the Day – but the RSA has not ended**

Instructions for Participants:

- **Before attending the RSA on December 10, 2020, participants are encouraged to drive through the area and complete/consider elements on the RSA Prompt List with a focus on safety.**
- **All participants will be actively involved in the process throughout. Participants are encouraged to come with thoughts and ideas, but are reminded that the synergy that develops and respect for others' opinions are key elements to the success of the overall RSA process.**
- **After the RSA meeting, participants will be asked to comment and respond to the document materials to assure it is reflective of the RSA completed by the multidisciplinary team.**

Appendix B. RSA Audit Team Contact List

Participating Audit Team Members

Date December 10, 2020
Location: Virtual

Audit Team Member	Agency/Affiliation	Email Address
Ana Fill	**MassDOT Traffic Safety**	ana.fill@state.ma.us;
Michelle Deng	MassDOT Traffic Safety	michelle.deng@state.ma.us;
Amitai Lipton	MassDOT District 6 Traffic	amitai.lipton@state.ma.us;
Brian Levine	MassDOT District 6 Projects	Brian.Levine@dot.state.ma.us;
Jesus Bastardo	MassDOT District 6 Traffic	jesus.bastardo@state.ma.us
Thomas Hannon	MassDOT Traffic Safety Intern	thannon@state.ma.us;
Erin Kennihan	MassDOT District 6 Project	erin.kinahan@state.ma.us;
Chris Sarno	MassDOT District 6 Project	christopher.sarno@state.ma.us;
Courtney Worhunsky	MassDOT Highway Design	Courtney.Dwyer@dot.state.ma.us;
Robert Guptill	MBTA	rguptill@mbta.com;
Chen-Yuan Wang	CTPS (Boston Region MPO)	cwang@ctps.org;
Robert Sloane	Walk Boston	bsloane@walkboston.org;
Dan Martin	Town of Brookline Transportation	dmartin@brooklinema.gov;
Dean Groves	Town of Brookline Engineering	grovesd@wseinc.com;
Todd Kirrane	Town of Brookline Transportation	tkirrane@brooklinema.gov;
Cpt. Tom Ferris	Town of Brookline Police Department	tferris@brooklinema.gov;
Todd Cantor	Town of Brookline Fire Department	tcantor@brooklinema.gov;
Alan Cloutier	WorldTech Engineering	acloutier@worldtecheng.com
Christian Poste	WorldTech Engineering	CPoste@worldtecheng.com;
Tim McGrath	WorldTech Engineering – On Washington Street	TMcGrath@worldtecheng.com

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Appendix C. Detailed Crash Data

WORLDTECH ENGINEERING

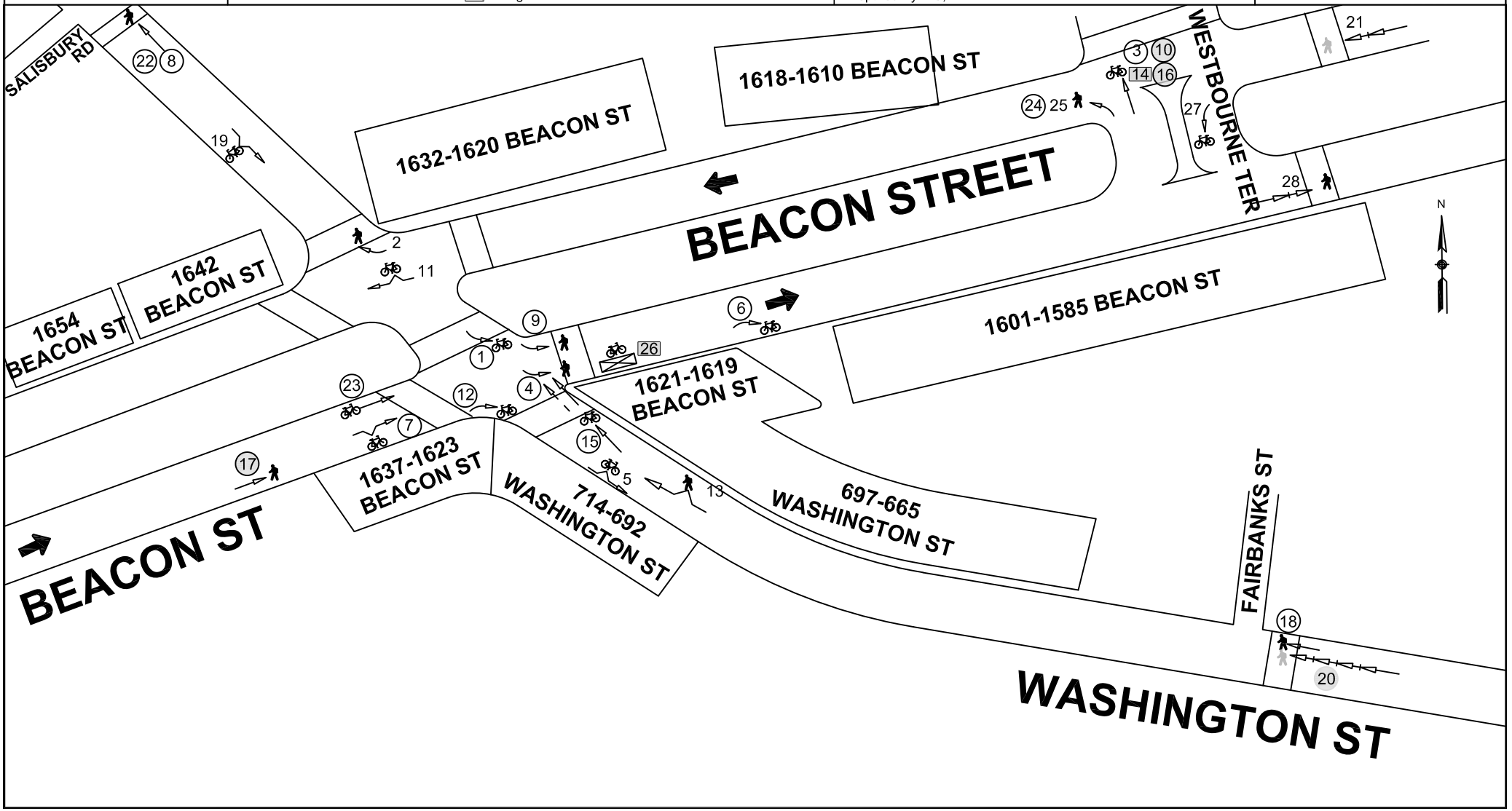
COLLISION DIAGRAM

SYMBOLS	TYPES OF CRASH	SEVERITY
Moving Vehicle	Rear End	(XX) Injury
Backing Vehicle	Head-On	
Pedestrian	Turning Movement	
Bicycle	Angle	Fatal
Animal	Sideswipe	
Parked Vehicle	Out-of-Control	XX Crash Summary Number
Fixed Object	Night Time Crash	

BROOKLINE, MA

WASHINGTON STREET AT BEACON STREET

Time Period Analyzed: 2010 to 2019	Project No.:N/A
Source of Crash Reports: BROOKLINE Police Department	FIGURE 1
Date Prepared: 6/8/2020	
Prepared By: AC,FX	



Crash Data Summary Table

Figure 1. Washington Street at Beacon Street, Brookline, MA
2010 - 2019

Crash Diagram Ref #	Crash Date	Crash Day	Time of Day	Manner of Collision	Light Condition	Weather Condition	Road Surface	Driver Contributing Code	V1 Driver Age	V2 Driver Age	Comments
#	mm/dd/yy	Day	hh:mm	Type	Type	Type	Type	Type	#	#	
1	03/17/11	Thursday	9:01 AM	Bicycle	Daylight	Clear	Dry	Failed to yield right of way	38	24	V1: SB on Washington Street, Turning left onto Beacon Street. Collided with Cyclist who was traveling NB on Washington Street
2	08/20/11	Saturday	6:10 PM	Pedestrian	Daylight	Clear	Dry	Unknown	64	50	V1: On Beacon Street, turning right onto Washington Street NB. Collision with pedestrian in the Washington Street cross walk.
3	09/15/11	Thursday	8:26 AM	Bicyclist	Daylight	Clear	Dry	Unknown	69	54	V1 was crossing over MBTA tracks from Beacon to Westbourne Ter. Cyclist 1 then crashed into the rear passenger side of V1.
4	07/10/12	Tuesday	9:19 AM	Angle	Daylight	Clear	Dry	Operating vehicle in erratic, reckless, careless, negligent, or aggressive manner	62	24	Courtesy crash: Crashed vehicles collided with pedestrian holding a bike. V1: Southbound Left turn to Beacon collided with northbound through vehicle. Northbound through vehicle went around a stopped vehicle who waved the left turner. After collided, vehicle collided with bike being held by pedestrian in the Beacon Street crosswalk.
5	12/22/12	Saturday		Bicyclist	Daylight	Clear	Dry	No improper driving	57	38	V1 was parked at 700 Washington Street. D1 stated he opened his door when a bicycle hit the lower corner of the car door.
6	04/11/13	Thursday	8:46 AM	Bicyclist	Daylight	Cloudy	Dry	Unknown	42	24	V1 eastbound on Beacon Street, with right turn signal preparing to enter the driveway of 1613 Beacon Street, when she came in contact with bicycle traveling on bicycle marked lanes.
7	09/03/13	Tuesday	7:55 AM	Bicyclist	Daylight	Clear	Dry	Failed to yield right of way	24	68	Vehicle, EB on Beacon Street struck a cyclist and forced the cyclist in to a parked vehicle. The operator of that vehicle then exited her car and told the cyclist and the operator of the other vehicle that she was in a rush and could not wait.
8	12/19/13	Thursday	11:40 AM	Pedestrian	Daylight	Cloudy	Wet	Distracted	69	38	V1: NB, Travelling straight ahead / collision with pedestrian in the cross walk at Salisbury Road. D1 indicated that did not see pedestrian.
9	02/06/14	Thursday	2:38 PM	Pedestrian	Daylight	Cloudy	Wet	No improper driving	49		V1: Single vehicle crash, turning left from Washington Street SB onto Beacon Street, Collision with pedestrian. Pedestrian was Crossing against a do not walk signal in a crosswalk. Operator of MV #1 stated MV was going approximately 15 MPH when it came In contact with the pedestrian.
10	05/21/14	Wednesday	7:50 PM	Bicyclist	Dusk	Clear	Dry	Failed to yield right of way	65		V1 turned left on Beacon St eastbound at Westbourne Ter, crossed over the MBTA tracks and was attempting to drive up Westbourne Ter. at which time he braked suddenly. A Bicyclist who was on Beacon St westbound, drove bike into the right rear quarter panel of V1.
11	08/20/14	Wednesday	6:30 PM	Bicyclist	Daylight	Clear	Dry	Swerving or avoiding due to wind, slippery surface, vehicle, object, non-motorist in roadway, etc.	34	26	Both vehicle and Cyclist were stopped at Red light on Beacon Street westbound. Upon green light, V1 was passing Cyclist in the middle of the intersection of Beacon Street and Washington Street and made contact with bicycle..
12	08/25/14	Monday	7:50 AM	Bicyclist	Daylight	Clear	Dry	Inattention	66	30	The cyclist was riding her bicycle in a marked crosswalk against traffic on Beacon St. She was traveling west on the eastbound side. The motorist was traveling east on Beacon St and took a right turn on to Washington St. The motorist had a green traffic signal. The pedestrian walk signal was also on indicating it was ok to cross Washington St. The operator of V1 struck the cyclist in the crosswalk.
13	10/09/14	Thursday	12:50 PM	Pedestrian	Daylight	Clear	Dry	No improper driving	38		V1: NB, Travelling straight ahead on Washington Street, mirror hit pedestrian who was crossing the street in front of 686 Washington Street. No crosswalks present in area.
14	12/01/15	Tuesday	6:10 PM	Bicyclist	Dark - lighted roadway	Clear	Dry	No improper driving	39		V1 was heading north, crossing Beacon Street and onto Westbourne Ter. The cyclist was heading west on Beacon Street and was passing vehicles stopped in traffic on the right. As cyclist approached the intersection of Westbourne Ter, he crashed into V1 traveling towards Westbourne Ter.
15	06/27/16	Monday	8:30 AM	Bicyclist	Daylight	Clear	Dry	Unknown	35-44	43	V1: NB, traveling straight ahead at intersection of Washington St and Beacon St/ rear ended Cyclist. Hit and run
16	10/27/16	Thursday	8:42 PM	Bicyclist	Dark - lighted roadway	Rain	Wet	Disregarded traffic signs, signals, road markings	Unknown	30	Vehicle #1 traveled north crossing the railroad tracks on Beacon St towards Westbourne Tr and failed to stop for the stop sign. At that point, Vehicle#1 struck a cyclist traveling west on Beacon St and fled the scene. The bicyclist hit the front right fender of Vehicle#1 causing her to be knocked to the ground.
17	11/21/16	Monday	6:09 PM	Pedestrian	Dark - lighted roadway	Clear	Dry	No improper driving	88	77	V1: EB, Travelling straight ahead on Beacon St, Collision with pedestrian not in a crosswalk. V1 was travelling eastbound on Beacon St at a slow rate of speed just past University Rd when the LF fender made contact with a pedestrian in the roadway, causing the pedestrian to fall to the ground and hit his head. The pedestrian, was not in a crosswalk when he was hit. Driver stated he was in the left travel lane and didn't see Pedestrian. Pedestrian was crossing the street in front of Gimbel's liquors and was hit by V1. Ped was wearing dark brown pants and a grey sweater.
18	05/08/17	Monday	2:33 PM	Pedestrian	Daylight	Clear	Dry	Failed to yield right of way			V1: Traveling NB on Washington Street. Struck pedestrian on marked crosswalk at Fairbanks Street.
19	08/09/17	Wednesday	7:31 AM	Bicyclist	Daylight	Clear	Dry	No improper driving	47	25	V1: SB, Travelling straight ahead in the left lane southbound on Washington St toward Beacon St, Cyclist, traveling in right lane southbound on Washington St signaled to turn left at which point V1 and cyclist made contact.
20	11/10/17	Friday	6:37 AM	Rear-end	Dawn	Cloudy	Wet	Unknown	Unknown		V1 NB on Washington Street stopped for pedestrian on marked crosswalk at Fairbanks Street. V4 rear ended V3 which rear ended V2 which rear ended V1.
21	12/8/17	Friday	3:30 PM	Rear-end	Daylight	Clear	Dry	Followed too closely	Unknown		V1 and V2 were traveling westbound on Beacon St, V1 stopped for a pedestrian. V2 did not stop in time and struck V1 in the rear bumper.

Crash Data Summary Table

Figure 1. Washington Street at Beacon Street, Brookline, MA
2010 - 2019

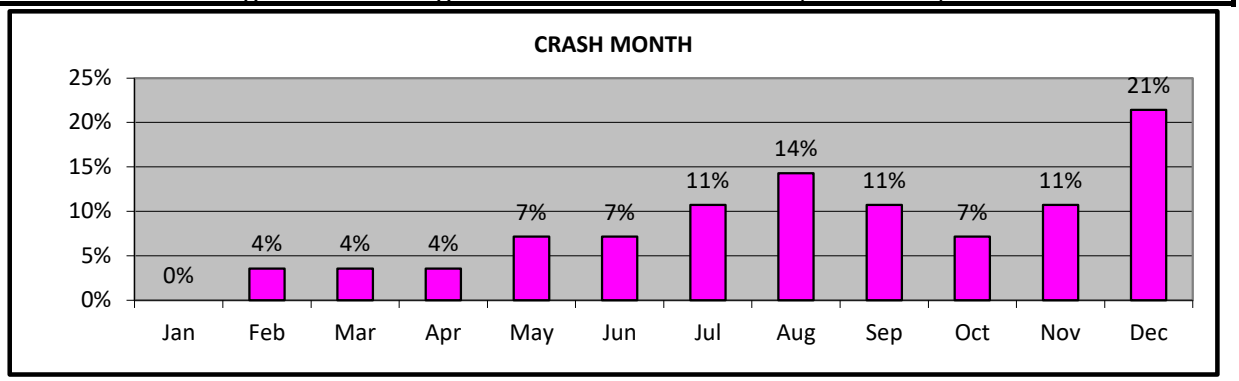
Crash Diagram Ref #	Crash Date	Crash Day	Time of Day	Manner of Collision	Light Condition	Weather Condition	Road Surface	Driver Contributing Code	V1 Driver Age	V2 Driver Age	Comments
#	*mm/dd/yy*	*Day*	*hh:mm*	*Type*	*Type*	*Type*	*Type*	*Type*	#	#	
22	12/15/17	Friday	2:43 PM	Pedestrian	Unknown	Unknown	Unknown	Unknown	47	46	V1: NB, Travelling straight ahead on Washington Street, Collision with pedestrian on a marked crosswalk. Driver stated that he was driving North Bound on Washington St, traffic on the Southbound side was backed up from Washington Sq and past Salisbury Rd. Driver stated that the young girl ran out into the crosswalk with a dog and this is when he struck Pedestrian with the front of his vehicle. Driver stated he did not see her until this moment. There were also two witnesses on Scene that were able to corroborate Drivers accounts.
23	06/08/18	Friday	7:30 AM	Bicyclist	Daylight	Clear	Dry	No improper driving	52	48	Bike: EB, Travelling straight ahead on Beacon Street struck the bumper of Vehicle which was at a complete stop for a red light traffic signal. The cyclist stated the brakes to the bike failed to lock for some unknown reason. The cyclist eventually made contact with the rear window of the car.
24	09/26/18	Wednesday	11:25 AM	Pedestrian	Daylight	Cloudy	Dry	No improper driving	43		The operator of V1 stated he entered the turnaround at Westbourne Ter to travel westbound on Beacon St. The operator stated before making the left turn onto Beacon St, he looked right to make sure Beacon St was clear to enter. As VI began to make the turn into the left lane, the operate did not see the pedestrian in the left lane who began to cross Beacon St, V1 then struck the pedestrian in the left lane.
25	11/06/18	Tuesday	7:11 AM	Pedestrian	Daylight	Clear	Dry	Failed to yield right of way	22		MV1 was driving eastbound on Beacon St and needed to turn around to drive westbound on Beacon St. In the area of Westbourne Ter, MV1 drove over the train tracks to make a legal U-turn onto Beacon St. Pedestrian crossed over Beacon St at Westbourne Ter towards the MBTA stop as MV1 crossed over the tracks. MV1 attempted to turn left and collided with pedestrian.
26	12/06/18	Thursday	8:10 PM	Bicyclist	Dark - lighted roadway	Clear	Dry	Inattention	64	30	V1: EB, Parked on the bike lane in front of 1621 Beacon St, Cyclist swerved onto lane of traffic to avoid parking vehicle, at this time driver of vehicle opened door striking cyclist.
27	07/07/19	Sunday	2:45 PM	Bicyclist	Daylight	Clear	Unknown	No improper driving	29		V1, a police vehicle was assisting a large number of bicyclists on a ride on Beacon St, V1 was stopped on the Beacon St crossover with Westbourne Ter. An adult bicyclist was also assisting and stopped on the left front bumper of the police vehicle. This was in the blind spot of the operator, when the operator took her foot of the brake V1 made contact with the rear wheel of the bicycle.
28	07/18/19	Thursday	8:00 AM	Rear-end	Daylight	Clear	Dry	Followed too closely	28	38	Both vehicles were traveling east on Beacon St when vehicle 2 came to a stop for a pedestrian entering the crosswalk at 1585 Beacon St. Vehicle 1 did not stop in time hitting vehicle 2 in the rear.

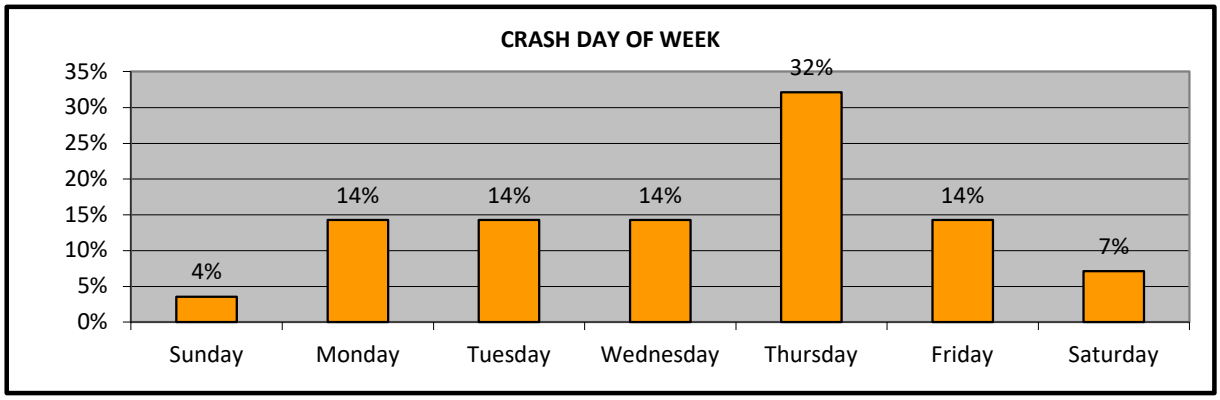
*Courtesy Crash - A term used to describe a crash that occurs subsequent to a non-involved mainline driver who gives the right of way, contrary to the rules of the road, to another driver.

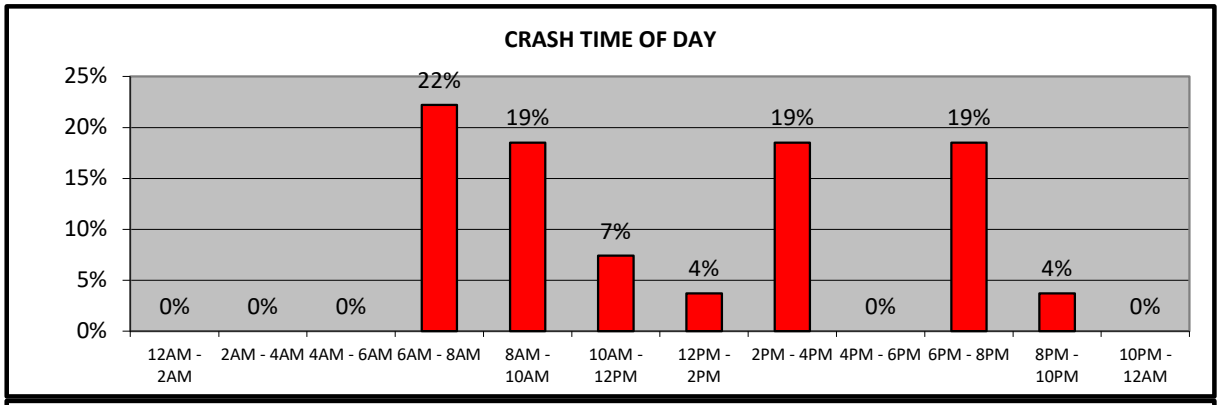
Summaries based on crash reports obtained from the City of Brookline Police Department.

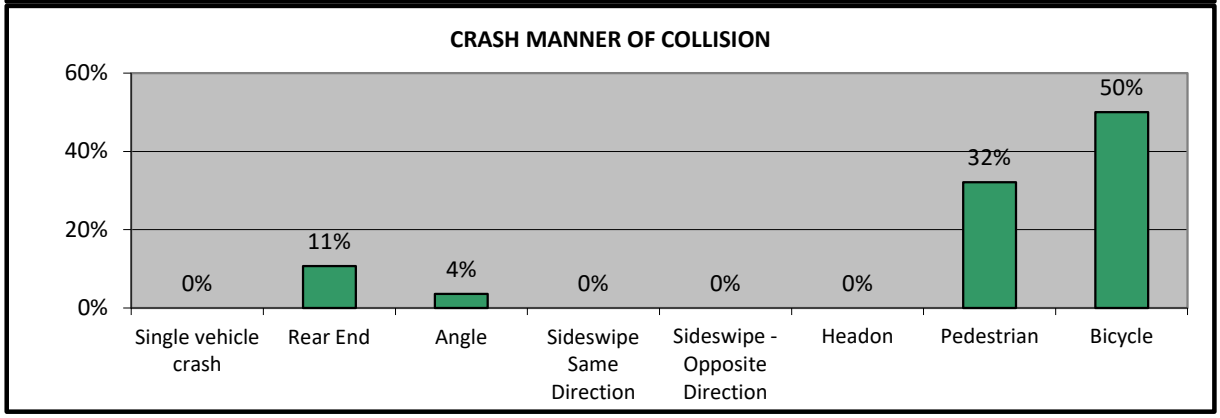
Crash Data Summary Charts

Figure 1. Washington Street at Beacon Street, Brookline, MA



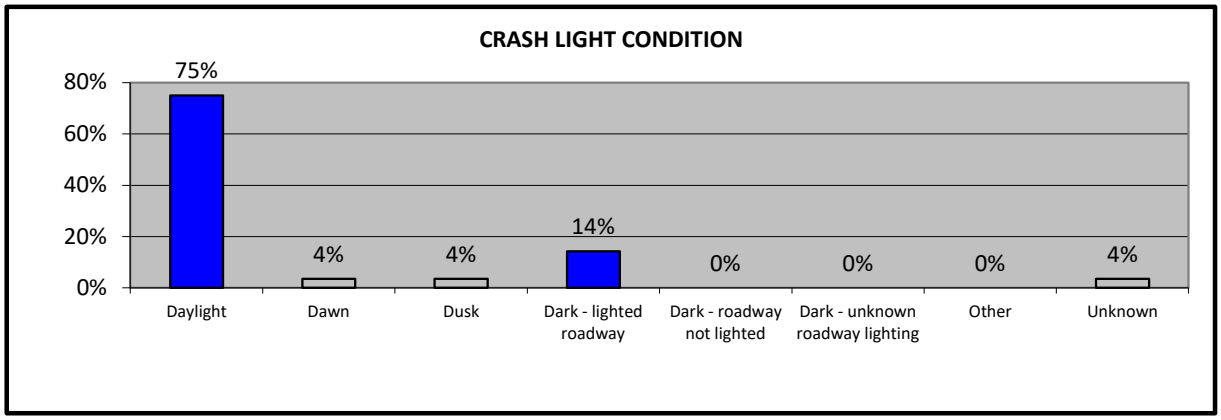


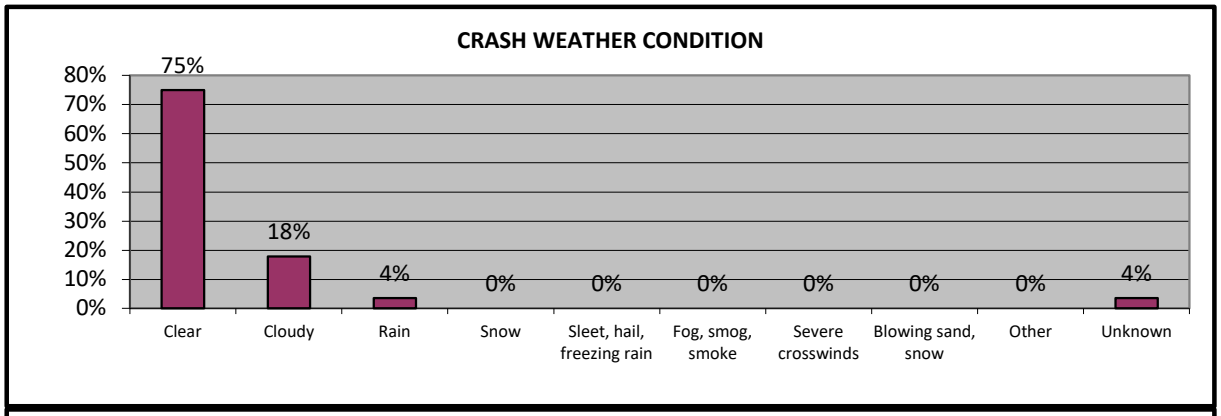


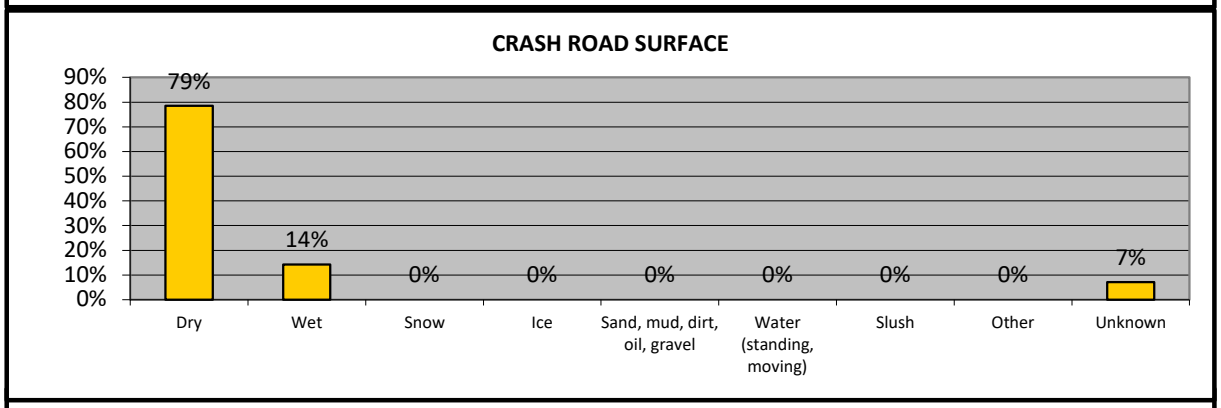


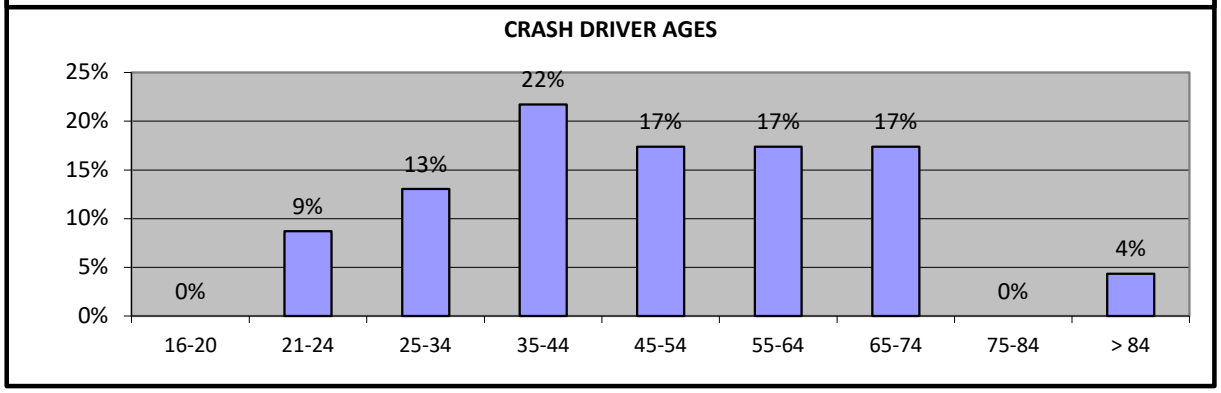
Crash Data Summary Charts

Figure 1. Washington Street at Beacon Street, Brookline, MA









WORLDTECH ENGINEERING

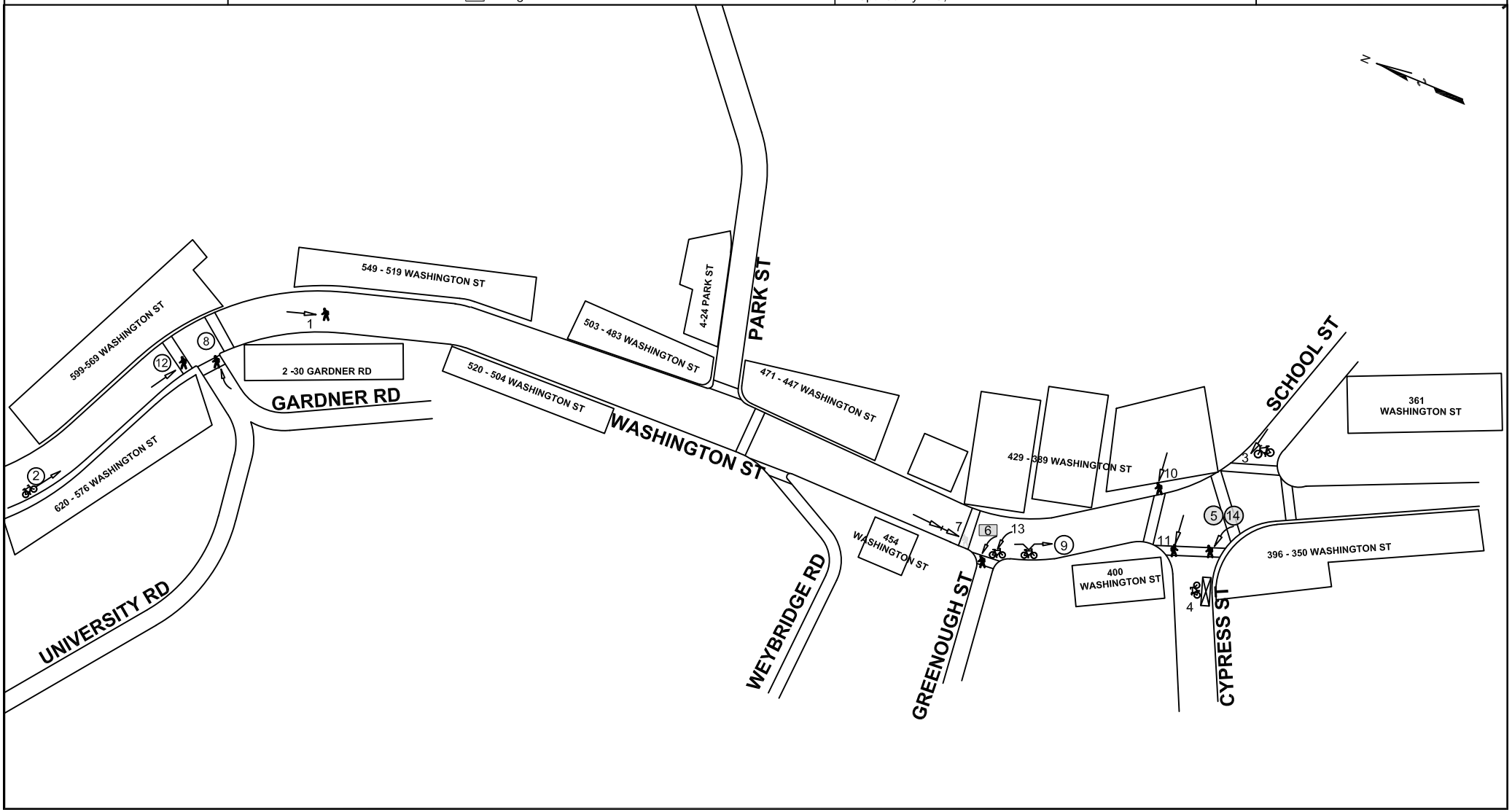
COLLISION DIAGRAM

SYMBOLS	TYPES OF CRASH	SEVERITY
Moving Vehicle	Rear End	(XX) Injury
Backing Vehicle	Head-On	
Pedestrian	Turning Movement	
Bicycle	Angle	Fatal
Animal	Sideswipe	
Parked Vehicle	Out-of-Control	XX Crash Summary Number
Fixed Object	Night Time Crash	

BROOKLINE, MA

WASHINGTON STREET FROM GARDNER RD & UNIVERSITY RD TO SCHOOL ST

Time Period Analyzed: 2010 to 2019	Project No.:N/A
Source of Crash Reports: BROOKLINE Police Department	FIGURE 2
Date Prepared: 6/8/2020	
Prepared By: AC,FX	



Crash Data Summary Table

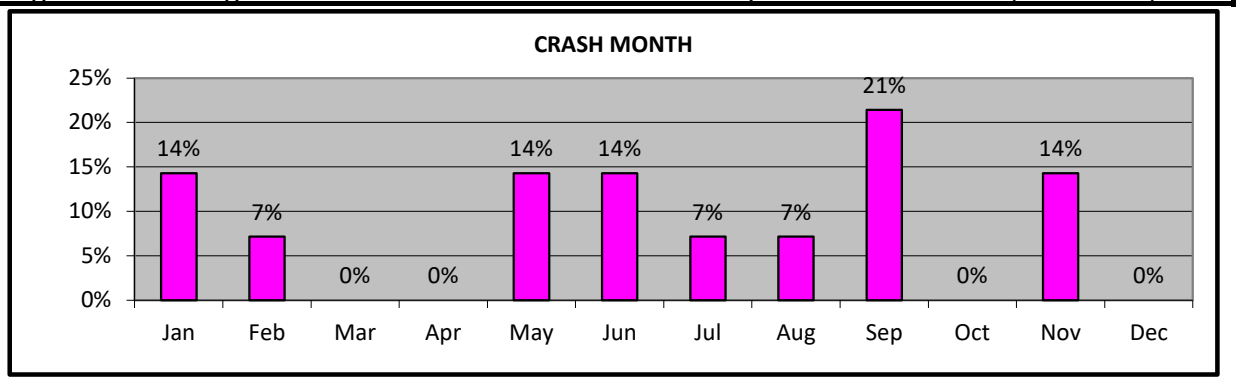
Figure 2. Washington Street from Gardner Rd & University Rd to School Street, Brookline, MA
2010 - 2019

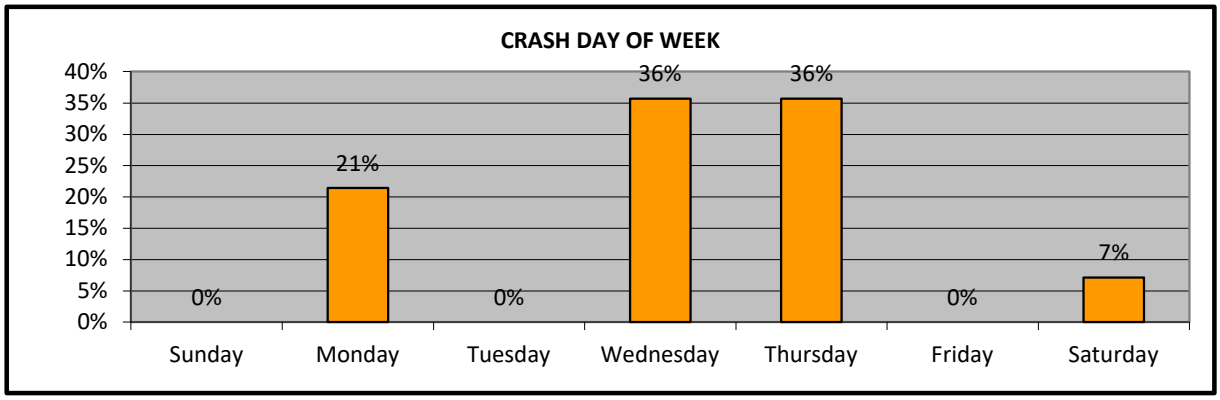
Crash Diagram Ref #	Crash Date	Crash Day	Time of Day	Manner of Collision	Light Condition	Weather Condition	Road Surface	Driver Contributing Code	V1 Driver Age	V2 Driver Age	Comments
#	mm/dd/yes	Day	hum	Type	Type	Type	Type	Type	#	#	
1	01/30/14	Thursday	8:05 AM	Pedestrian	Daylight	Clear	Dry	No improper driving	30	27	V1: SB, traveling straight ahead on Washington St, struck a pedestrian, crossing the street from behind an MBTA bus. There was significant glare at the time.
2	08/18/14	Monday	7:50 AM	Bicyclist	Daylight	Clear	Dry	Other improper action	46	46	The operator of V1 was using a forklift to unload a flatbed truck. The flatbed truck was parked on the right side of the roadway blocking the bicycle lane. The driver stated that he stopped to let pedestrians cross in the marked crosswalk. The bicyclist was traveling south in the bicycle lane and rode into the forks striking the metal arm with his face causing him to be thrown from the bicycle.
3	09/11/14	Thursday	8:02 AM	Bicyclist	Daylight	Clear	Dry	No improper driving	27		Cyclist and Driver were traveling westbound on School Street approaching Washington Street. Bicyclist turned left, colliding with vehicle V1
4	09/17/14	Wednesday	3:05 PM	Bicyclist	Daylight	Clear	Dry	Inattention	63		The operator of V1 parked his vehicle in a metered space at 4 Cypress St when he attempted to get out of V1. He failed to check for oncoming bicyclist and opened his driver's side door. Bicyclist ran into the door, which struck the right side of her body.
5	02/04/16	Thursday	5:33 PM	Pedestrian	Dark - lighted roadway	Clear	Dry	No improper driving	65-74		V1: NB, turning left at the intersection of Washington St and Cypress St, Child got away from mother's grasp and ran into side of V1.
6	01/11/17	Wednesday	4:53 PM	Pedestrian	Dark - lighted roadway	Clear	Dry	Failed to yield right of way	55-64		V1: NB, Turning left at Greenough Street/Washington Street, Collision with pedestrian on marked crosswalk. Driver stated that was traveling at very low speed and never saw pedestrian.
7	06/05/17	Monday	2:20 PM	Rear-end	Daylight	Rain	Wet	No improper driving	30		V2 stopped abruptly for a pedestrian in the crosswalk, when V1 was traveling south on Washington St at Greenough St. After V2 stopped, V1 rear-end V2.
8	07/06/17	Thursday	12:43 PM	Pedestrian	Daylight	Clear	Dry	Unknown	65-74		V1: EB, Turning right at the intersection of Gardner Rd and Washington St, struck jogger in crosswalk. Jogger saw vehicle stopped and began to cross Gardner Street.
9	11/04/17	Saturday	8:23 AM	Bicyclist	Daylight	Clear	Dry	Other improper action	59	33	V1: SB traveling straight ahead at 417 Washington Street, Sideswipe, did not observe the two bicyclist located on the right side of the roadway due to the sun glare. V1 then sideswiped the two bicyclists. The first bicyclist Involved in the accident, stated he was stopped on Washington St., (right side of the road), with the second bicyclist, . C1 stated he was assisting C2 with a problem to her bicycle.
10	05/16/18	Wednesday	7:10 PM	Pedestrian	Daylight	Cloudy	Dry	Failed to yield right of way	23		V1 was exiting the rear alley of 397 Washington St. And ran over the right foot of pedestrian that was running sidewalk.
11	09/05/18	Wednesday	5:45 PM	Pedestrian	Daylight	Clear	Dry	Failed to yield right of way/Glare	46		V1 was traveling south across Washington St onto Cypress St and struck scooter in the crosswalk on Cypress St.
12	05/13/19	Monday	8:26 AM	Pedestrian	Daylight	Cloudy	Dry	Failed to yield right of way	78		V1 traveling southbound on Washington St, struck pedestrian in crosswalk at Gardner Road. The pedestrian stated he believed V1 observed him to allow him to cross.
13	06/06/19	Thursday	2:28 PM	Bicyclist	Daylight	Clear	Dry	Failed to yield right of way	30		V1 was traveling northbound on Washington St and while turning left onto Greenough St hit a cyclist, who was traveling southbound on Washington St.
14	11/20/19	Wednesday	6:40 PM	Pedestrian	Dark - lighted roadway	Rain	Wet	Failed to yield right of way	40		V1 was traveling north on Washington St, attempted to take left onto Cypress St, hit a pedestrian who was in her wheelchair in a marked crosswalk.

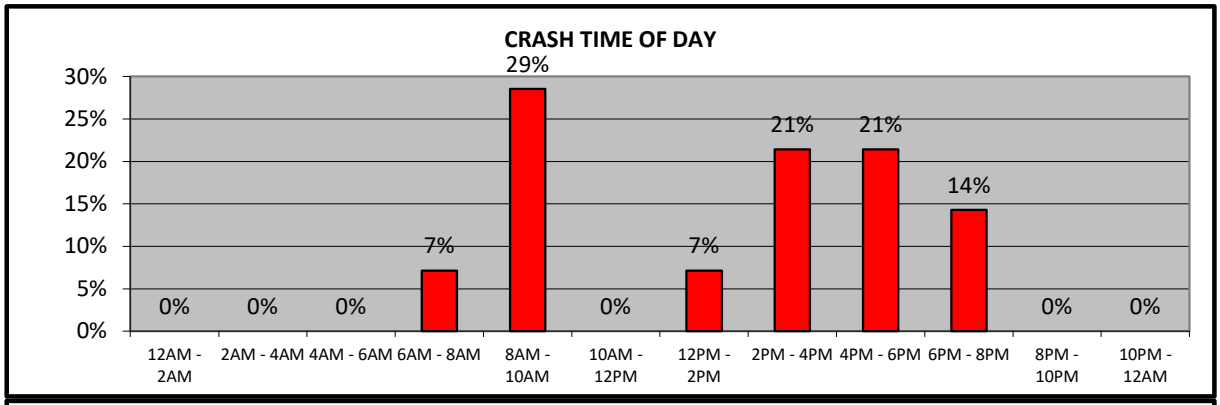
Summaries based on crash reports obtained from the City of Brookline Police Department.

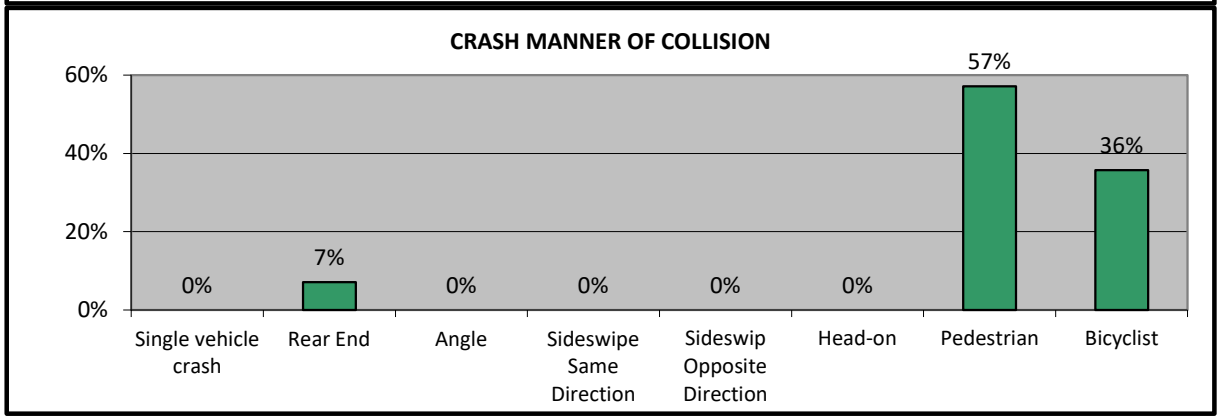
Crash Data Summary Charts

Figure 2. Washington Street from Gardner Rd & University Rd to School Street, Brookline, MA



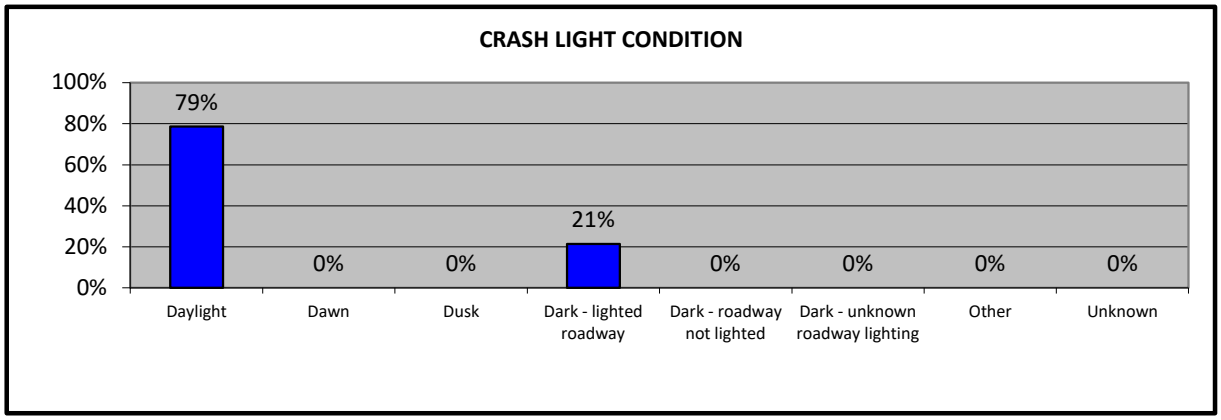


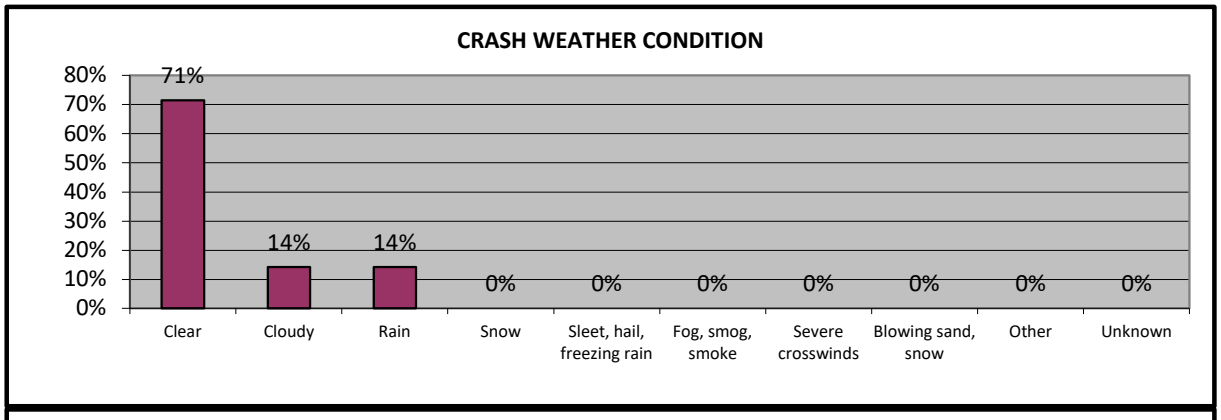


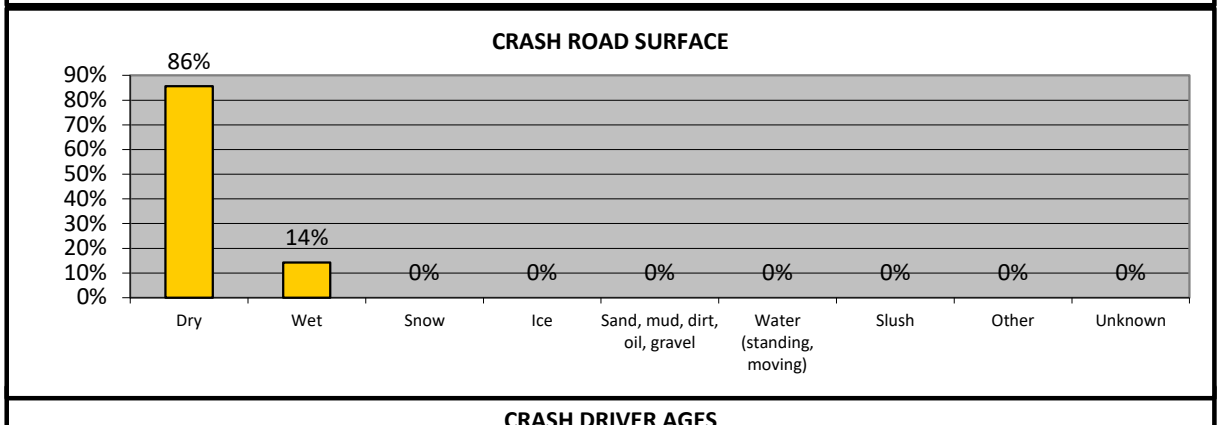


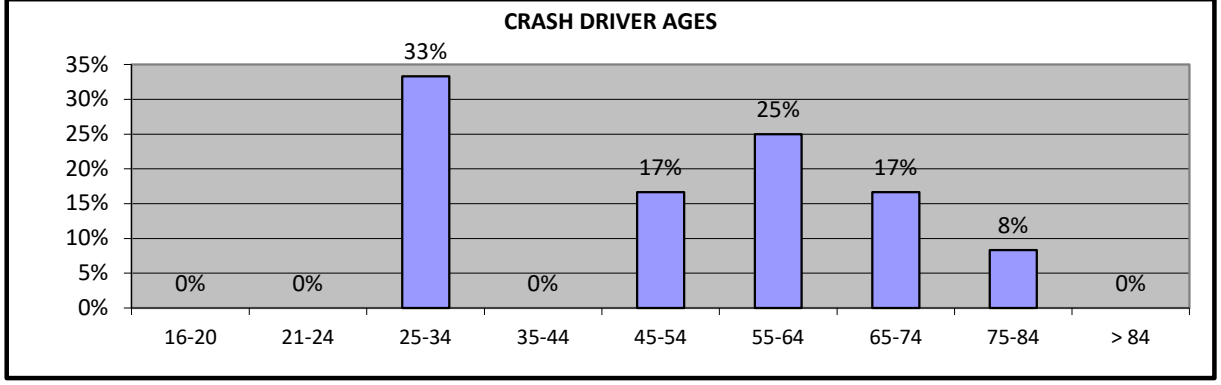
Crash Data Summary Charts

Figure 2. Washington Street from Gardner Rd & University Rd to School Street, Brookline, MA









WORLDTECH ENGINEERING

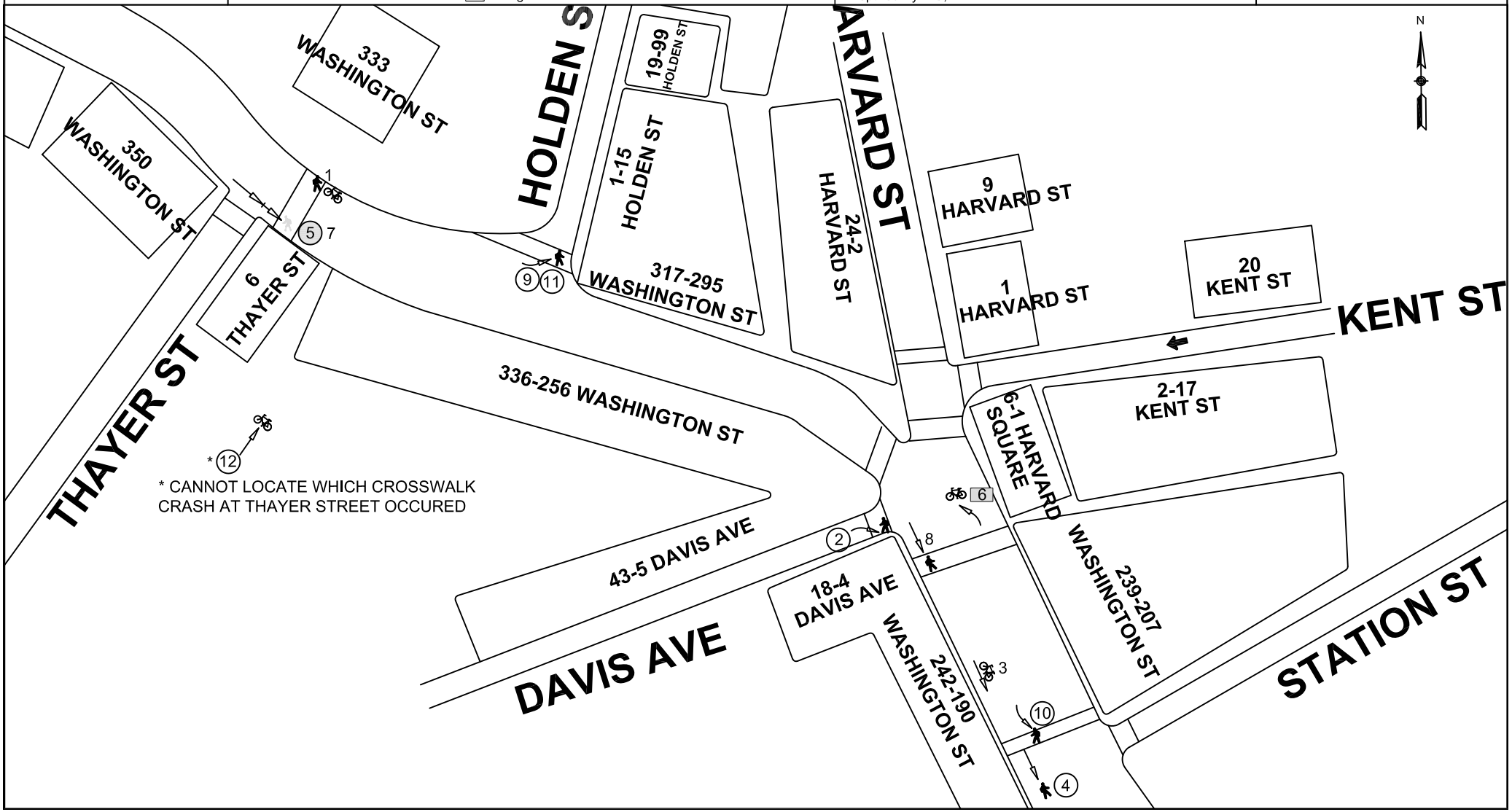
COLLISION DIAGRAM

SYMBOLS	TYPES OF CRASH	SEVERITY
Moving Vehicle	Rear End	(XX) Injury
Backing Vehicle	Head-On	
Pedestrian	Turning Movement	
Bicycle	Angle	Fatal
Animal	Sideswipe	
Parked Vehicle	Out-of-Control	XX Crash Summary Number
Fixed Object	Night Time Crash	

BROOKLINE MA

WASHINGTON STREET FROM HOLDEN STREET TO STATION STREET

Time Period Analyzed: 2010 to 2019	Project No.:N/A
Source of Crash Reports: Brookline Police Department	FIGURE 3
Date Prepared: 6/8/2020	
Prepared By: AC, FX	



Crash Data Summary Table

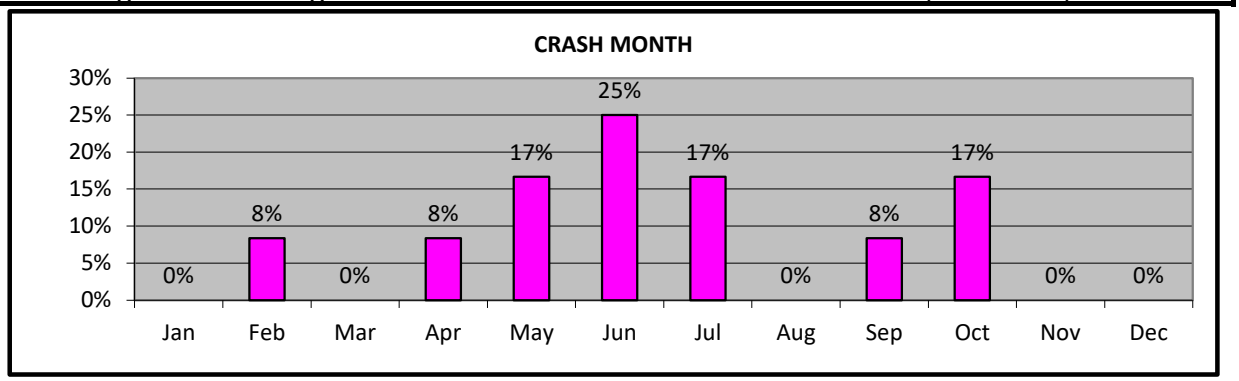
Figure 3. Washington Street from Holden Street to Station Street, Brookline, MA
2010 - 2019

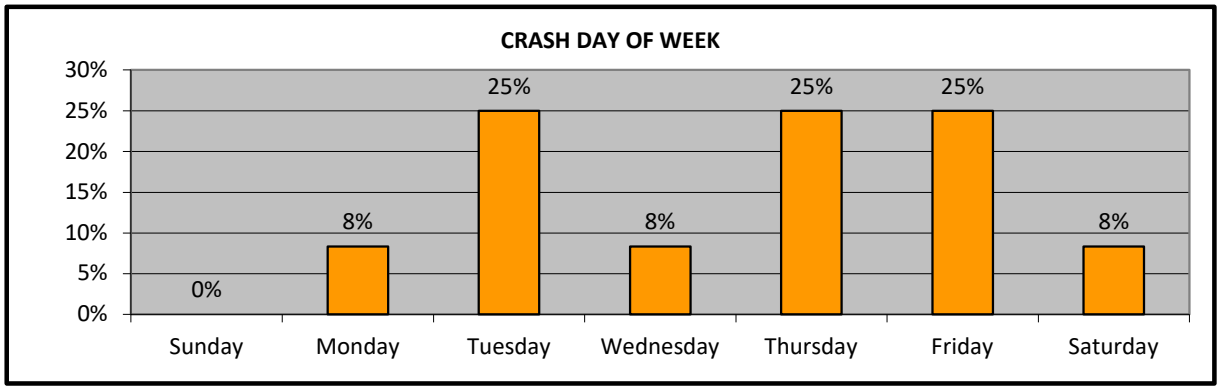
Crash Diagram Ref #	Crash Date	Crash Day	Time of Day	Manner of Collision	Light Condition	Weather Condition	Road Surface	Driver Contributing Code	V1 Driver Age	V2 Driver Age	Comments
#	*mm/dd/yy*	*Day*	*hh:mm*	*Type*	*Type*	*Type*	*Type*	*Type*	#	#	
1	10/22/10	Friday	7:43 AM	Pedestrian - Bicycle	Daylight	Clear	Dry	Driving too fast for conditions	Unknown		Bike: SB, Travelling straight ahead on Washington Street, Collision with Pedestrian (traffic crossing guard) on crosswalk.
2	02/01/11	Tuesday	7:04 AM	Pedestrian	Daylight	Cloudy	Sand, mud, dirt, oil, gravel	Failed to yield right of way	23		Hit and Run: Pedestrian was crossing Davis Ave inside the marked crosswalk when she was struck by V1. Pedestrian said that the vehicle then proceeded to take a right -hand turn onto Washington St towards Boylston St.(route 9). She said that the traffic signal at the intersection of Davis Ave./Washington St was red and that is why she crossed Davis Ave.
3	06/10/11	Friday	4:13 PM	Bicyclist	Daylight	Clear	Dry	No improper driving	59	24	Cyclist travelling South on Washington St along the right side of the road near the parked vehicles in front of 224 Washington St. Operator of vehicle1 opened the door and cyclist did not have enough time to stop. Cyclist hit the car door and was thrown off of her bike and landed on the ground.
4	10/23/12	Tuesday	3:15 PM	Pedestrian	Daylight	Clear	Dry	Disregarded traffic signs, signals, road markings	46	22	V1: SB, Travelling straight ahead, Collision with skateboarder on roadway. Skateboarder was not on a marked crosswalk and was skating between vehicles.
5	06/28/13	Friday	11:45 PM	Rear-end	Dark - lighted roadway	Clear	Dry	Inattention	33	27	V2: SB, Travelling straight ahead on Washington Street, rear ended V1: stopped for pedestrian on crosswalk at Thayer Street. D2 operating under influence (OUI).
6	06/21/14	Saturday	12:00 PM	Bicyclist	Dark - lighted roadway	Clear	Dry	No improper driving	19	22	Cyclist traveling south on Harvard Street towards Washington ran a red light at Harvard and Kent proceeding through the intersection. Two vehicles that had the left green arrow that were traveling north on Washington Street Proceeded through through green light Vehicle number 1 hit cyclist causing the cyclist to roll over the hood.
7	05/07/15	Thursday	9:50 AM	Rear-end	Daylight	Clear	Dry	Unknown	33	24	V1 traveling south on Washington St, V1 slowed down to stop for pedestrian in crosswalk at Thayer St. V2 rear ended V1.
8	05/13/15	Wednesday	12:34 PM	Pedestrian	Daylight	Clear	Dry	No improper driving	75	58	V1: SB, Travelling straight ahead, Collision with pedestrian at 238 Washington Street Pedestrian stated that he was at the cross walk when the vehicle approaching the cross walk slowed down. At this time the driver motioned to him to cross the street. Pedestrian stepped out but the vehicle did not stop for him. Driver stated that she was traveling very slowly due to traffic in the village, when a pedestrian walked out in front of her vehicle. Driver indicated that did not see the pedestrian.
9	07/23/15	Thursday	9:40 AM	Pedestrian	Daylight	Clear	Dry	Failed to yield right of way	65-74		V1: SB, Turning left from Washington Street to Holden Street, Collision with pedestrian on crosswalk.
10	09/15/15	Tuesday	3:20 PM	Pedestrian	Daylight	Clear	Dry	Inattention	51	65	V1: SB, Turning left at the intersection of Washington Street and Station St, Collision with pedestrian on crosswalk.
11	04/28/16	Thursday	1:49 PM	Pedestrian	Daylight	Clear	Dry	Made an improper turn	55		V1: SB, Turning left from Washington Street onto Holden St, collided with pedestrian. One pedestrian waived vehicle to proceed, and while turning left driver did not see two other pedestrians crossing on crosswalk and struck them.
12	07/16/18	Monday	6:15 PM	Bicyclist	Daylight	Clear	Dry	Distracted	36		Cyclist was in a marked crosswalk on her bike when she was hit by V1 at the intersection of Washington St and Thayer St.

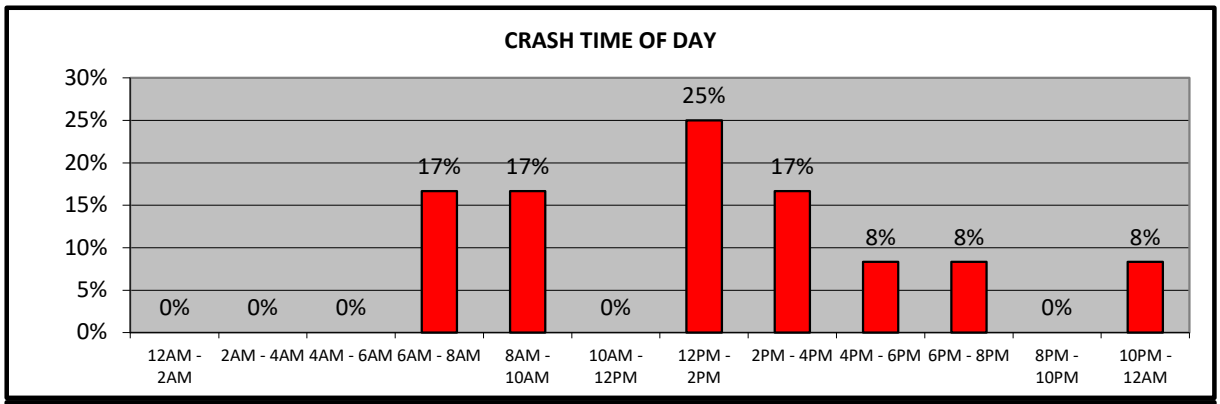
Summaries based on crash reports obtained from the City of Brookline Police Department

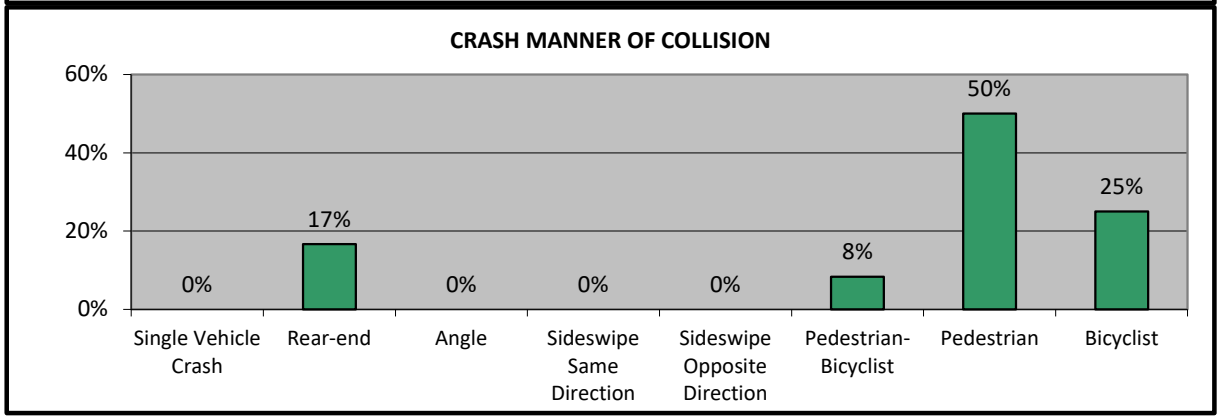
Crash Data Summary Charts

Figure 3. Washington Street from Holden Street to Station Street, Brookline, MA



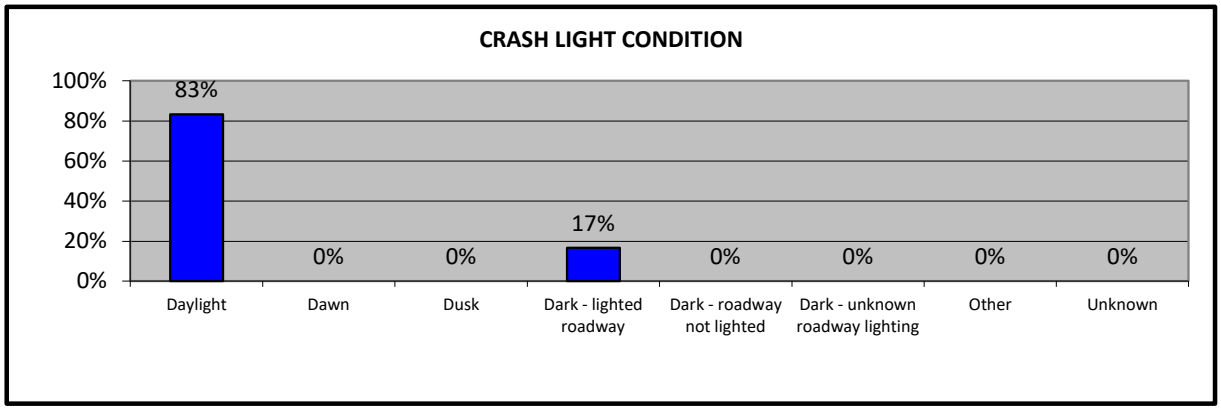


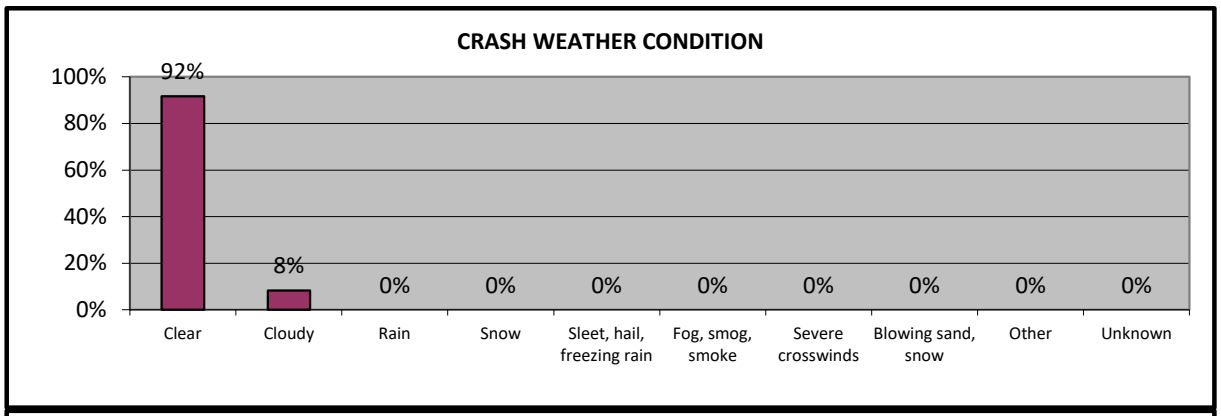


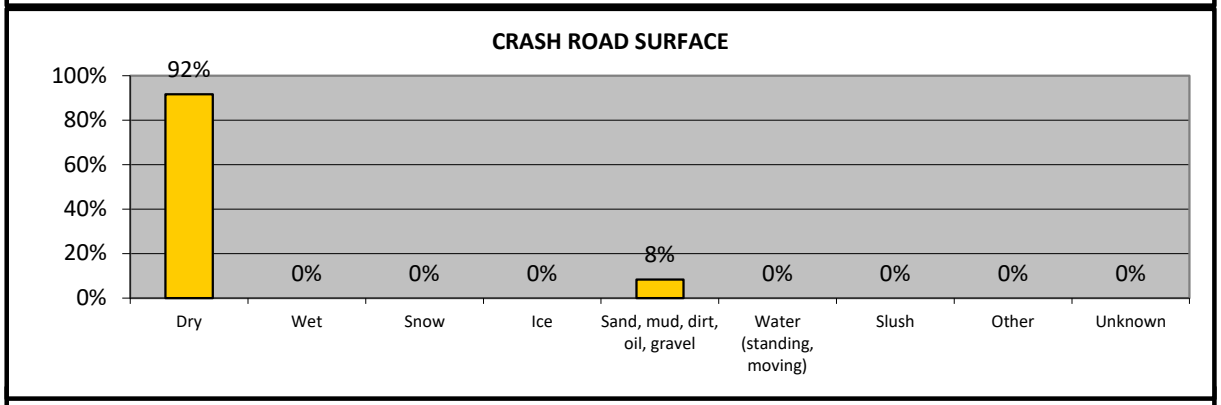


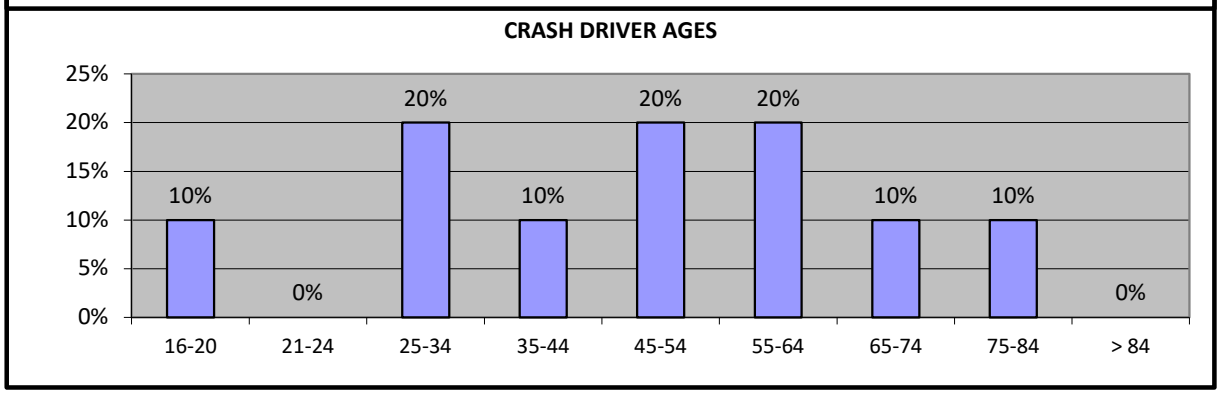
Crash Data Summary Charts

Figure 3. Washington Street from Holden Street to Station Street, Brookline, MA









WORLDTECH ENGINEERING

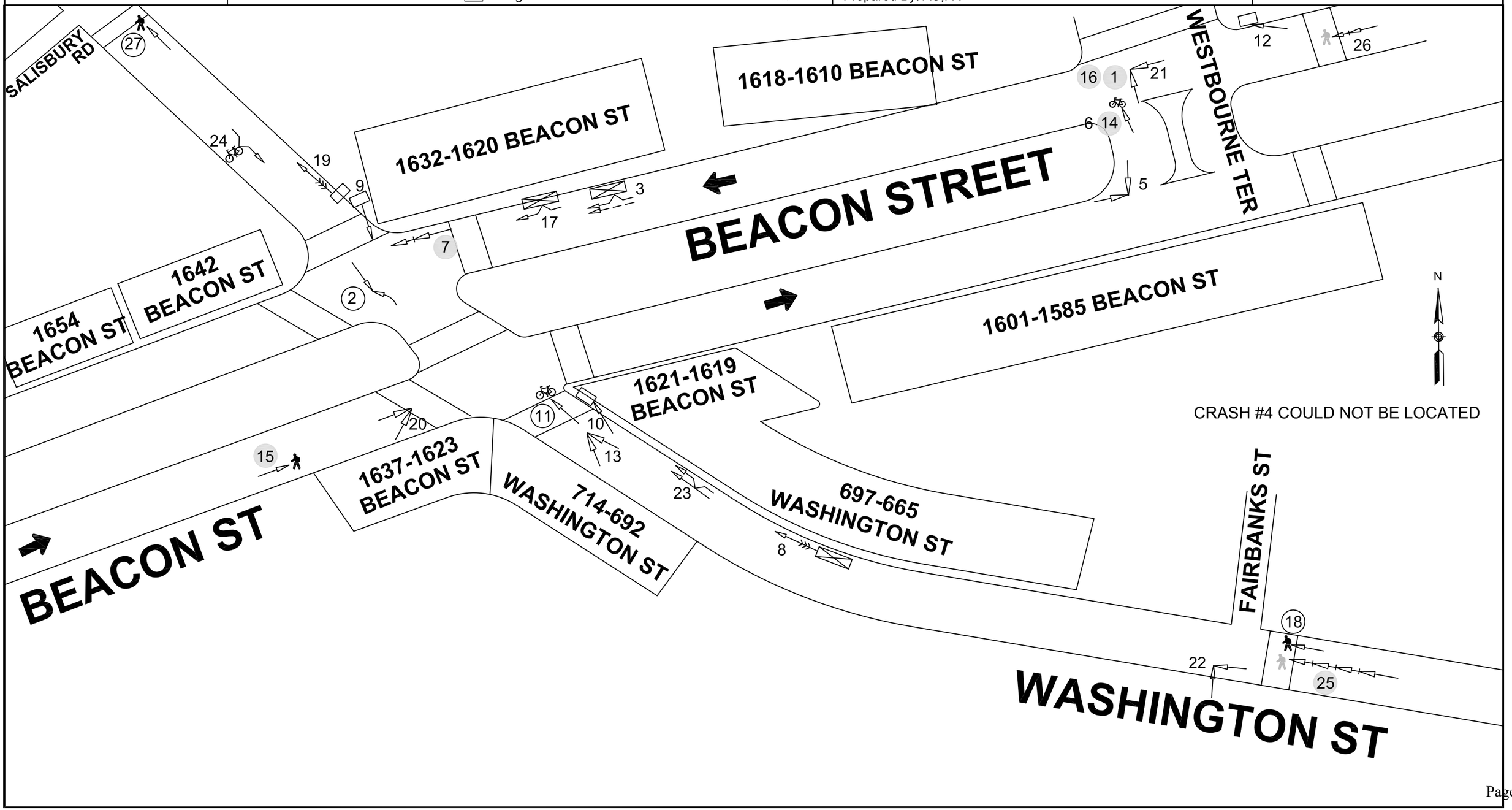
COLLISION DIAGRAM

SYMBOLS	TYPES OF CRASH	SEVERITY
Moving Vehicle	Rear End	XX Injury
Backing Vehicle	Head-On	
Pedestrian	Turning Movement	
Bicycle	Angle	Fatal
Animal	Sideswipe	
Parked Vehicle	Out-of-Control	XX Crash Summary Number
Fixed Object	Night Time Crash	

BROOKLINE, MA

WASHINGTON STREET AT BEACON STREET

Time Period Analyzed: 2015 to 2017	Project No.:N/A
Source of Crash Reports: BROOKLINE Police Department	FIGURE 4
Date Prepared: 6/16/2020	
Prepared By: AC,FX	



Crash Data Summary Table

Figure 4. Washington Street at Beacon Street, Brookline, MA
2015 - 2017

Crash Diagram Ref #	Crash Date	Crash Day	Time of Day	Manner of Collision	Light Condition	Weather Condition	Road Surface	Driver Contributing Code	V1 Driver Age	V2 Driver Age	Comments
#	mm/dd/yy	Day	hh:mm	Type	Type	Type	Type	Type	#	#	
1	03/05/15	Thursday	5:45 PM	Angle	Dark - lighted roadway	Cloudy	Dry	Visibility obstructed	30	57	Coutrsy crash. V1 crossed the trolley tracks on Beacon St to turn onto Westbourne Ter. A vehicle in the left lane on Beacon St, stopped to allow V1 to proceed. V2 was travelling in the right lane and was unaware V1 was attempting to enter Westbourne Ter. V2 collided with V1.
2	05/13/15	Wednesday	6:40 PM	Angle	Daylight	Clear	Dry	Made an improper turn	79	36	Vehicle #1 was traveling straight ahead (south) on Washington St. Vehicle #2 was traveling north on Washington St. turning left onto Beacon St. When it crashed into Vehicle #1.
3	08/06/15	Thursday	6:06 PM	Single vehicle crash	Daylight	Clear	Dry	Unknown	Unknown		Uber stopped at the light at the intersection of Beacon St and Washington St to change. While waiting for the light, one of the Uber passenger stated that she wanted to exit the vehicle on the right, as she opened the door, V1 was traveling past the vehicle on the right, V1 was forced to swerve to the right to avoid the door and struck V2 parked in front of 1620 Beacon St.
4	10/24/15	Saturday	4:42 PM	Single vehicle crash	Daylight	Clear	Dry	Failure to keep in proper lane or running off road	31		V1 parking on median spaces. D1 failed to put vehicle on park and vehicle started to move, D1 jumped into vehicle to stop but hit gas instead of brakes.
5	11/11/15	Wednesday	1:25 PM	Angle	Daylight	Rain	Wet	Made an improper turn	67	22	V1 attempted to make a U-turn from Beacon St westbound onto Beacon St eastbound. V1 drove past the designated turn around. V1 then made U-turn in the lane designated for eastbound traffic to turn westbound. This lane of travel is clearly posted "Do Not Enter". V1 continued to travel in the wrong lane and completed the U-turn onto Beacon St eastboun. After that V1 struck V2.
6	12/1/15	Tuesday	6:10 PM	Bicyclist	Dark - lighted roadway	Clear	Dry	No improper driving	39		V1 was heading north, crossing Beacon Street and onto Westbourne Ter. When crash occurred. The cyclist was heading west on Beacon Street and was passing vehicles stopped in traffic on the right. As cyclist approached the intersection of Westbourne Ter, he crashed into V1 traveling towards Westbourne Ter.
7	01/30/16	Saturday	5:11 PM	Rear-end	Dark - lighted roadway	Clear	Dry	Followed too closely	68	44	V1 was slowed and or stopped on Beacon St (westbound) at the intersection of Washington St when it was rear ended by V2. Operator of V2 stated light had just turned from red to green and traffic was moving.Operator of V1 stated he could not remember if the signal had changed from red to green or not.
8	05/21/16	Saturday	5:22 PM	Single vehicle crash	Daylight	Clear	Dry	Unknown	Unknown		V1: Backing, Collision with V2:Parked at 670 Washington Street.
9	06/07/16	Tuesday	3:40 PM	Single vehicle crash	Daylight	Clear	Dry	Made an improper turn	25		V1 double parked in front of 1634 Beacon St. During delivery V1 parked on Washington St. northbound facing the wrong direction, after completing his delivery V1 did a U turn on Washington St. to go onto Beacon St. While turning around he struck a light pole with the rear of the vehicle.
10	06/08/16	Wednesday	7:57 AM	Single vehicle crash	Daylight	Clear	Dry	No improper driving	48		V#1 traveling northbound on Washington St. to cross Beacon St, approached the road construction on Washington St. he slowed down following the traffic that was diverted to the right travel lane on Washington St. The operator of V#1 stated as he proceeded slowly between the construction equipment and the right side of the road, the right top side of the box on the truck made contact with a flag pole post mounted on the roadside of a light pole causing the light to fall from the light pole.
11	06/27/16	Monday	8:30 AM	Bicyclist	Daylight	Clear	Dry	Unknown	43	22	V1: NB, Travelling straight ahead at intersection of Washington St and Beacon St/ rear ended Cyclist. Hit and run
12	07/06/16	Wednesday	10:43 AM	Single vehicle crash	Daylight	Clear	Dry	Failure to keep in proper lane or running off road	18		V#1 traveling westbound on Beacon St. In the right lane when the vehicle made contact with the curb. The operator stated after making contact with the curb she lost control of the vehicle causing V1 to strike a tree, parking sign and light box located on the sidewalk.
13	10/18/16	Tuesday	7:10 AM	Sideswipe, same direction	Daylight	Cloudy	Wet	No improper driving	46	42	V1 travelling north on Washington Street in the right lane when vehicle #2 merged from the left lane into the right lane and made contact with V1.
14	10/27/16	Thursday	8:42 PM	Bicyclist	Dark - lighted roadway	Rain	Wet	Disregarded traffic signs, signals, road markings	30		Vehicle #1 traveled north crossing the railroad tracks on Beacon St towards Westbourne Tr and failed to stop for the stop sign. At that point, Vehicle#1 struck a cyclist traveling west on Beacon St and fled the scene. The bicyclist hit the front right fender of Vehicle#1 causing her to be knocked to the ground.

Crash Data Summary Table

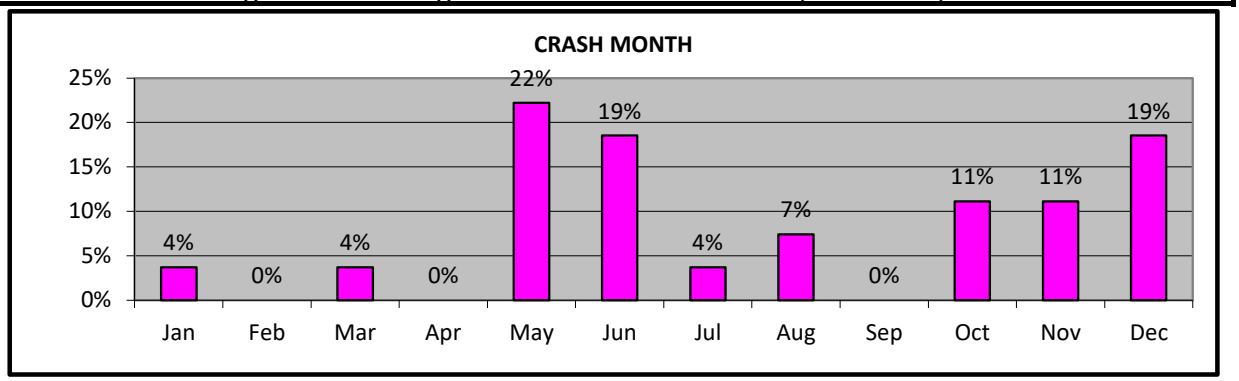
Figure 4. Washington Street at Beacon Street, Brookline, MA
2015 - 2017

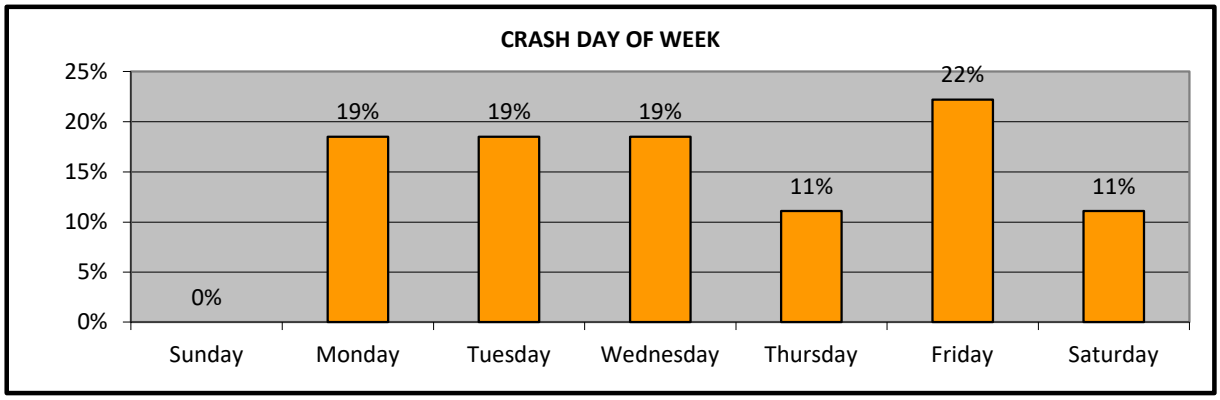
Crash Diagram Ref #	Crash Date	Crash Day	Time of Day	Manner of Collision	Light Condition	Weather Condition	Road Surface	Driver Contributing Code	V1 Driver Age	V2 Driver Age	Comments
#	mm/dd/yy	Day	hh:mm	Type	Type	Type	Type	Type	#	#	
15	11/21/16	Monday	6:09 PM	Pedestrian	Dark - lighted roadway	Clear	Dry	No improper driving	88		V1: EB, Travelling straight ahead on Beacon St, Collision with pedestrian not in a crosswalk. V1 was travelling eastbound on Beacon St at a slow rate of speed just past University Rd when the LF fender made contact with a pedestrian in the roadway, causing the pedestrian to fall to the ground and hit his head. The pedestrian, was not in a crosswalk when he was hit. Driver stated he was in the left travel lane and didn't see Pedestrian. Pedestrian was crossing the street in front of Gimbel's liquors and was hit by V1. Ped was wearing dark brown pants and a grey sweater.
16	12/19/16	Monday	6:14 PM	Angle	Dark - lighted roadway	Clear	Dry	Failed to yield right of way	59	50	V1 travelling on Beacon St westbound near the intersection with westbourne Ter when V2 came through the U-turn/turnaround on the eastbound side of Beacon. V1 struck V2.
17	12/27/16	Tuesday	9:41 AM	Single vehicle crash	Daylight	Clear	Wet	Unknown	30	26	V1 was parked in cab stand in front of 1626 Beacon St. V2 moved to the right to make room for a police vehicle with lights and sirens on. V2 side swiped V1.
18	05/08/17	Monday	2:33 PM	Pedestrian	Daylight	Clear	Dry	Failed to yield right of way	Unknown		Traveling NB on Washington Street. Struck pedestrian on marked crosswalk at Fairbanks Street.
19	05/15/17	Monday	2:44 PM	Single vehicle crash	Daylight	Clear	Dry	No improper driving	Unknown		V1: Backing, up to exit parking spot collided with traffic sign post
20	05/23/17	Tuesday	9:10 AM	Sideswipe, same direction	Daylight	Clear	Dry	No improper driving	46	36	V1 was traveling straight ahead in the middle lane of Beacon St. eastbound. V2 was stopped in the right lane of Beacon St. eastbound. V2 attempted to change lanes to enter the middle lane at which point V2 made contact with V1.
21	5/26/17	Friday	3:20 PM	Angle	Daylight	Rain	Wet	Disregarded traffic signs, signals, road markings	27	26	V1 was attempting to cross Beacon Street towards Westbourne Ter, and failed to stop at the stop sign.
22	06/09/17	Friday	6:08 PM	Angle	Daylight	Clear	Dry	Failed to yield right of way	42	38	Vehicle #1 was traveling north on Washington Street. Vehicle #2 was exiting the driveway of 632 Washington Street. As Vehicle #2 was entering into the travel lane of Washington Street it made contact with Vehicle #1.
23	06/09/17	Friday	6:20 PM	Sideswipe, same direction	Daylight	Clear	Dry	Failed to yield right of way	65	30	At 693 Washington St, the operator of V1 stated she moved over to the right side of the road to let fire trucks pass by. V1 stated she put her left turn signal on and then entered traffic, that is when she came in contact with V2 which was traveling North on Washington St.
24	08/09/17	Wednesday	7:31 AM	Bicyclist	Daylight	Clear	Dry	No improper driving	47	27	V1: SB, Travelling straight ahead in the left lane southbound on Washington St toward Beacon St, Cyclist, traveling in right lane southbound on Washington St signaled to turn left at which point V1 and cyclist made contact.
25	11/10/17	Friday	6:37 AM	Rear-end	Dawn	Cloudy	Wet	Unknown	55-64		V1 NB on Washington Street stopped for pedestrian on marked crosswalk at Fairbanks Street. V4 rear ended V3 which rear ended V2 which rear ended V1.
26	12/8/17	Friday	3:30 PM	Rear-end	Daylight	Clear	Dry	Followed too closely	Unknown		V1 and V2 were traveling westbound on Beacon St, V1 stopped for a pedestrian. V2 did not stop in time and struck V1 in the rear bumper.
27	12/15/17	Friday	2:43 PM	Pedestrian	Unknown	Unknown	Unknown	Unknown	47		V1: NB, Travelling straight ahead on Washington Street, Collision with pedestrian, on a marked crosswalk. Driver stated that he was driving North Bound on Washington St, traffic on the Southbound side was backed up from Washington Sq and past Salisbury Rd. Driver stated that the young girl ran out into the crosswalk with a dog and this is when he struck Pedestrian with the front of his vehicle. Driver stated he did not see her until this moment. There were also two witnesses on Scene that were able to corroborate Drivers accounts.

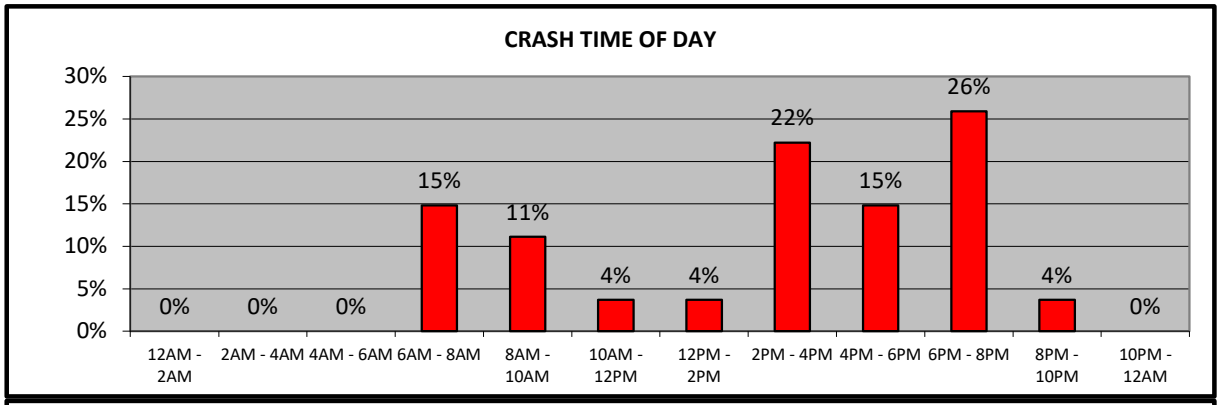
Summaries based on crash reports obtained from the City of Brookline Police Department

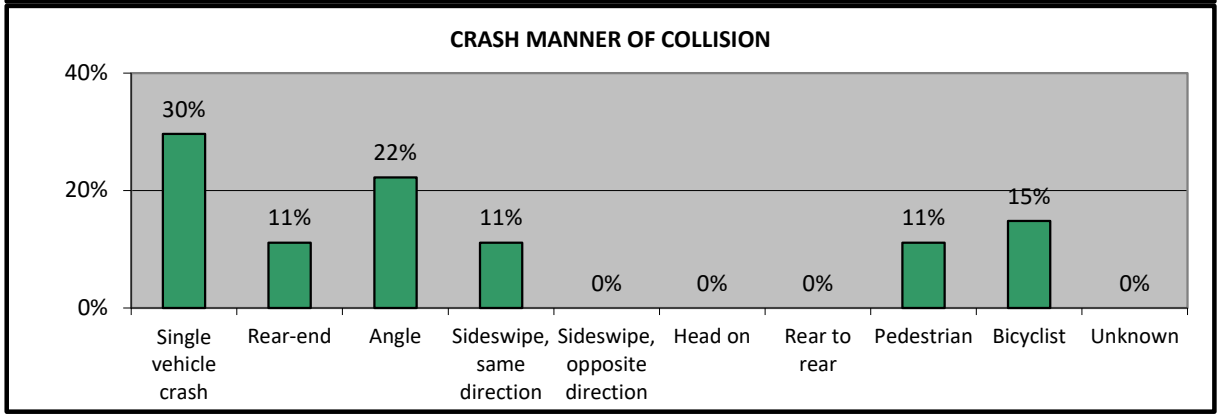
Crash Data Summary Charts

Figure 4. Washington Street at Beacon Street, Brookline, MA



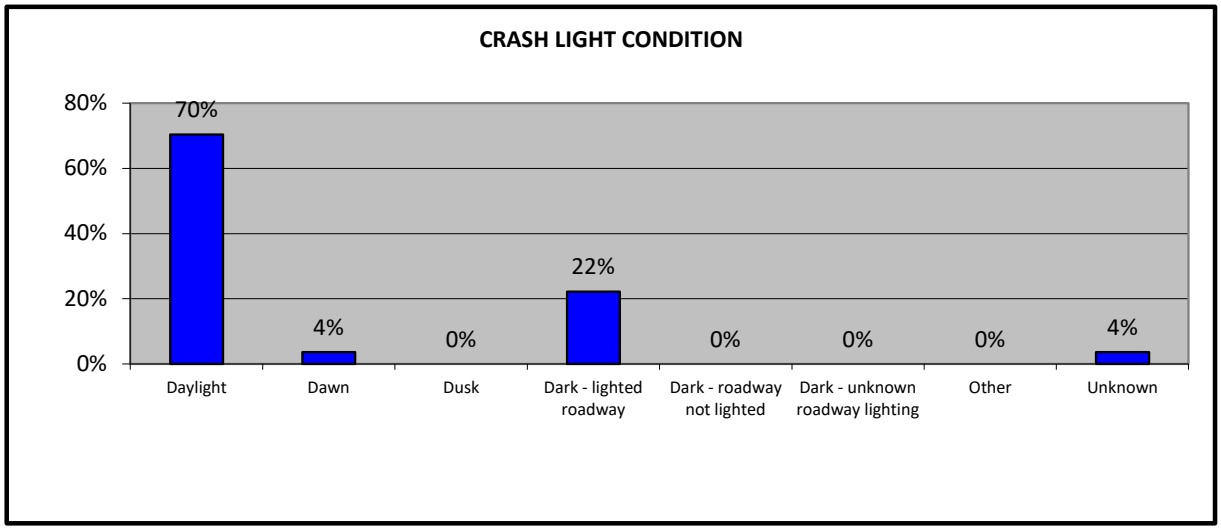


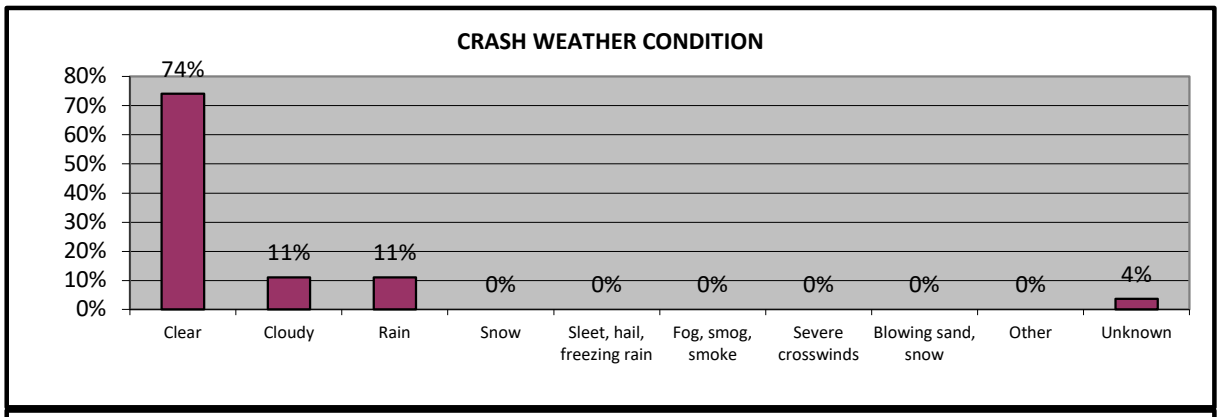


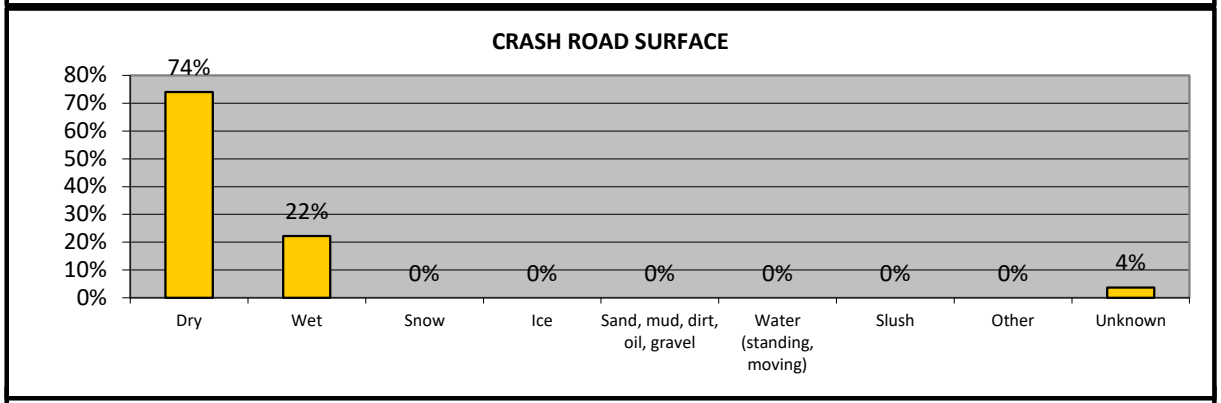


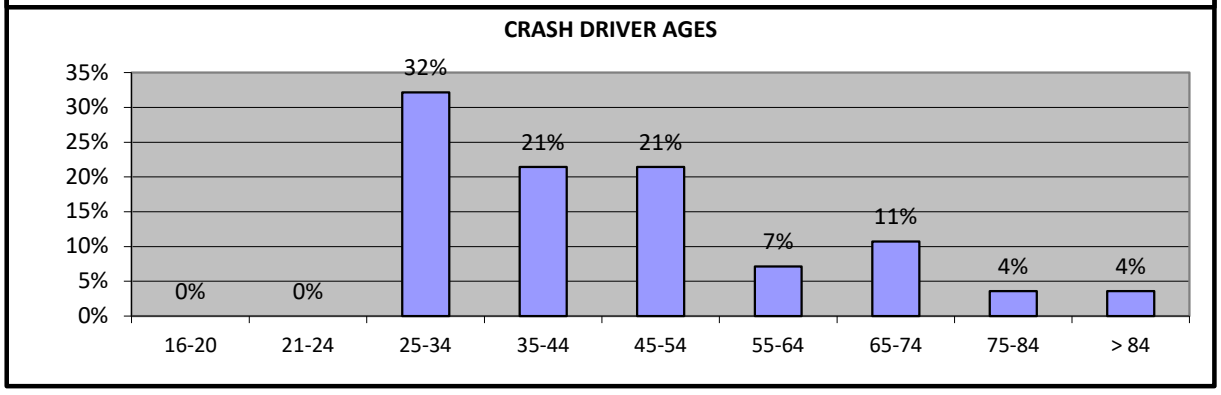
Crash Data Summary Charts

Figure 4. Washington Street at Beacon Street, Brookline, MA









WORLDTECH ENGINEERING

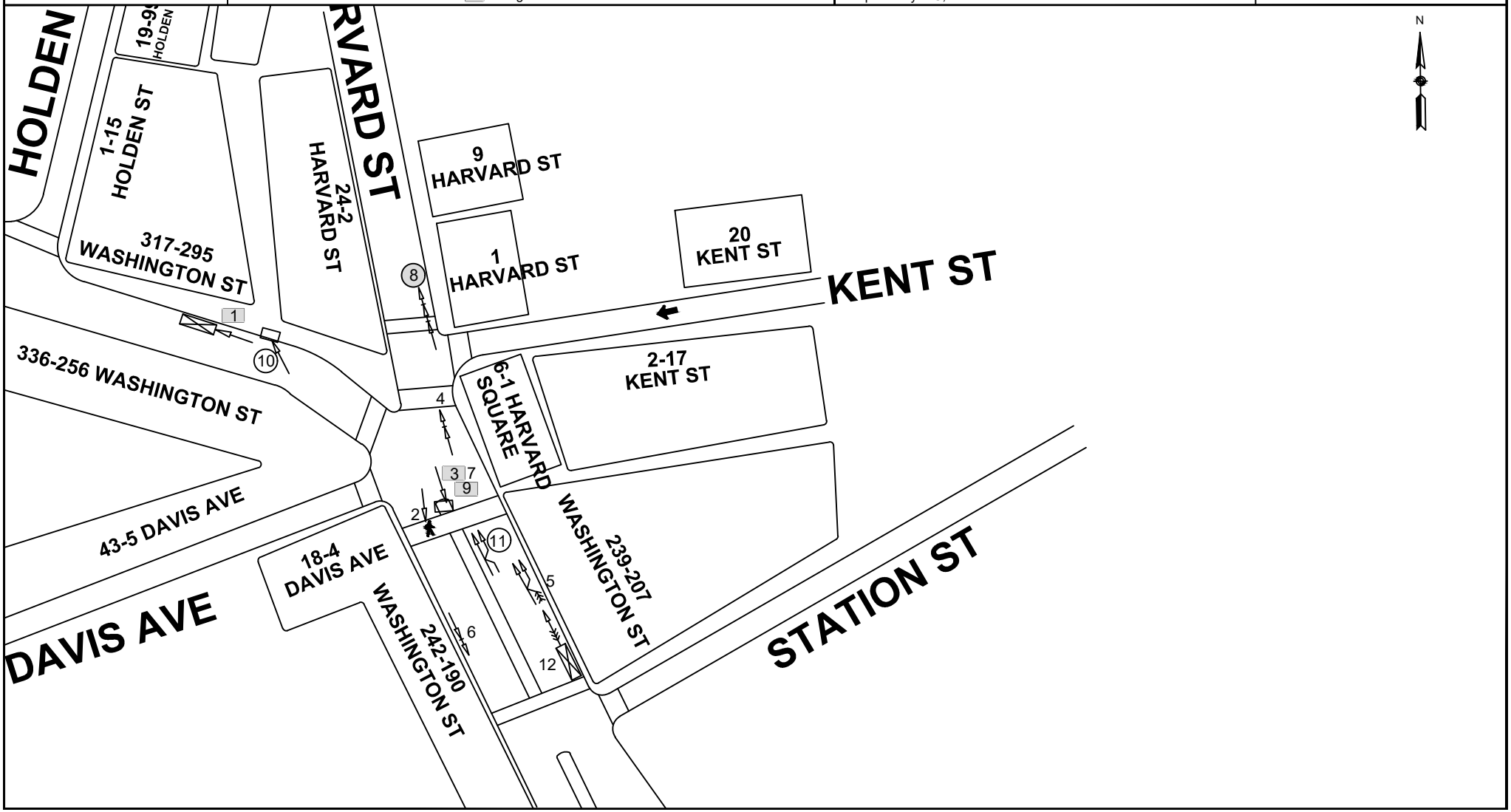
COLLISION DIAGRAM

SYMBOLS	TYPES OF CRASH	SEVERITY
Moving Vehicle	Rear End	(XX) Injury
Backing Vehicle	Head-On	
Pedestrian	Turning Movement	
Bicycle	Angle	Fatal
Animal	Sideswipe	
Parked Vehicle	Out-of-Control	XX Crash Summary Number
Fixed Object	Night Time Crash	

BROOKLINE MA

WASHINGTON STREET AT HARVARD STREET

Time Period Analyzed: 2015 to 2017	Project No.:N/A
Source of Crash Reports: Brookline Police Department	FIGURE 5
Date Prepared: 3/20/2020	
Prepared By: AC, FX	



Crash Data Summary Table

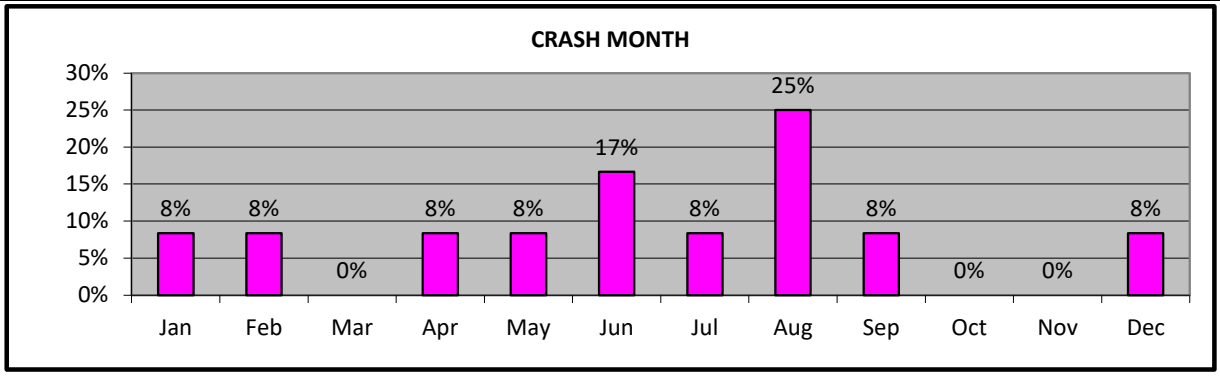
Figure 5. Washington Street at Davis Ave / Harvard Street & Kent Street , Brookline, MA
2015 - 2017

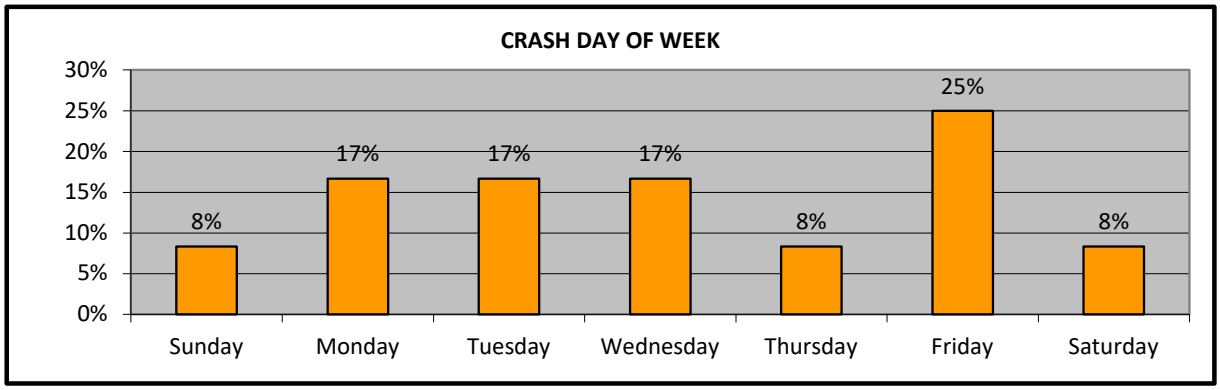
Crash Diagram Ref #	Crash Date	Crash Day	Time of Day	Manner of Collision	Light Condition	Weather Condition	Road Surface	Driver Contributing Code	V1 Driver Age	V2 Driver Age	Comments
#	mm/dd/yy	Day	hh:mm	Type	Type	Type	Type	Type	#	#	
1	02/24/15	Tuesday	10:32 PM	Rear-end	Dark - lighted roadway	Clear	Unknown	Unknown	Unknown		Hit and run. V1 operator noticed damage to bumper of parked vehicle.
2	05/13/15	Wednesday	12:34 PM	Pedestrian	Daylight	Clear	Dry	No improper driving	75	57	V1: SB, Travelling straight ahead, Collision with pedestrian at 238 Washington Street Pedestrian stated that he was at the cross walk when the vehicle approaching the cross walk slowed down. At this time the driver motioned to him to cross the street. Pedestrian stepped out but the vehicle did not stop for him. Driver stated that she was traveling very slowly due to traffic in the village, when a pedestrian walked out in front of her vehicle. Driver indicated that did not see the pedestrian.
3	06/14/15	Sunday	12:00 AM	Single vehicle crash	Dark - lighted roadway	Clear	Dry	Unknown	51		Hit and run. Appears that V1 was traveling SB on Washington Street and hit signal pole. Signal was knocked off base and left in street.
4	09/25/15	Friday	8:45 AM	Rear-end	Daylight	Clear	Dry	Followed too closely	21-24		V1: NB, on Harvard Street at Kent Street was rear ended by V2.
5	04/21/16	Thursday	1:20 PM	Sideswipe, same direction	Daylight	Clear	Dry	No improper driving	45-54		V1: NB, parallel parking at 225 Washington Street was sideswiped by V2. Hit and run.
6	06/08/16	Wednesday	12:30 PM	Rear-end	Daylight	Clear	Dry	Driving too fast for conditions	25-34		V1 and V2 turned left from Kent Street onto Washington Street southbound. V1 hit rear of V2 while attempting to change lanes.
7	08/02/16	Tuesday	5:14 PM	Single vehicle crash	Daylight	Clear	Dry	Failure to keep in proper lane or running off road	45-54		V1 turning left from Andem Place onto Washington Street SB misjudged turn and hit sign in median.
8	12/23/16	Friday	6:44 PM	Rear-end	Dark - lighted roadway	Clear	Dry	Unknown	21-24		V1: NB, Travelling straight ahead at the intersection of Harvard Street and Kent Street. rear-ended by V2 which in turn was rear-ended by V3.
9	01/20/17	Friday	2:25 AM	Single vehicle crash	Dark - lighted roadway	Clear	Dry	Inattention	25-34		V1 started to turn left from Washington Street SB onto Harvard Square when D1 decided to continue to go straight resulting in V1 hitting sign in median.
10	07/15/17	Saturday	7:17 AM	Single vehicle crash	Daylight	Clear	Dry	Unknown	25-34		V1 traveling NB on Washington Street felt truck was driving in wrong lane and swerved to avoid it hitting curb and tree at 295 Washington Street.
11	08/14/17	Monday	3:45 PM	Sideswipe, same direction	Daylight	Clear	Dry	No improper driving	35-44		V1 in left turn lane NB on Washington Street sideswipes V2 in through lane.
12	08/14/17	Monday	11:45 AM	Single vehicle crash	Daylight	Clear	Dry	No improper driving	35-44		V1 attempting to parallel park at 225 Washington Street hit accelerator instead of brake backing into sidewalk and building.

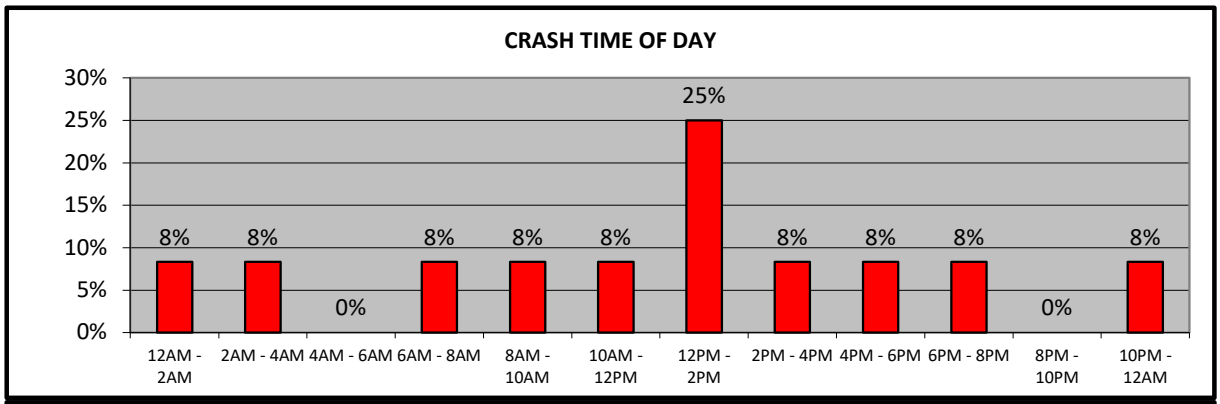
Summaries based on crash reports obtained from the City of Brookline Police Department.

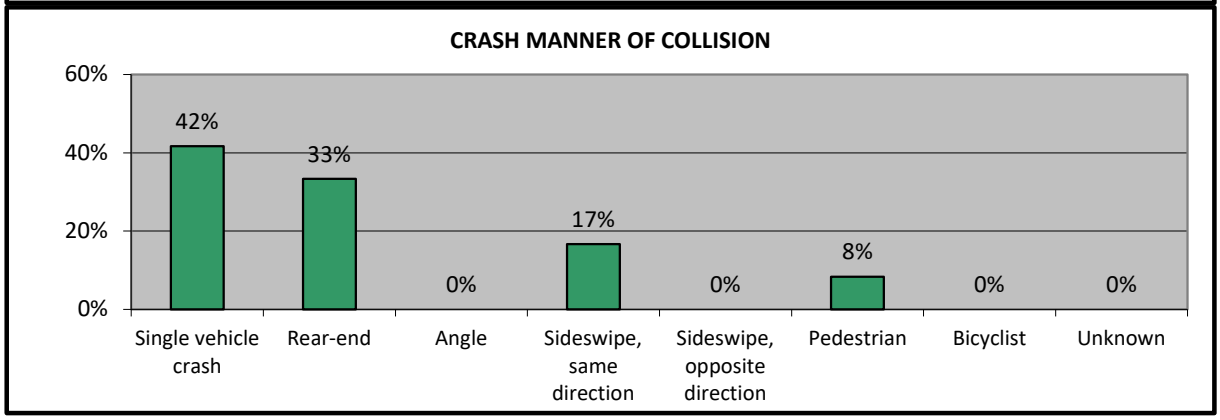
Crash Data Summary Charts

Figure 5. Washington Street at Davis Ave / Harvard Street & Kent Street , Brookline, MA



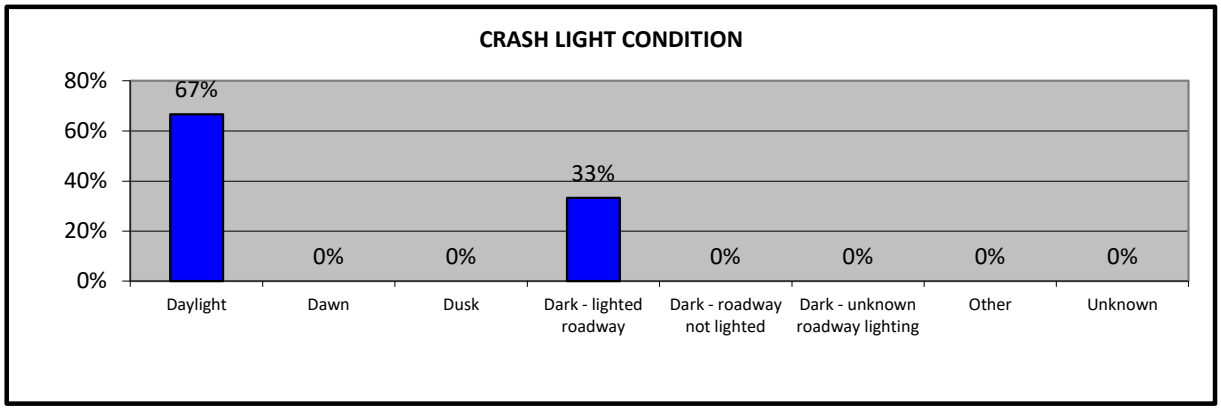


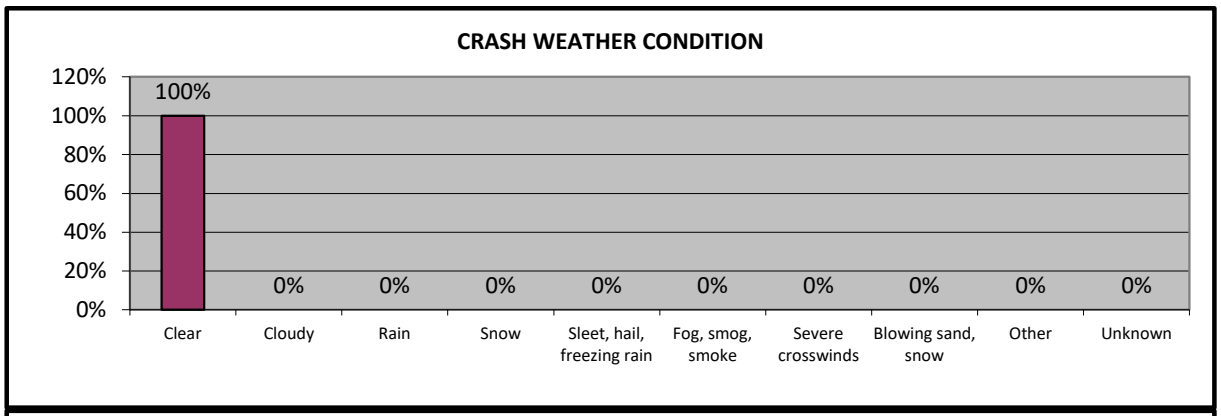


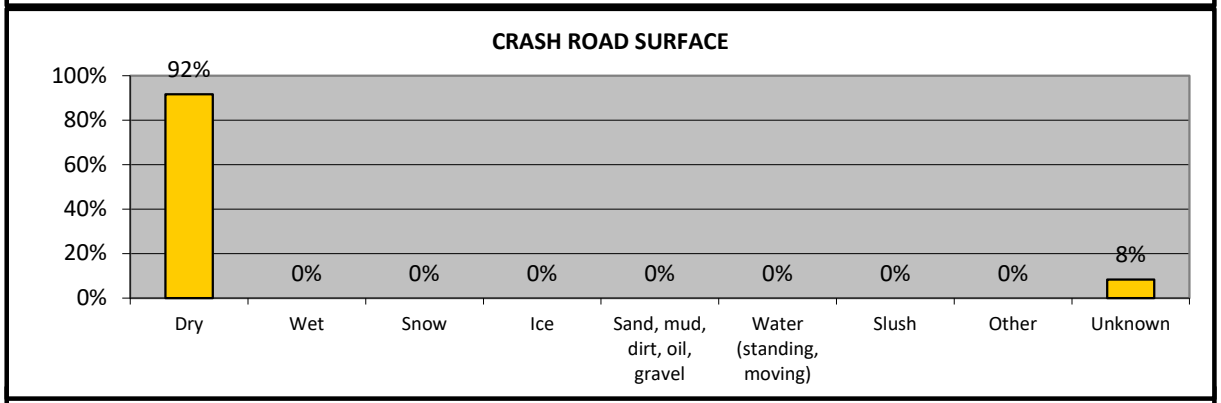


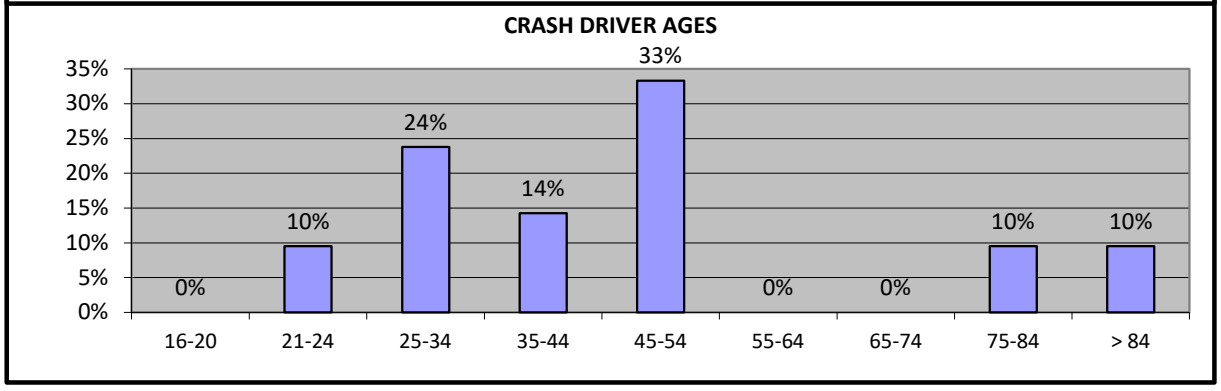
Crash Data Summary Charts

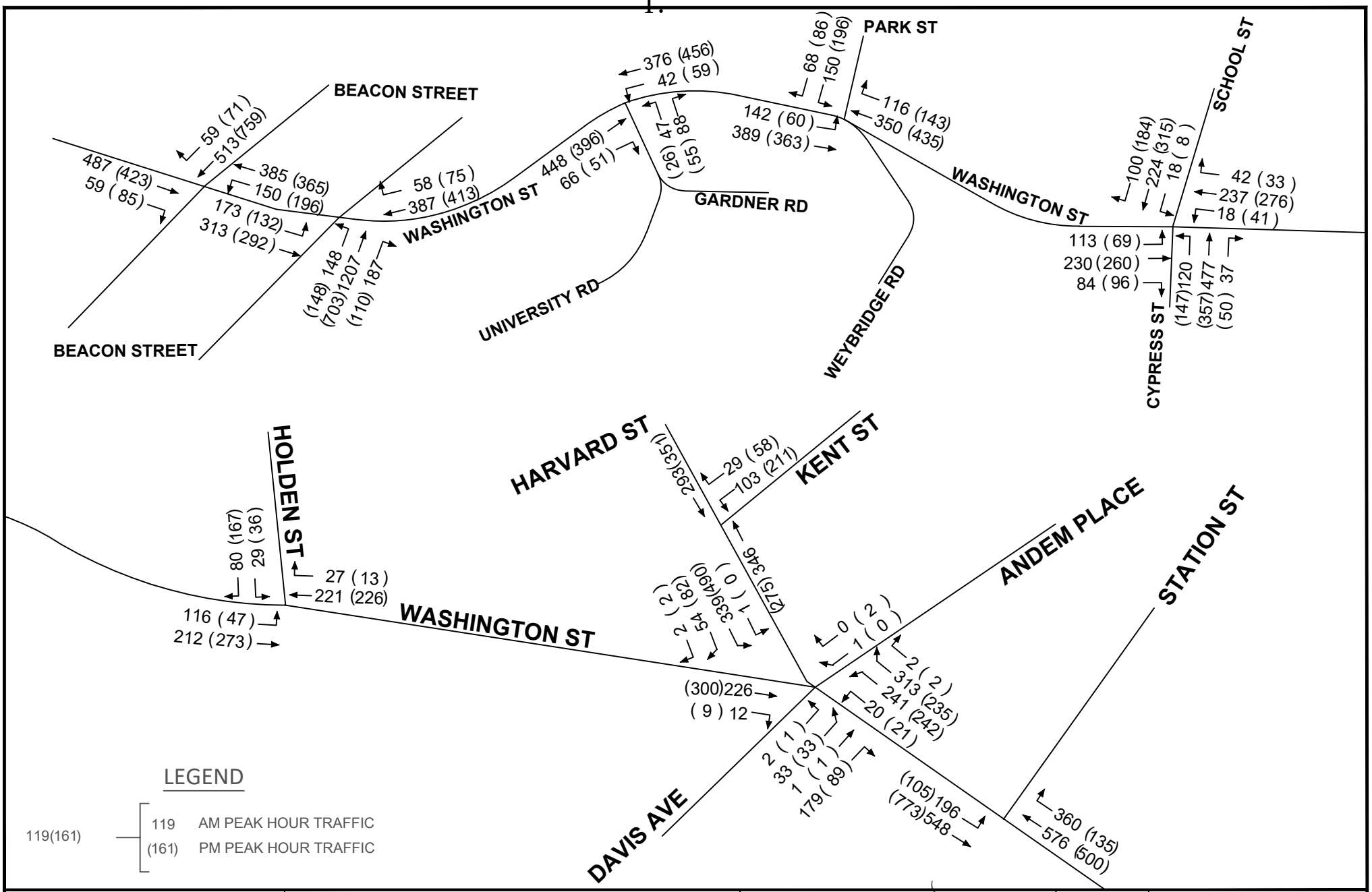
Figure 5. Washington Street at Davis Ave / Harvard Street & Kent Street , Brookline, MA



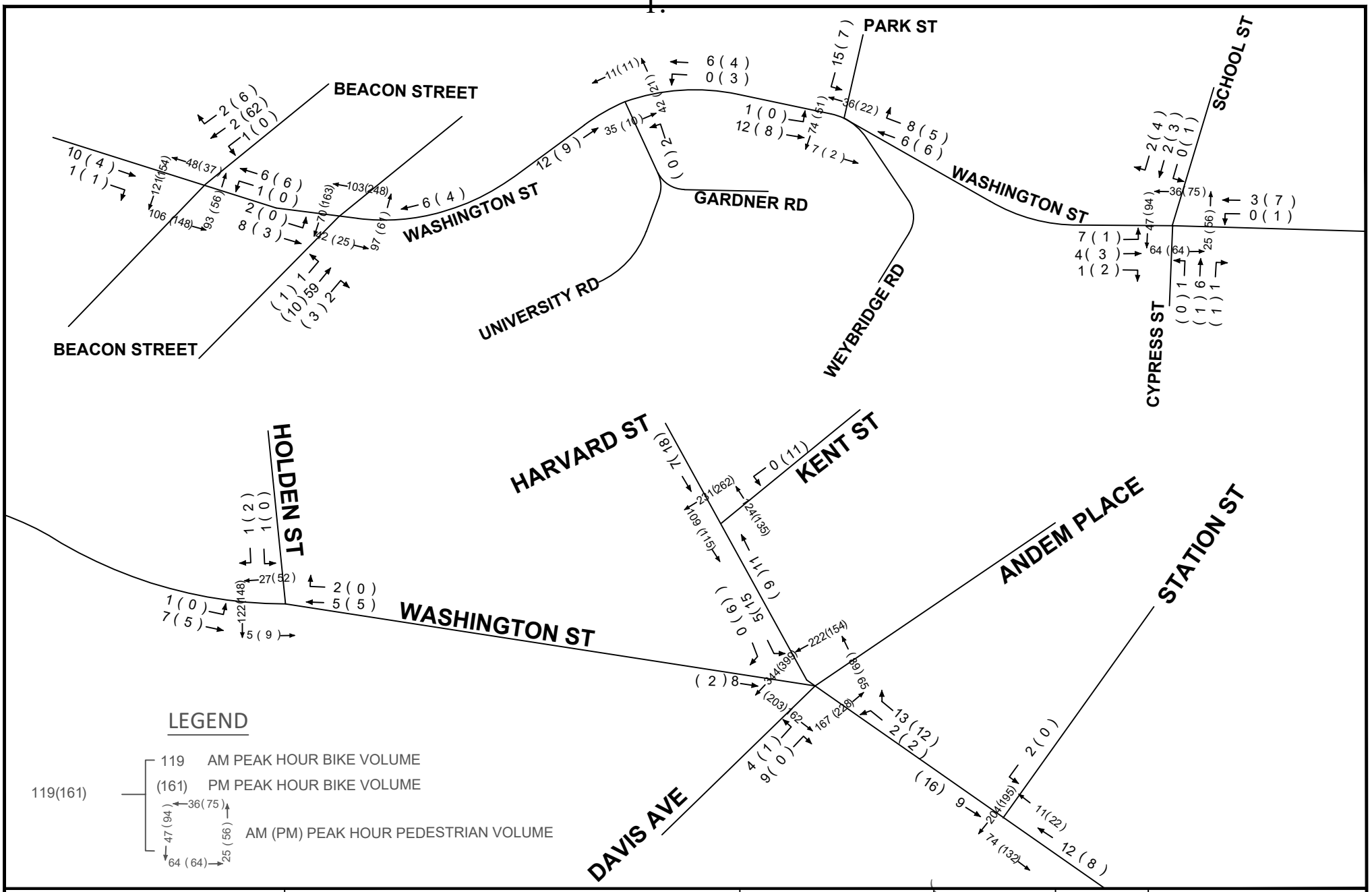








PREPARED FOR:	TITLE:		DATE: 3/26/20	SCALE: N.T.S.
	Washington Street Corridor Study - Rehabilitation of Washington Street Brookline, Massachusetts	N	PREPARED BY: WORLDTECH ENGINEERING 300 TRADE CENTER, SUITE 5580 WOBURN, MASSACHUSETTS 01801 PHONE: 781.933.4800	Figure 3
	2020 Existing AM (PM) Peak Hour Traffic Volumes			



PREPARED FOR:	TITLE:		DATE: 3/26/20	SCALE: N.T.S.
	Washington Street Corridor Study - Rehabilitation of Washington Street Brookline, Massachusetts		PREPARED BY: WORLDTECH ENGINEERING 300 TRADE CENTER, SUITE 5580 WOBURN, MASSACHUSETTS 01801 PHONE: 781.933.4800	Figure 2
	2020 AM (PM) Peak Hour Peds & Bike Traffic Volumes			

Appendix D. Road Safety Audit References

Road Safety Audit References

FHWA Office of Safety - Proven Safety Countermeasures, U.S. Department of Transportation, Federal Highway Administration https://safety.fhwa.dot.gov/provencountermeasures/.

Road Safety Audits, A Synthesis of Highway Practice. NCHRP Synthesis 336. Transportation Research Board, National Cooperative Highway Research Program, 2004.

Road Safety Audits. U.S. Department of Transportation, Federal Highway Administration, https://safety.fhwa.dot.gov/rsa/

FHWA Road Safety Audit Guidelines. U.S. Department of Transportation, Federal Highway Administration, 2006.

Road Safety Audit, 2nd edition. Austroads, 2000.

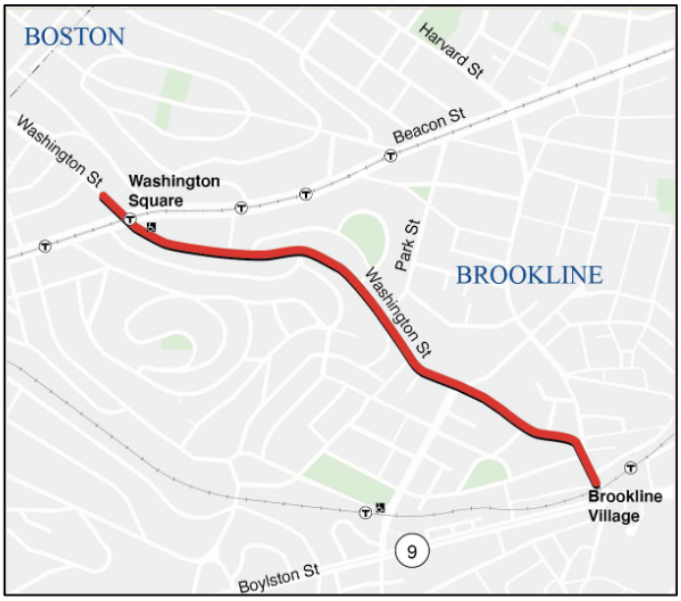
Road Safety Audits. ITE Technical Council Committee 4S-7. Institute of Transportation Engineers, February 1995.

Brookline: Rehabilitation of Washington Street (610932)

MPO Investment Program: Complete Streets

Evaluation Score: 56.9

Cost: $25,888,631



Main Objectives:

- The primary goal of this project is to create a true complete street throughout the Washington Street corridor. This includes improving safety and operations along the corridor for drivers, bicyclists, pedestrians, and transit users.

Project Details:

- Washington Street is currently constrained with a relatively narrow right of way that tries to accommodate two lanes of traffic, on street parking in both directions, bicycling, and significant volumes of pedestrians.
- Washington Street provides a major connection between Route 9 (to/from Boston) and Beacon Street as well as Commonwealth Avenue and Cambridge Street in the Allston/ Brighton area of Boston. In addition to vehicles, the roadway provides a significant connection for bicyclists to Washington Square and Brookline Center.
- The sidewalks are in poor condition, especially north of School Street. Sections are heaving and are impassible to pedestrians with mobility impairments. The project area contains a large HSIP bicycle cluster.
- The proposed project will reconstruct sidewalks along both sides of the entire corridor and will provide protected bicycle facilities in both directions that are separated from vehicular traffic for a vast majority of the corridor. Other multimodal improvements include the provision of dedicated bus pull-out space outside of the travel lanes.
- The project will replace the existing signals along Washington Street's length and will reconstruct the roadway surface.
- At its southern end, this project will directly connect with the recently completed Gateway East project, the MPO-funded reconstruction of Washington Street east of Brookline Village.

Memorandum

WORLDTECH ENGINEERING

To: Matt Genova Date: February 8, 2021

From: Rich Benevento

c. Erin Gallentine, Town of Brookline
Todd Kirrane, Town of Brookline
Dan Martin, Town of Brookline

RE: Project Scoring

Project: Rehabilitation of Washington Street, Brookline, MA

Project No: MassDOT 610932

WorldTech Engineering has reviewed the initial scoring for the above referenced project and offer the follow comments.

The project scored a Total Base Score of 42 points and Equity Score of 12 points (Net Scaled Equity Score 6.2) for a Final Score of 48.2. Based on our review of the categories, the project may be eligible for 14 additional base points for a Total Revised Base Score of 56 and 4.5 addition equity points for a Total Revised Equity Score of 16.5 (Net Scaled Revised Equity Score 8.5) This results in a revised **Final Score of 64.5**. Note all bonus points remain unchanged unless adjusted per revised applicable base score. Our breakdown is included below.

SAFETY: TRANSPORTATION BY ALL MODES WILL BE SAFE

Criteria 1c – Project addresses truck related safety issue (up to 2 points)
Current Score: 0
Revised Score: 1

The truck percentage is approximately 3% of daily traffic, or approximately 300-400 trucks per day. A number of design elements will improve truck related safety issues. These include.

- Improved visibility of traffic signals and turning radii at intersections.
- Improved roadway geometry and consistent roadway cross-section.
- Reduced truck/ bicycle conflicts due to relocating the bike lane.
- Improved pavement condition.

The project has a "Medium total effectiveness of truck safety improvements (1 point).

Criteria 1e – Project improves pedestrian safety (up to 2 points).
Current Score: 1
Revised Score: 2
Equity Score: 1

A new signalized pedestrian crossing will be added across Washington Street at Park Street. In addition, safety improvements will be implemented where multiple pedestrian crashes have occurred, including at Cypress Street and Fairbanks Road.

Memorandum

Although sidewalks currently exist on Washington Street, they are in poor to fair condition. The curbing along the northern section of the project is low, providing very little separation between the roadway and the sidewalk. The curbing will be improved.

In addition, there have been numerous pedestrian crashes along the corridor, resulting in some of the corridor qualifying as an HSIP Pedestrian Cluster. Pedestrian safety improvements consist of a new signalized crossing, shorter pedestrian crossings, rectangular rapid flashing beacons, and improved visibility of pedestrian crossing due to removed parking.

The project has a "High total effectiveness of pedestrian safety improvements" (2 points).

Criteria 1f – Project improves safety for all users (up to 2 points).
Current Score: 0
Revised Score: 2

The Select Board's policy requires that the "Town of Brookline shall plan, construct, and maintain its public ways to enhance safety, access, inclusion, convenience, and comfort for all users, thereby creating "complete streets." The Town will create a comprehensive transportation network that sufficiently accommodates people of all ages and abilities, whether traveling by foot, bicycle, wheelchair, mass transit, or motor vehicle. Achieving these objectives will require context-sensitive treatments and operational strategies to balance the needs of all users."

The project includes traffic signal improvements replace outdated and deficient traffic signal equipment. In addition, a new signalized pedestrian crossing will be added at the Washington Street at Park Street intersection. In addition, safety improvements will be implemented at Cypress Street and Fairbanks Road, where multiple pedestrian crashes have occurred.

Under existing conditions, the corridor features a wide travel lane or a narrow travel lane adjacent to an on-road bike lane. The proposed project will implement separated bike lanes. Therefore, the uniform width travel lane will be either adjacent to parked vehicles or a raised buffer, thereby reducing the available pavement width. The reduced roadway width will serve as traffic calming.

Lastly, relocated bus stops will improve safety for transit users, allowing crossings to occur behind the bus, which is a safer maneuver. It will also remove substandard bus stops, such as at Gardner Road, where the bus currently stops within the intersection.

The project includes "three or more eligible multi-modal safety improvements" (2 points).

SYSTEM PRESERVATION

Criteria 2a – Project incorporates resiliency elements into its design (up to 5 points).
Current Score: 1
Revised Score: 4
Equity Score: 2

In addition to the Town's 2018 Climate Action Plan Brookline has adopted policies and have advanced initiatives to address climate change and implement resiliency solutions.

Memorandum

The project improves stormwater infrastructure (+1 base point, 0.5 equity points).
This project will improve stormwater infrastructure by installing a completely new drainage system. The work, necessitated by revised roadway geometry and aging drainage infrastructure, will include new drain lines, manholes and deep sump catch basins.

The project implements innovative resiliency solutions (+1 base point, 0.5 equity points).
The Brookline Select Board Complete Streets Policy specifically requires that all plans address seven overarching values including "Environmental sustainability and transportation choices that reduce carbon emissions and other adverse environmental and public health impacts". Additionally, the specific design guidance requires that "For transportation and other projects affecting the public way, the Town shall strive to incorporate green infrastructure such as trees, bioswales, rain gardens, other landscaping and permeable surfaces, wherever applicable and practical, to naturally manage stormwater, improve watershed health, reduce heat island effects, and beautify Brookline's streets and public spaces."

The project designed to meet a range of future climate projections (+1 base point, 0.5 equity points).
The Town is in the process of developing an Urban Forest Climate Resiliency Master Plan that is intended to position the Town to proactively and equitably be prepared for and protect against the impacts of climate change on Brookline's public and private trees and prepare for and mitigate impacts to the community and environment overall. In addition, The Select Board's Climate Action Committee recommends prioritizing planning to achieve zero emissions by 2050 (no reliance on fossil fuels) Town- and community-wide. The plan calls for implementing projects that provide for transportation options in the public way to reduce carbon dioxide emissions.

<u>Criteria 2c – Project improves existing transit assets (up to 2 points).</u>
Current Score: 1
Revised Score: 2
Equity Score: 1

The MBTA has already expressed a desire to consolidate and relocate bus stops along Washington Street. Improved bus stop accommodations will include installation of bus shelters as well as relocation of selected bus stop locations for improved operation (I.E., to far side stops at traffic signal locations).

Along the corridor, transit signal priority will be implemented into all of the traffic signals.

In addition, sidewalks and pedestrian crossings will be improved at the Washington Square green line stop, providing Green Line users with improved access and facilities.

This project should qualify as "Project makes significant improvement to existing transit assets" and is eligible for 2 points.

<u>Criteria 2d – Project improves existing pedestrian facilities (up to 3 points).</u>
Current Score: 2
Revised Score: 3
Equity Score: 1.5

Although the project does not add new sidewalks were none currently exist the sidewalk network is segmented due to disrepair, non-compliance or other safety concerns. For example, sidewalks within

the project area are not ADA compliant. The curbing along the northern section of the project has very little reveal, providing minimal separation between the roadway and the sidewalk. The curbing will be improved. In addition, there have been numerous pedestrian crashes along the corridor, resulting segments of the corridor qualifying as an HSIP Pedestrian Cluster.

Pedestrian safety improvements consist of a new signalized crossing, shorter pedestrian crossings, rectangular rapid flashing beacons, and improved visibility of pedestrian crossing due to removed parking.

Therefore, the project should qualify as "existing pedestrian facilities are in poor condition and improvements are included in the project" (+3 points).

Criteria 2g – Project improves other existing assets.
Current Score: 1
Revised Score: 2

The project includes improvements to traffic signals and pavement markings as originally scored. In addition, it is anticipated that overhead street lighting will at least be partially upgraded. Also, the project will include drainage system improvements that will address water quality through an upgraded drainage system that includes deep sump catch basins, potential for rain gardens and other stormwater best management practices. Three or more assets are improved (+2 points).

CAPACITY MANAGEMENT / MOBILITY

Criteria 3c – Project improves pedestrian network and ADA accessibility (up to 3 points).
Current Score: 0
Revised Score: 3
Equity Score: 1.5

Although the project does not add new sidewalks were none currently exist the sidewalk network is segmented due to disrepair, non-compliance or other safety concerns. Sidewalks within the project area have not been improved or upgraded for many years. Crossing across Washington Street will be improved, providing an improved and safer corridor for pedestrians. Curb Extensions will be provided where feasible to shorten pedestrian crossing distances. New cement concrete sidewalks with ADA compliant handicap ramps are included in the project. Likewise, all signal locations will be equipped with smart traffic signal technology and ADA features to accommodate all users. In addition, at select location Rectangular Rapid Flashing Beacons will be installed to further enhance pedestrian safety. The project is located on a high-utility link (+3 points).

Memorandum

WORLDTECH ENGINEERING

CLEAN AIR/SUSTAINABLE COMMUNITIES

Criteria 4c - Enhance Natural Environment (up to 4 points).
Current Score: 1
Revised Score: 2

The project will include stormwater Best Management Practices (BMP) including deep sump catch basins, rain gardens and other solutions. This is consistent with other Town projects, MassDOT design guidelines and DEP requirements. Project Improves Water Quality (1 point)

ECONOMIC VITALITY

Criteria 5c Bonus Point – Project proponent supports robust community outreach.
Current Bonus Score: 0
Revised Bonus Score: 1

As with all projects in Brookline the Town of Brookline is committed to community engagement and has discussed the project at Select Board meetings. For the Washington Street project, the Town is planning a robust community outreach process beginning with community meetings to engage the public and solicit input. The consultant design Team include a communications specialist to coordinate the community outreach process. Meetings will be held to provide valuable insights to community concerns and an opportunity for the Town to discuss the project, present conceptual plans, review timelines and talk about next steps. The communication program and public feedback opportunities during this project will include a mix of strategies for stakeholder outreach, consistent with the MassDOT Project Development & Design Guide. A mix of in-person (or "face to face") events, and online, interactive tools will be critical to the overall success of the project. The outreach plan would include both elements, if possible, in a post-COVID world. Specific methods include: Community Workshops / Technical Advisory Committee Meetings; 25% Design Public Hearing; Business Working Group Meetings/Communications; Neighborhood/Institution Briefings; Online and Printed Materials (website, email updates, and tracking). The Town of Brookline is planning a robust community outreach process as part of the project (+1 point).