Dedham, Massachusetts

Dedham Square

November 2018

PEDESTRIAN SIGNAL EVALUATION

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Dedham, Massachusetts

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Prepared by: BETA GROUP, INC.

Prepared for: Town of Dedham, Massachusetts

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1.0 INTRODUCTION

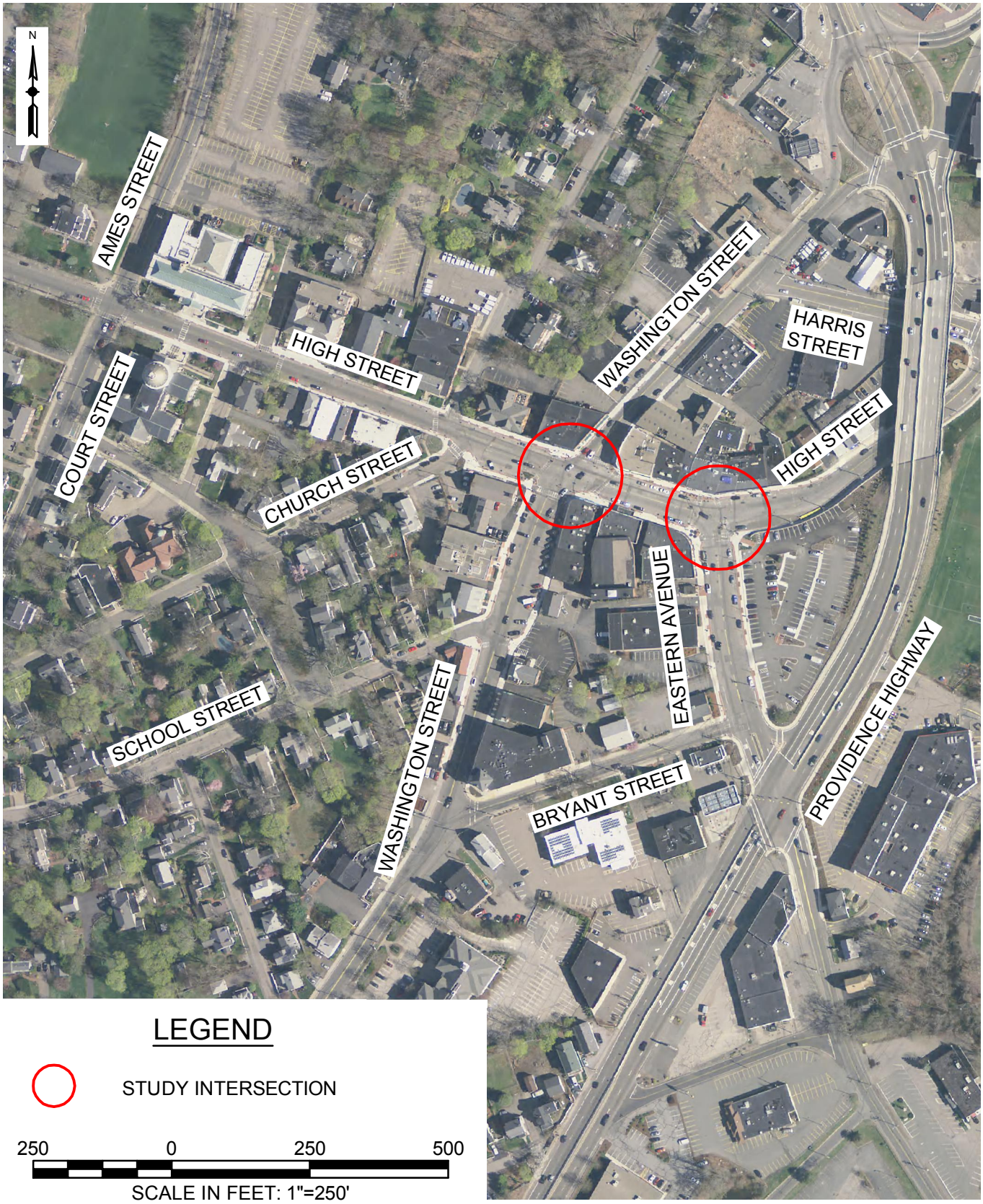
The Town of Dedham, acting through its Board of Selectmen and its Engineering Department, commissioned this study to evaluate operations and pedestrian safety in Dedham Square. Specifically, the study aims to evaluate and make recommendations related to pedestrian safety through potential modifications to pedestrian signal phasing at the two study intersections of High Street at Washington Street and High Street at Eastern Avenue, as shown in **Figure 1**. The two intersections presently operate under a single traffic signal controller and provide concurrent pedestrian phasing with a Leading Pedestrian Interval (LPI) for the High Street and Washington Street intersection, and an exclusive pedestrian phase at the High Street and Eastern Avenue intersection.

The town is seeking to assess the current pedestrian safety at the two intersections and evaluate the impacts to traffic operations and traffic flows if pedestrian phasing adjustments are implemented. The specific adjustments to be evaluated include, but are not limited to, the implementation of "No Turn on Red" signage for every approach at both intersections, conversion from concurrent pedestrian phasing to exclusive phasing at the Washington Street intersection and additional phasing and signal optimizations at both intersections.

BETA Group, Inc. (BETA) provided design services to the town for the reconstruction of Dedham Square, completed in late 2013. The project replaced an outdated single point 4-way traffic control signal at the intersection of High Street and Washington Street with modern traffic signal control at both Washington Street and Eastern Avenue, including pedestrian signals with pushbuttons at both intersections.

A study was conducted by BETA in 2013 to provide a post-construction evaluation of Dedham Square, including evaluation of the intersection of High Street at Court Street and Ames Street west of the Square and the Lower Square intersections of High Street at Harris Street and East Street, and High Street at East Street and Harvard Street. This study made further phasing adjustments to the two Dedham Square intersections, including the addition of an overlap trailing green interval to clear vehicles on High Street in between Washington Street and Eastern Avenue, and a trailing green phase to clear vehicles from Eastern Avenue through High Street westbound at Washington Street. These modifications refined other adjustments made during construction and initial implementation of the new traffic signals in the Square. Comparisons to the 2013 study and to the March 2011 design Traffic Report will be provided to evaluate patterns in traffic volumes, crash history and operational analysis from the initial design stage through post-construction evaluation to the present.

This report presents the findings of BETA's evaluation of pedestrian signal operation and safety, assesses potential adjustments to phasing and recommends improvement strategies to address remaining deficiencies.



LEGEND

STUDY INTERSECTION

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SCALE IN FEET: 1"=250'

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Figure 1

Location Map

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2.0 EXISTING CONDITIONS

2.1 PHYSICAL CHARACTERISTICS

2.1.1 HIGH STREET

High Street is an urban principal arterial oriented in an east-west direction and under the jurisdiction of the Town. High Street provides a single travel lane westbound throughout the study area, with an adjacent 8-foot parking lane from the Providence Highway overpass to Ames Street. An exclusive westbound left turn lane is provided at Eastern Avenue. High Street provides a single travel lane eastbound with no adjacent parking from Court Street to Church Street, and then widens to provide two travel lanes approaching Washington Street with adjacent angle parking serving the Police Station. The two eastbound lanes continue through the intersection at Eastern Avenue, merging east of Eastern Avenue before the Providence Highway overpass. On-street parking is provided in an adjacent 8-foot parking lane along the south side of High Street from Washington Street to the Providence Highway overpass.

2.1.2 HIGH STREET AT WASHINGTON STREET

The intersection of High Street and Washington Street is a four-way intersection at the heart of Dedham Square. Prior to the 2013 reconstruction project, traffic signal control at the intersection was provided by an outdated single 4-way signal located on a cement concrete "dummy" located in the center of the intersection. Traffic signal control is now provided by modern traffic signals located overhead on ornamental mast arm structures. Improvements also modified the Washington Street approaches so that they are more directly aligned with each other, adding a left turn lane in each direction. As previously discussed, High Street eastbound widens in advance of Washington Street to provide two through lanes. High Street westbound provides a single travel lane approaching Washington Street. On-street parking is provided on both sides of High Street east of Washington Street, on the north side of High Street west of Washington Street, and on the west side of Washington Street south of High Street. Angle parking is provided on the south side of High Street west of Washington Street serving the police station, and on the east side of Washington Street south of High Street serving adjacent businesses.

Sidewalks are provided on both sides of all approaches, and crosswalks are provided across all four legs of the intersection. Wheelchair ramps were recently reconstructed and meet current ADA/AAB standards.

The traffic signal at the intersection of High Street and Washington Street operates in tandem with and on the same traffic signal controller as the new traffic signal at High Street and Eastern Avenue. The signal provides two-phase operation at Washington Street with concurrent pedestrian operation. The traffic signal also provides a three second leading pedestrian interval (LPI) upon pedestrian actuation. This feature offers a short interval during which the pedestrian is shown the WALK indication before the concurrent vehicle movement is shown a green indication. This allows the pedestrian to enter the crosswalk during the LPI and be more visible during potential conflicts with turning vehicles, which are allowed as permissive movements during concurrent operation. All vehicle movements are allowed at the intersection.

2.1.3 High Street at Eastern Avenue

The intersection of High Street and Eastern Avenue is a T-intersection approximately 200 feet east of the intersection of High Street and Washington Street. The intersection was signalized as part of the 2013 reconstruction project. High Street eastbound provides two lanes through the intersection, merging back to a single lane approximately 100 feet east of Eastern Avenue. Field observations reveal that through vehicles generally favor the left lane approaching Eastern Avenue, in anticipation of the lane merge. High Street westbound provides a through lane and a left turn lane at Eastern Avenue. Eastern Avenue provides a two lane approach: a left turn lane and a right turn lane.

Eastern Avenue has a signalized intersection with Providence Highway approximately 400 feet south of High Street, and as such serves as the primary gateway to Dedham Square from the south. The Keystone Parking Lot is located on the southeast corner of the intersection and provides parking for the various commercial and government properties. On-street parking is provided on both sides of High Street and on both sides of Eastern Avenue in the vicinity of the intersection.

Sidewalks are provided on both sides of all approaches, and crosswalks are provided across all three legs of the intersection. Wheelchair ramps were recently reconstructed and meet current ADA/AAB standards.

The traffic signal provides five phases and operates in tandem with an on the same traffic controller as the traffic signal at High Street and Washington Street. The signal provides an advance phase for the westbound left turn from High Street to Eastern Avenue, with westbound through movements allowed at both Eastern Avenue and Washington Street; a phase for through movements with permissive turns for High Street in both directions at both intersections; a pedestrian-actuated exclusive pedestrian phase at High Street and Eastern Avenue, which operates at the same time as the Washington Street green phase and the concurrent pedestrian crossing across High Street at Washington Street; a phase for Eastern Avenue which operates concurrently with the Washington Street phase, and a clearance phase for Eastern Avenue which also provides a green indication for High Street westbound at Washington Street. A right-turn overlap is provided for the Eastern Avenue right turn in conjunction with the advance phase for westbound left turns. Current phasing has been modified from the 2013 design phasing to introduce an overlap trailing green phase, which provides additional green time to clear vehicles on High Street in between Washington Street and Eastern Avenue following the end of the High Street green phase at both intersections, as well as the Eastern Avenue clearance phase.

3.0 TRAFFIC DATA COMPARISON

3.1 EXISTING (2018) TRAFFIC VOLUMES

To assess existing traffic conditions within the project area, manual turning movement counts (TMC's) were collected at the intersections of High Street at Washington Street and High Street at Eastern Avenue on Thursday, September 13th, 2018. The intersections were counted for twelve hours, from 7:00 AM to 7:00 PM. Data collection was completed using cameras and specialized software which identifies each unique vehicle, pedestrian, or bicycle and recognizes how they travel through the intersection. The morning peak hour of the intersection was found to be from 7:15 to 8:15 AM, while the afternoon peak hour occurs from 5:00 to 6:00 PM. Peak hour turning movements are shown in **Figure 2** and pedestrian and bicycle turning movements shown in **Figure 3**. Full traffic volume summaries are included in the Appendix.

Automatic Traffic Recorder (ATR) Counts were collected for High Street, Washington Street and for Eastern Avenue for a 48-hour period from Wednesday, September 12th, 2018 through Thursday, September 13th, 2018. Summarized data is presented in **Table 1**; complete ATR data is included in the Appendix.

Table 1 – 2018 Average Daily Traffic Volumes

	Weekday	Weekday Morning Peak Hour			Weekday Evening Peak Hour		
Location	ADT	Volume	K Factor	Dir. Dist.	Volume	K Factor	Dir. Dist.
High Street				WB			EB
East of Washington Street	12,210	919	7.5%	54%	1,102	9.0%	58%
High Street				WB			WB
West of Washington Street	9,310	579	6.2%	64%	505	5.4%	55%
Washington Street				NB			SB
North of High Street	6,540	293	4.5%	56%	415	6.3%	56%
Washington Street				NB			SB
South of School Street	9,120	705	7.7%	77%	768	8.4%	54%
Eastern Avenue				NB			SB
South of High Street	8,320	514	6.2%	55%	676	8.1%	52%

A review of data shown in **Table 1** reveals Average Daily Traffic (ADT) volumes of 12,210 vehicles per day (vpd) on High Street, 9,120 vpd on Washington Street and 8,320 vpd on Eastern Avenue. The K factor is the percentage of ADT occurring within the peak hour. The K factor was generally found to be higher in the weekday evening peak hour, illustrating that traffic volumes on all approaches in the evening peak hour are greater than those experienced in the morning peak hour.

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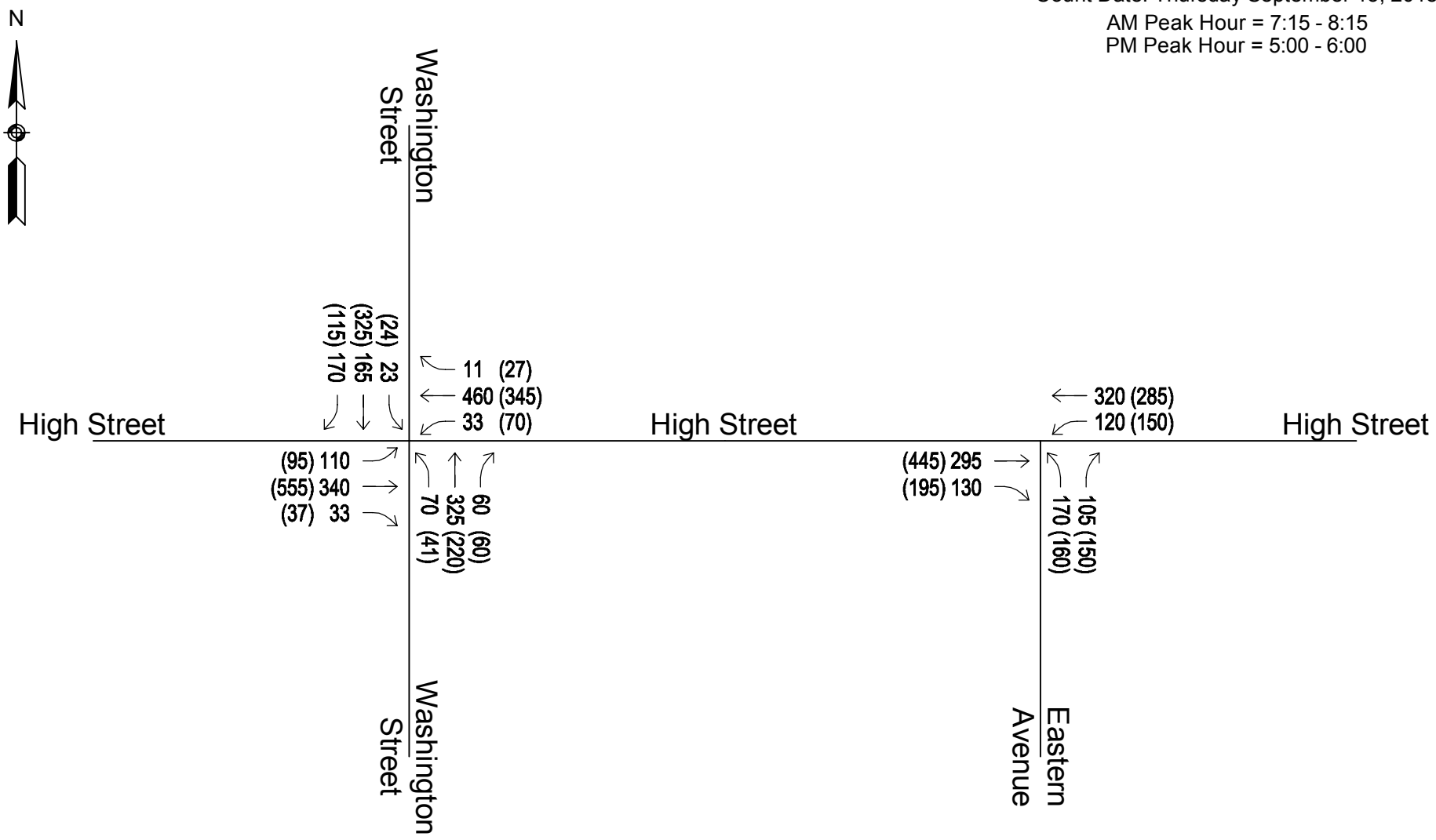
Count Date: Thursday September 13, 2018
AM Peak Hour = 7:15 - 8:15
PM Peak Hour = 5:00 - 6:00



AM (PM) Peak Hour Traffic Volumes

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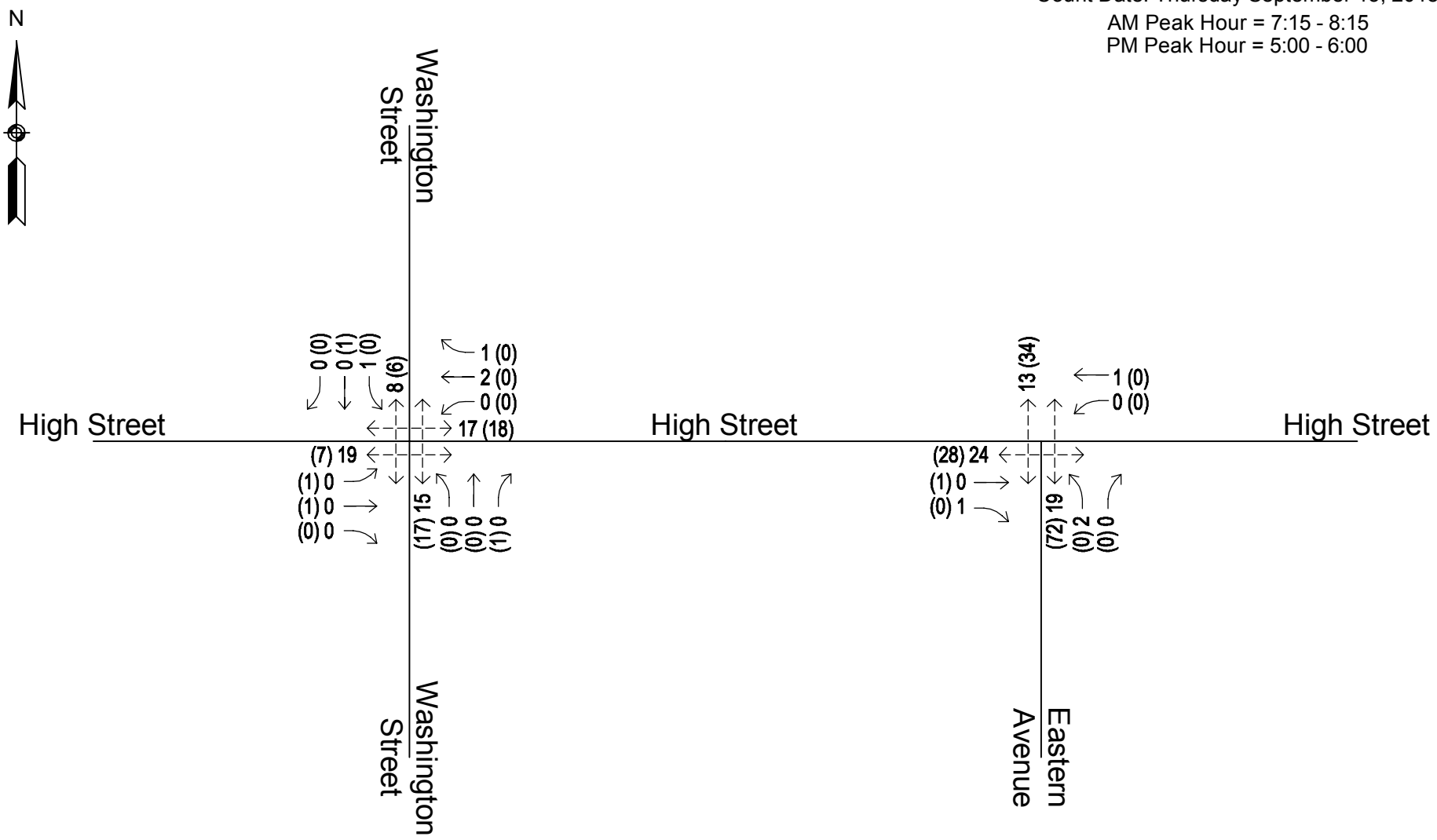
Figure 2

Existing (2018) Peak Hour
Turning Movement Volumes

Count Date: Thursday September 13, 2018
AM Peak Hour = 7:15 - 8:15
PM Peak Hour = 5:00 - 6:00



AM (PM) Peak Hour Traffic Volumes

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Figure 3

Existing (2018) Peak Hour
Pedestrian and Bicycle
Turning Movement Volumes

3.2 TRAFFIC VOLUME COMPARISON

Traffic volume data were previously collected in Dedham Square in 2009 for the traffic study accompanying the Dedham Square Improvements project and in 2014 for the post-construction study. ATR counts were collected in September of 2009 for High Street, Washington Street and Eastern Avenue, and have been compared to recently collected 2018 ATR data to determine the change in average daily volume in and entering Dedham Square over the nine year period from initial design study to five years post construction. This data comparison is presented in **Table 2.**

Table 2 – Average Daily Traffic Volume Comparison

Location	2009 ADT	2018 ADT	2009-2018	% Change / Year
High Street East of Washington Street	13,375	12,210	-1,165	-1.0%
High Street West of Washington Street	N/A	9,310	N/A	N/A
Washington Street North of High Street	11,715	6,540	-5,175	-6.3%
Washington Street South of School Street	9,380	9,120	-260	-0.3%
Eastern Avenue South of High Street	9,465	8,320	-1,145	-1.4%

Data presented in **Table 2** show a slight decrease in traffic volumes from 2009 to 2018. Minor fluctuations in traffic volume are to be expected on a day to day basis, and the collection of ATR data over a 2-day period can be susceptible to these day to day fluctuations. Comparison of two data points nine years apart can be indicative of an overall reduction in vehicular volume, but can also reflect these expected daily fluctuations. Of particular note is the reduction in traffic on Washington Street north of High Street. The Providence Highway overpass over High and Harris Streets was under construction in 2009, and higher volumes on Washington Street may have been a result of vehicles using Washington Street to bypass the construction impacts. In addition to the bridge reconstruction, operational improvements have been made to Providence Highway both at Eastern Avenue and at Dedham Circle, and reductions in traffic on Washington Street may be indicative of a reduction in cut-through traffic.

TMC counts were collected in September of 2009 for the design study at the intersections of High Street at Washington Street, High Street at Eastern Avenue, and High Street at Harris Street and East Street. Counts were taken in September 2013 for the post-construction study at the intersection of High Street at Harris Street and East Street, and additional counts were collected as part of a follow-up study in April 2014 at the intersections of High Street at Washington Street and High Street at Eastern Avenue.

The September 2018 TMC data were compared to both the April 2014 and September 2009 TMC data to determine volume trends over the four and nine year periods, respectively. The peak hours determined by the 2018 volumes match both the 2014 and 2009 data for the morning peak hours and match the 2009 data in the afternoon peak hour. The peak hour for the afternoon 2014 data is shifted 15 minutes earlier, beginning at 4:45 rather than 5:00 PM. For purpose of comparison, September 2018, April 2014 and September 2009 data were adjusted using seasonal adjustment factors maintained by MassDOT Highway Division. September is approximately 6% higher than the average-month volume, while April is approximately 4% higher. The results of the comparison for seasonally-adjusted AM and PM peak hour vehicular volumes are shown in **Table 3** and **Table 4** and the comparison of pedestrian volumes are shown in **Table 5** and **Table 6**.

The comparison of collected and seasonally adjusted data from 2018, 2014 and 2009 revealed a decrease in traffic over both the four year and nine year period. The comparison of September 2018 data to April 2014 data revealed decreases of 1.3% and 2.1% per year in the morning peak hour at the intersections of Washington Street and Eastern Avenue, respectively, and slight increases of 0.2% and 0.7% in the afternoon peak hour. The comparison of September 2018 data to September 2009 data revealed per year decreases of 1.1% and 1.6% in the morning peak hour, as well as a 0.7% decrease at Washington Street and a 0.2% increase at Eastern Avenue in the afternoon peak hour.

Pedestrian volumes are comparable between 2009, 2014 and 2018, displaying a slight increase in the morning peak hour and a slight decrease in the afternoon peak hour. Scattered showers were present on the day of the 2018 count, which likely impact pedestrian volumes. The 2009 and 2014 counts were conducted on days with no recorded precipitation, based on historical data collected at Logan Airport.

Table 3 – Historical Vehicular Volume Comparison – High Street at Washington Street

Approach	Movement	2009		2014		2018		2014 to 2018		% Change / Year		2009 to 2018		% Change / Year	
		AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Washington Street	NBL	94	94	95	62	66	39	-29	-23	-8.7%	-10.9%	-28	-55	-3.9%	-9.3%
	NBT	354	221	309	190	306	207	-3	17	-0.2%	2.2%	-48	-14	-1.6%	-0.7%
	NBR	56	75	57	76	56	56	-1	-20	-0.4%	-7.4%	0	-19	0.0%	-3.2%
Washington Street	SBL	52	33	13	40	22	23	9	-17	14.1%	-12.9%	-30	-10	-9.1%	-3.9%
	SBT	185	366	138	280	155	306	17	26	2.9%	2.2%	-30	-60	-1.9%	-2.0%
	SBR	130	100	171	128	160	108	-11	-20	-1.6%	-4.2%	30	8	2.3%	0.9%
High Street	EBL	113	98	90	133	103	89	13	-44	3.4%	-9.6%	-10	-9	-1.0%	-1.1%
	EBT	337	501	304	494	320	522	16	28	1.3%	1.4%	-17	21	-0.6%	0.5%
	EBR	50	63	38	48	31	35	-7	-13	-5.0%	-7.6%	-19	-28	-5.2%	-6.3%
High Street	WBL	28	47	29	29	31	66	2	37	1.7%	22.8%	3	19	1.1%	3.8%
	WBT	455	304	537	285	432	324	-105	39	-5.3%	3.3%	-23	20	-0.6%	0.7%
	WBR	12	20	4	20	10	25	6	5	25.7%	5.7%	-2	5	-2.0%	2.5%
Intersection Total		*1,866*	*1,922*	*1,785*	*1,785*	*1,692*	*1,800*	*-93*	*15*	*-1.3%*	*0.2%*	*-174*	*-122*	*-1.1%*	*-0.7%*

Table 4 – Historical Vehicular Volume Comparison – High Street at Eastern Avenue

Approach	Movement	2009		2014		2018		2014 to 2018		% Change / Year		2009 to 2018		% Change / Year	
		AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Eastern Avenue	NBL	105	117	190	119	160	150	-30	31	-4.2%	6.0%	55	33	4.8%	2.8%
	NBR	124	109	81	143	99	141	18	-2	5.1%	-0.4%	-25	32	-2.5%	2.9%
High Street	EBT	278	422	247	366	277	418	30	52	2.9%	3.4%	-1	-4	0.0%	-0.1%
	EBR	167	187	128	242	122	183	-6	-59	-1.2%	-6.7%	-45	-4	-3.4%	-0.2%
High Street	WBL	170	188	147	181	113	141	-34	-40	-6.4%	-6.1%	-57	-47	-4.4%	-3.1%
	WBT	390	254	375	214	301	268	-74	54	-5.3%	5.8%	-89	14	-2.8%	0.6%
Intersection Total		*1,234*	*1,277*	*1,168*	*1,265*	*1,072*	*1,301*	*-96*	*36*	*-2.1%*	*0.7%*	*-162*	*24*	*-1.6%*	*0.2%*

Table 5 – Historical Pedestrian Volume Comparison – High Street at Washington Street

Across Approach	2009		2014		2018		2014 to 2018		% Change / Year		2009 to 2018		% Change / Year	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Washington Street NB	17	13	14	22	19	7	5	-15	7.9%	-24.9%	2	-6	1.2%	-6.6%
Washington Street SB	13	25	10	19	17	18	7	-1	14.2%	-1.3%	4	-7	3.0%	-3.6%
High Street EB	9	2	9	6	8	6	-1	0	-2.9%	0.0%	-1	4	-1.3%	13.0%
High Street WB	9	13	9	9	15	17	6	8	13.6%	17.2%	6	4	5.8%	3.0%
Intersection Total	*48*	*53*	*42*	*56*	*59*	*48*	*17*	*-8*	*8.9%*	*-3.8%*	*11*	*-5*	*2.3%*	*-1.1%*

Table 6 – Historical Pedestrian Volume Comparison – High Street at Eastern Avenue

Across Approach	2009		2014		2018		2014 to 2018		% Change / Year		2009 to 2018		% Change / Year	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
Eastern Avenue NB	40	79	35	42	24	28	-11	-14	-9.0%	-9.6%	-16	-51	-5.5%	-10.9%
High Street EB	10	50	5	36	13	34	8	-2	27.0%	-1.4%	3	-16	3.0%	-4.2%
High Street WB	5	15	7	75	19	72	12	-3	28.4%	-1.0%	14	56	16.0%	18.2%
Intersection Total	*55*	*145*	*47*	*153*	*56*	*134*	*9*	*-19*	*4.5%*	*-3.3%*	*1*	*-11*	*0.2%*	*-0.9%*

3.3 CRASH DATA

Crash data for the study intersections were obtained from Dedham Police Department for the three most recent years available, from 2015 to 2017. Crash data for the 2011 traffic study were obtained from MassDOT for the most recent three year period available at the time of the study (2007 to 2009). MassDOT data were also collected for the most recent three year period available (2014 to 2016) to allow a more direct comparison between data sources. Collected data is shown in **Table 7**. Complete crash data, crash rate worksheets, collision diagram and corridor collision mapping are included in the Appendix.

Table 7 – Historical Crash Data Comparison

	2007-2009 – MassDOT Data			2014-2016 – MassDOT Data			2015-2017 Town Data		
Location	**Total**	**Crash/Yr**	**Crash Rate**	**Total**	**Crash/Yr**	**Crash Rate**	**Total**	**Crash/Yr**	**Crash Rate**
High Street at Washington Street	17	5.67	0.57	10	3.33	0.43	25	8.33	1.07
High Street at Eastern Avenue	4	1.33	0.22	3	1.00	0.18	9	3.00	0.53

The comparison of MassDOT data from both before and after reconstruction of Dedham Square shows a slight reduction in crashes at High Street and Eastern Avenue, and a more distinct reduction in crashes at High Street and Washington Street. Data collected from the Town shows more crashes at both locations, but this can be the result of the reporting mechanism. For example – operator reports may be submitted to the Town but are not included in the data submitted to the RMV which is used by MassDOT. While the Town data is likely to be more representative of the actual crash history of the intersection, and may even be understated due to crashes which occur but do not include police involvement, comparison of the MassDOT data over the two periods allows for a more meaningful comparison for the purpose of determining historical trends.

It should be noted that while MassDOT data does not specifically identify pedestrian-related crashes, Town data from 2015 to 2017 does not include any crashes involving pedestrians. Of note is one bicycle-related crash on Washington Street at High Street.

4.0 OPERATIONAL EVALUATION

4.1 EXISTING (2018) LEVEL OF SERVICE ANALYSIS

In order to evaluate existing traffic conditions, a capacity (level of service) analysis was performed. This analysis was performed using methods of the 2000 *Highway Capacity Manual* published by the Transportation Research Board. For intersections, six levels of service (LOS), "A"-"F", have been established with "A" representing very good operation and "F" representing very poor operation. For signalized intersections, level of service is defined in terms of total delay and is computed for individual intersection turning movements. Delay is a measure of driver discomfort, frustration, fuel consumption, and lost travel time. Level of service criteria for signalized intersections has been defined as shown in **Table 8**.

Table 8 – Level of Service Criteria

LOS	Signalized Delay (Sec/Veh)	General Description
A	≤ 10	Free flow
B	> 10 and ≤ 20	Stable flow (slight delays)
C	> 20 and ≤ 35	Stable flow (acceptable delays)
D	> 35 and ≤ 55	Approaching unstable flow (tolerable delay)
E	> 55 and ≤ 80	Unstable flow (intolerable delay)
F	> 80	Forced flow (jammed)

A level of service analysis was performed for the existing signalized intersections of High Street at Washington Street and High Street at Eastern Avenue using Synchro 8. The analysis was also compared to the 2019 Build (projected) analysis for the 2009 traffic study and a summary of the results are shown in **Table 9** and **Table 10.** It should be noted that signal phasing differs between the 2019 Build (projected) and 2018 Existing analyses, as the 2019 Build (projected) was based on the design phasing, which was refined both during and after construction of Dedham Square. The 2018 Existing analyses include these refinements and represent signal phasing and timing currently implemented in the Square.

Table 9 – Comparison of Projected and Existing Results – AM Peak Hour

INTERSECTION	2019 Build (Projected) (from 2009 Design Traffic Report)					2018 Existing				
	LOS	Delay*	v/c	50th % Queue	95th % Queue	LOS	Delay*	v/c	50th % Queue	95th % Queue
High Street at Washington Street										
High Street EB	C	21.8	0.45	181’	236’	D	41.6	0.80	251’	284’
High Street WB	B	14.9	0.77	125	#226	A	7.3	0.60	143	174
Washington Street NB L	C	28.0	0.57	72	#167	D	42.9	0.62	63	#140
Washington Street NB TH/R	C	32.8	0.75	329	#501	D	51.1	0.83	369	#543
Washington Street SB L	C	24.6	0.42	39	89	C	32.6	0.24	19	45
Washington Street SB TH/R	C	29.5	0.67	265	372	D	50.9	0.83	348	#441
Overall	**C**	**24.4**				**D**	**36.0**			
High Street at Eastern Avenue										
High Street EB	B	17.8	0.47	196’	275’	B	19.7	0.57	159’	133’
High Street WB L	C	22.9	0.43	104	165	D	35.2	0.56	94	139
High Street WB TH	C	26.3	0.66	273	400	D	43.2	0.76	310	392
Eastern Avenue NB L	D	52.2	0.68	100	#167	C	28.6	0.31	121	189
Eastern Avenue NB R	C	22.2	0.14	0	22	B	17.9	0.09	0	34
Overall	**C**	**24.2**				**C**	**29.0**			

* Delay is expressed in seconds per vehicle

- 95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after 2 cycles.

Table 10 – Comparison of Projected and Existing Results – PM Peak Hour

INTERSECTION	2019 Build (Projected) (from 2009 Design Traffic Report)					2018 Existing				
	LOS	Delay*	v/c	50th % Queue	95th % Queue	LOS	Delay*	v/c	50th % Queue	95th % Queue
High Street at Washington Street										
High Street EB	C	29.2	0.64	264’	337’	D	43.5	0.84	262’	#431’
High Street WB	B	12.7	0.61	112	149	B	14.8	0.67	123	158
Washington Street NB L	C	22.4	0.53	48	#129	C	32.3	0.39	26	76
Washington Street NB TH/R	C	20.0	0.44	169	254	C	33.8	0.53	180	316
Washington Street SB L	B	16.8	0.11	17	40	C	28.4	0.11	14	41
Washington Street SB TH/R	C	29.6	0.78	383	#553	D	49.6	0.85	334	#609
Overall	**C**	**24.6**				**D**	**36.3**			
High Street at Eastern Avenue										
High Street EB	B	12.1	0.53	287’	353’	B	18.5	0.72	217’	280’
High Street WB L	C	31.0	0.62	136	#220	D	38.1	0.63	95	172
High Street WB TH	C	26.4	0.47	164	251	D	37.5	0.65	207	344
Eastern Avenue NB L	D	48.3	0.64	96	#176	C	28.1	0.29	107	168
Eastern Avenue NB R	C	26.3	0.12	0	31	B	18.0	0.13	0	38
Overall	**C**	**21.5**				**C**	**25.9**			

* Delay is expressed in seconds per vehicle

- 95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after 2 cycles.

Overall, the High Street at Washington Street intersection experiences LOS D in both peak hours, a reduction from LOS C predicted by the 2019 Build (Projected) analysis. High Street at Eastern Avenue operates at LOS C overall, as predicted, with slight increases in overall delay.

All lane groups operate at acceptable LOS (D or better) at both intersections in both peak periods under existing conditions. Increases in delay and/or degradation in LOS can be attributed to the signal phasing and timing modifications which were introduced to the two study intersections both during and after reconstruction. Modifications were designed to provide lead time for pedestrians and clearance intervals aimed to clear specific movements through the intersection. These focused modifications improve operations for specific movements but can negatively impact overall operations. The benefit of these focused modifications can most clearly be seen for High Street westbound at Washington Street in the morning peak hour, in reductions in queue for High Street eastbound at Eastern Avenue, and for Eastern Avenue itself in both peak hours.

Calculated queue lengths are comparable between the two analysis scenarios. Increases of 2 car lengths or greater (50 feet) exist for Washington Street southbound at High Street in both the morning and afternoon peak periods and for Washington Street northbound at High Street and for High Street westbound at Eastern Avenue in the afternoon peak period. Calculated queue length reductions of greater than 2 car lengths exist for High Street eastbound at Eastern Avenue in both the morning and afternoon peak periods and for High Street westbound at Washington Street in the morning peak period.

5.0 POTENTIAL IMPROVEMENTS

5.1 IMPROVEMENT STRATEGIES

Improvement strategies were developed in part based the Town's stated desire of increasing pedestrian safety within Dedham Square, potentially by introducing an exclusive pedestrian phase.

Three separate improvement options were developed and are presented herein. Capacity analyses were conducted for each option for the intersections of High Street at Washington Street and High Street at Eastern Avenue. All options maintain existing geometry at both intersections, with proposed improvements limited to signage, signal phasing and signal timing.

A summary of the improvement strategy analyses results are shown in **Table 11** and **Table 12** along with Existing (2018) analysis for comparison purposes. The three alternatives evaluate differing improvements, with Options 2 and 3 providing additional refinement with regard to phasing and optimization.

Option 1 – "No Turn on Red" Signage on All Approaches

Option 1 implements "No Turn on Red" restrictions on all approaches to both intersections while maintaining existing phasing and timing. This is in addition to the "No Turn on Red" restriction which currently exists for Washington Street southbound at High Street in the existing condition.

This option would eliminate conflicts between pedestrians and turning vehicles from the opposing approach during the concurrent pedestrian phase, and provide an additional safety benefit to the existing leading pedestrian interval (LPI). The following example clarifies the benefit of the "No Turn on Red" restriction: during the Washington Street green phase at High Street, pedestrians are provided with a concurrent crossing of High Street, crossing parallel with Washington Street first through the LPI preceding the Washington Street green indication, then through the walk and flashing don't walk indications concurrent with the green indication on Washington Street. During this time, vehicles from High Street can presently turn right on red, potentially in conflict with the pedestrians crossing High Street, although pedestrians do have the legal right-of-way in this scenario. A "No Turn on Red" restriction would eliminate this potential conflict. Vehicles turning left or right from the concurrent vehicular movement (Washington Street in this example) would still be allowed to turn across the concurrent pedestrian movement.

The intersection of High Street and Eastern Avenue currently operates with an exclusive pedestrian phase instead of a concurrent phase with LPI. A "No Turn on Red" restriction would eliminate all turning conflicts between pedestrians and vehicles based on signal control.

Option 2 – Combined Exclusive Pedestrian Phase for Both Intersections

Option 2 removes the LPI at the Washington Street intersection and implements a combined exclusive pedestrian phase for both study intersections. Both intersections will operate an exclusive pedestrian phase simultaneously, allowing pedestrians protected crossings across High Street, Washington Street and Eastern Avenue. In addition to the combination of pedestrian phases, signal timings were optimized to better accommodate these changes in phasing. As part of the optimized timings, updates to pedestrian clearance times were incorporated to provide adequate time to cross the intersections.

In addition to Option 2, a secondary Option 2A was developed to evaluate the impact of a simultaneous exclusive phase at both intersections and a "No Turn on Red" restriction on all approaches. Options 2 and 2A are compared in **Table 13** and **Table 14**.

Option 3 – Separate Exclusive Pedestrian Phases for Both Intersections

Option 3 also removes LPI timing at the Washington Street intersection, but instead of a simultaneous phase provides separate exclusive pedestrian phases at the two intersections, with each operating concurrently with a vehicular phase at the other study intersection. The exclusive pedestrian phase at the Washington Street intersection when actuated will operate at the same time as the Eastern Avenue approach. This option would maintain the overlap trailing green for High Street, providing a clearance phase for queued vehicles along High Street between the two intersections before the exclusive pedestrian phase at Washington Street is activated. The phasing sequence for this option would also maintain the clearance phase for Eastern Avenue following the exclusive pedestrian phase at Washington Street, allowing vehicles turning left from Eastern Avenue to navigate through a green interval on High Street westbound at Washington Street. As with Option 2, signal timings were optimized along with updates to pedestrian clearance times under Option 3.

A secondary Option 3A was also developed to evaluate the impact of the phasing improvements described above in conjunction with a "No Turn on Red" restriction on all approaches. Options 3 and 3A are compared in **Table 13** and **Table 14**.

Table 11 – Improvement Strategy Options – AM Peak Hour

INTERSECTION	Existing (2018)					Option 1 – "No Turn on Red", All Approaches					Option 2 – Combined Exclusive Pedestrian Phase, Optimized					Option 3 – Separate Exclusive Pedestrian Phases, Optimized				
	LOS	Delay*	v/c	50th % Queue	95th % Queue	LOS	Delay*	v/c	50th % Queue	95th % Queue	LOS	Delay*	v/c	50th % Queue	95th % Queue	LOS	Delay*	v/c	50th % Queue	95th % Queue
High Street at Washington Street																				
High Street EB	D	41.6	0.80	251'	284'	D	41.6	0.79	254'	287'	E	57.1	0.93	248'	#311'	D	45.3	0.87	160'	#298'
High Street WB	A	7.3	0.60	143	174	A	7.4	0.60	144	175	A	9.0	0.70	141	m168	A	4.1	0.67	0	175
Washington Street NB L	D	42.9	0.62	63	#140	D	43.9	0.61	63	#141	E	66.2	0.79	59	#154	D	42.9	0.68	38	#143
Washington Street NB TH/R	D	51.1	0.83	369	#543	D	52.7	0.85	378	#551	D	46.3	0.84	322	#498	D	41.1	0.80	216	#487
Washington Street SB L	C	32.6	0.24	19	45	C	33.0	0.25	19	46	C	29.8	0.33	17	44	C	27.3	0.27	11	42
Washington Street SB TH/R	D	50.9	0.83	348	#441	D	51.8	0.83	351	#441	D	46.6	0.83	304	#418	D	40.9	0.80	204	#407
Overall	**D**	**36.0**				**D**	**36.6**				**D**	**39.8**				**C**	**32.1**			
High Street at Eastern Avenue																				
High Street EB	B	19.7	0.57	159'	133'	C	22.0	0.60	192'	163'	B	18.1	0.72	154'	174'	B	19.6	0.65	129'	156'
High Street WB L	D	35.2	0.56	94	139	D	35.5	0.56	94	139	C	33.3	0.46	90	137	C	31.6	0.48	61	135
High Street WB TH	D	43.2	0.76	310	392	D	42.7	0.75	310	392	D	54.5	0.88	295	#428	D	46.8	0.84	200	#418
Eastern Avenue NB L	C	28.6	0.31	121	189	C	29.0	0.31	122	189	C	21.5	0.28	99	158	D	38.0	0.52	114	182
Eastern Avenue NB R	B	17.9	0.09	0	34	B	19.2	0.19	58	100	B	10.4	0.09	0	28	C	21.7	0.09	0	34
Overall	**C**	**29.0**				**C**	**29.9**				**C**	**29.7**				**C**	**31.1**			

* Delay is expressed in seconds per vehicle
m – Queue is metered by upstream signal
- 95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after 2 cycles.

Table 12 – Improvement Strategy Options – PM Peak Hour

INTERSECTION	Existing (2018)					Option 1 – "No Turn on Red", All Approaches					Option 2 – Combined Exclusive Pedestrian Phase, Optimized					Option 3 – Separate Exclusive Pedestrian Phases, Optimized				
	LOS	Delay*	v/c	50th % Queue	95th % Queue	LOS	Delay*	v/c	50th % Queue	95th % Queue	LOS	Delay*	v/c	50th % Queue	95th % Queue	LOS	Delay*	v/c	50th % Queue	95th % Queue
High Street at Washington Street																				
High Street EB	D	43.5	0.84	262'	#431'	D	43.2	0.83	263'	#433'	E	55.7	0.94	319'	#446'	D	47.3	0.92	180'	#417'
High Street WB	B	14.8	0.67	123	158	B	14.6	0.67	124	158	B	14.6	0.76	126	#194	A	7.5	0.70	49	#166
Washington Street NB L	C	32.3	0.39	26	76	C	32.6	0.40	26	76	D	46.1	0.64	31	#101	D	48.2	0.67	19	#99
Washington Street NB TH/R	C	33.8	0.53	180	316	C	34.4	0.55	187	325	C	31.7	0.56	194	292	C	29.3	0.57	119	279
Washington Street SB L	C	28.4	0.11	14	41	C	28.6	0.11	14	41	C	26.7	0.14	15	40	C	24.5	0.15	9	39
Washington Street SB TH/R	D	49.6	0.85	334	#609	D	50.5	0.85	334	#609	D	52.7	0.89	362	#577	D	54.3	0.92	223	#561
Overall	**D**	**36.3**				**D**	**36.4**				**D**	**41.2**				**D**	**36.6**			
High Street at Eastern Avenue																				
High Street EB	B	18.5	0.72	217'	280'	C	21.1	0.76	255'	332'	B	11.9	0.74	130'	m171'	B	12.1	0.73	78'	m153'
High Street WB L	D	38.1	0.63	95	172	D	38.0	0.63	95	172	D	42.9	0.73	108	#184	D	36.7	0.69	67	#168
High Street WB TH	D	37.5	0.65	207	344	D	37.3	0.64	207	344	D	40.3	0.73	236	#357	D	37.3	0.74	146	#348
Eastern Avenue NB L	C	28.1	0.29	107	168	C	28.3	0.29	107	168	C	20.7	0.25	91	147	C	32.0	0.44	92	152
Eastern Avenue NB R	B	18.0	0.13	0	38	B	19.6	0.26	80	130	B	13.0	0.13	0	36	C	21.5	0.13	0	39
Overall	**C**	**25.9**				**C**	**27.2**				**C**	**22.7**				**C**	**23.6**			

* Delay is expressed in seconds per vehicle

m – Queue is metered by upstream signal

- 95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after 2 cycles.

Table 13 – Supplemental Strategy Options – AM Peak Hour

INTERSECTION	Option 2 – Combined Exclusive Pedestrian Phase, Optimized					Option 2A – Combined Exclusive Pedestrian Phase, "No Turn on Red"					Option 3 – Separate Exclusive Pedestrian Phases, Optimized					Option 3A – Separate Exclusive Pedestrian Phases, "No Turn on Red"				
	LOS	Delay*	v/c	50th % Queue	95th % Queue	LOS	Delay*	v/c	50th % Queue	95th % Queue	LOS	Delay*	v/c	50th % Queue	95th % Queue	LOS	Delay*	v/c	50th % Queue	95th % Queue
High Street at Washington Street																				
High Street EB	E	57.1	0.93	248'	#311'	E	58.4	0.94	258'	#314'	D	45.3	0.87	160'	#298'	D	45.9	0.88	162'	#302'
High Street WB	A	9.0	0.70	141	m168	A	9.0	0.70	142	m168	A	4.1	0.67	0	175	A	4.1	0.67	0	175
Washington Street NB L	E	66.2	0.79	59	#154	E	66.2	0.79	59	#154	D	42.9	0.68	38	#143	D	42.9	0.68	38	#143
Washington Street NB TH/R	D	46.3	0.84	322	#498	D	47.5	0.85	328	#505	D	41.1	0.80	216	#487	D	41.9	0.81	220	#494
Washington Street SB L	C	29.8	0.33	17	44	C	29.8	0.33	17	44	C	27.3	0.27	11	42	C	27.3	0.27	11	42
Washington Street SB TH/R	D	46.6	0.83	304	#418	D	46.6	0.83	304	#418	D	40.9	0.80	204	#407	D	40.9	0.80	204	#407
Overall	**D**	**39.8**				**D**	**40.5**				**C**	**32.1**				**C**	**32.5**			
High Street at Eastern Avenue																				
High Street EB	B	18.1	0.72	154'	174'	C	21.4	0.77	185'	209'	B	19.6	0.65	129'	156'	C	22.1	0.70	152'	191'
High Street WB L	C	33.3	0.46	90	137	C	33.3	0.46	90	137	C	31.6	0.48	61	135	C	31.6	0.48	61	135
High Street WB TH	D	54.5	0.88	295	#428	D	54.5	0.88	295	#428	D	46.8	0.84	200	#418	D	46.8	0.84	200	#418
Eastern Avenue NB L	C	21.5	0.28	99	158	C	21.5	0.28	99	158	D	38.0	0.52	114	182	D	38.0	0.52	114	182
Eastern Avenue NB R	B	10.4	0.09	0	28	B	10.9	0.16	44	77	C	21.7	0.09	0	34	C	23.2	0.24	53	94
Overall	**C**	**29.7**				**C**	**31.0**				**C**	**31.1**				**C**	**32.2**			

* Delay is expressed in seconds per vehicle

m – Queue is metered by upstream signal

- 95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after 2 cycles.

Table 14 – Supplemental Strategy Options – PM Peak Hour

INTERSECTION	Option 2 – Combined Exclusive Pedestrian Phase, Optimized					Option 2A – Combined Exclusive Pedestrian Phase, "No Turn on Red"					Option 3 – Separate Exclusive Pedestrian Phases, Optimized					Option 3A – Separate Exclusive Pedestrian Phases, "No Turn on Red"				
	LOS	Delay*	v/c	50th % Queue	95th % Queue	LOS	Delay*	v/c	50th % Queue	95th % Queue	LOS	Delay*	v/c	50th % Queue	95th % Queue	LOS	Delay*	v/c	50th % Queue	95th % Queue
High Street at Washington Street																				
High Street EB	E	55.7	0.94	319'	#446'	E	56.4	0.95	322'	#446'	D	47.3	0.92	180'	#417'	D	48.1	0.92	182'	#417'
High Street WB	B	14.6	0.76	126	#194	B	14.6	0.76	127	#198	A	7.5	0.70	49	#166	A	7.6	0.70	49	#158
Washington Street NB L	D	46.1	0.64	31	#101	D	46.1	0.64	31	#101	D	48.2	0.67	19	#99	D	48.2	0.67	19	#99
Washington Street NB TH/R	C	31.7	0.56	194	292	C	32.1	0.57	202	302	C	29.3	0.57	119	279	C	29.7	0.59	125	288
Washington Street SB L	C	26.7	0.14	15	40	C	26.7	0.14	15	40	C	24.5	0.15	9	39	C	24.5	0.15	9	39
Washington Street SB TH/R	D	52.7	0.89	362	#577	D	52.7	0.89	362	#577	D	54.3	0.92	223	#561	D	54.3	0.92	223	#561
Overall	**D**	**41.2**				**D**	**41.5**				**D**	**36.6**				**D**	**37.0**			
High Street at Eastern Avenue																				
High Street EB	B	11.9	0.74	130'	m171'	B	13.6	0.79	162'	m207'	B	12.1	0.73	78'	m153'	B	14.6	0.77	109'	m216'
High Street WB L	D	42.9	0.73	108	#184	D	42.9	0.73	108	#184	D	36.7	0.69	67	#168	D	36.7	0.69	67	#168
High Street WB TH	D	40.3	0.73	236	#357	D	40.3	0.73	236	#357	D	37.3	0.74	146	#348	D	37.3	0.74	146	#348
Eastern Avenue NB L	C	20.7	0.25	91	147	C	20.7	0.25	91	147	C	32.0	0.44	92	152	C	32.0	0.44	92	152
Eastern Avenue NB R	B	13.0	0.13	0	36	B	13.9	0.24	71	118	C	21.5	0.13	0	39	C	23.6	0.35	74	126
Overall	**C**	**22.7**				**C**	**23.5**				**C**	**23.6**				**C**	**25.0**			

* Delay is expressed in seconds per vehicle

m – Queue is metered by upstream signal

- 95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after 2 cycles.

The three primary options were compared to determine the option which best meets the stated study purpose of improving pedestrian signal phasing and safety, while still maintaining acceptable traffic operations. A review of capacity analysis results shown in **Table 11** and **Table 12** reveals that Option 3 was found to provide acceptable LOS, while providing the added safety of an exclusive pedestrian phase at both intersections. Option 3 differs from Option 2 in that it provides exclusive pedestrian phases at each intersection under separate phases. It is not necessary for the exclusive pedestrian phases at the two intersections to occur simultaneously, and in fact separate phases may benefit pedestrians walking through the Square using the exclusive pedestrian phase at both locations. Both Option 2 and Option 3 provide the flexibility to accommodate additional pedestrian demand within Dedham Square.

Option 3 maintains an overall LOS C for the intersection of High Street and Eastern Avenue in both peak hours when compared with the existing operation, maintains LOS D at the intersection of High Street and Washington Street in the afternoon peak hour, and improves High Street and Washington Street from LOS D to LOS C overall in the morning peak hour. A closer look at individual lane groups at both intersections reveals that the left turn from High Street to Eastern Avenue improves from LOS D to LOS C in the morning peak hour, while High Street westbound at Washington Street improves from LOS B to LOS A in the afternoon peak hour. Degradation of LOS is seen in Option 3 when compared to the existing condition for the Washington Street northbound left turn (LOS C to LOS D) in the morning peak hour, for the Eastern Avenue left turn (LOS C to LOS D) in the morning peak hour, and for the Eastern Avenue right turn (LOS B to LOS C) in both peak hours. A review of queuing suggests that despite increases in delay, Eastern Avenue will experience consistent or slightly improved queueing in Option 3 compared to the existing condition.

Option 3 and Option 3A were also compared to determine whether the additional safety benefit of introducing “No Turn on Red” signs on every approach could be accommodated. A review of capacity analysis results shown in **Table 13** and **Table 14** reveal nominal increases in delay and no change in LOS, except for High Street eastbound at Eastern Avenue which degrades from LOS B to LOS C in the morning peak hour due to a slight increase in delay. Since all lane groups will continue to operate at acceptable LOS in both peak hours, Option 3A is recommended for implementation.

95th percentile queues reported by Synchro are generally consistent but in some instances increase when comparing Option 3A to existing conditions. The study intersections were also analyzed using SimTraffic simulation software, which analyzes on a macroscopic level and considers the effect of storage lengths, blocking and spillback on queuing. SimTraffic queueing results are presented in **Table 15**. Available storage length refers to the length of proposed queue lengths.

Table 15 – Preferred Alternative (Option 3A) – Queuing Analysis

INTERSECTION	Available Storage Length*	AM Peak Hour				PM Peak Hour			
		Synchro		SimTraffic		Synchro		SimTraffic	
		50th % Queue	95th % Queue	50th % Queue	95th % Queue	50th % Queue	95th % Queue	50th % Queue	95th % Queue
High Street at Washington Street									
High Street EB L/TH	-	162’	#302’	424’	444’	182’	#417’	421’	430’
High Street EB TH/R	140’			121	232			152	212
High Street WB	-	0	175	133	272	49	#158	155	276
Washington St NB L	140	38	#143	123	207	19	#99	135	206
Washington St NB TH/R	-	220	#494	524	861	125	288	509	876
Washington St SB L	75	11	42	27	78	9	39	13	55
Washington St SB TH/R	-	204	#407	217	400	223	#561	436	638
High Street at Eastern Avenue									
High Street EB TH	-	152’	191’	102’	206’	109’	m216’	84’	175’
High Street EB TH/R	-			44	104			40	84
High Street WB L	85’	61	135	71	126	67	#168	87	126
High Street WB TH	-	200	#418	156	213	146	#348	150	218
Eastern Avenue NB L	-	114	182	170	310	92	152	152	298
Eastern Avenue NB R	-	53	94	58	328	74	126	74	143

* Storage length for 2-lane segments refers to the length of 2-lane segment proposed (or to remain)

m – Queue is metered by upstream signal

- 95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after 2 cycles.

5.2 ADVANCED TECHNOLOGIES

In addition to traditional operational analysis, advanced technologies were considered for their potential to increase pedestrian safety and improve operations in Dedham Square.

Advances in communication and networking between traffic signals in conjunction with the ability to enact commands in a master-slave configuration between locations have unlocked additional flexibility and control between connected locations. These types of peer-to-peer communication commands can function in conjunction with or in place of traditional traffic signal coordination to improve operations along a corridor or within a connected system. Unfortunately, these types of features cannot be realized

within the confines of Dedham Square because the two study intersections operate under a single traffic controller. Phasing at the two intersections is linked through this single controller.

"No Turn on Red" blank-out signs are another potential consideration within Dedham Square. These signs would normally be dark and would illuminate the "No Turn on Red" display only when there are potential conflicts; in this instance, they would illuminate when the exclusive pedestrian phase is active. This would allow vehicles to turn right on red during other portions of the cycle when safe to do so. Given the limited additional impact shown in the comparison of options when "No Turn on Red" is implemented at all times on all approaches, it does not appear that the additional expense of illuminated blank-out "No Turn on Red" signs is justified.

Finally, adaptive or traffic responsive signal control was considered along the High Street corridor. Adaptive signal systems collect traffic data and make real-time adjustments based on computer algorithms to provide green time where demand exists. Traffic responsive systems adjust cycle lengths and phase times based on preset traffic volume thresholds. In simpler terms, these systems have the potential to increase green time to avoid congestion along a particular approach, and then adjust green times accordingly throughout the day as demand changes. As with coordination, adaptive control has the potential to benefit drivers along High Street while increasing delay for vehicles entering via Washington Street, Eastern Avenue, East Street, Ames Street and Court Street. Traffic responsive systems can be more beneficial to all approaches based on traffic volume criteria.

Many adaptive solutions are available from many different manufacturers. Systems vary in their design and operation, but typically take feedback from various input devices such as stop line detectors and system detection, then use a proprietary device in the traffic signal cabinet to process demand and adjust timings. The need for additional advance detection will require the installation of additional traffic signal equipment and would likely require additional poles to accommodate wireless detection and communication, and/or reconstruction of sidewalk to accommodate additional pull boxes and conduit to connect the advance detection to the existing traffic signal controller located on the north side of High Street at Eastern Avenue.

Adaptive or traffic responsive control would also be most beneficial when considered along High Street both inside and outside of Dedham Square, including the Lower Square intersections of High Street with Harris Street, East Street and Harvard Street, as well as the signalized intersection to the west of the Square with Court Street and Ames Street. This increases both the impact and cost of implementing an adaptive of traffic responsive system.

Should the town consider investment in either an adaptive or traffic responsive system, there may not be an obvious, immediate benefit following implementation. As discussed above, an adaptive system may improve operations along High Street, but further degrade operations for intersecting streets. A traffic responsive system has greater potential to adapt to fluctuations in day-to-day traffic, but would require extensive observation and adjustment following implementation.

5.3 SIGNAL COORDINATION

Traffic signal coordination was considered as part of the 2014 post-construction study but was not implemented for High Street from Court Street and Ames Street to East Street in the Lower Square. As noted in the 2014 report, a well-timed coordination system permits continuous movement along an arterial with minimum stops and delays. It accomplishes this by offsetting green periods so that a vehicle

traveling through the system will experience moderated delay. However, this has the consequence of increasing delay for other users within the system.

Coordination was also considered in the 2014 report between the two clustered systems at Dedham Square and the Lower Square. Analysis reports revealed no improvement in overall capacity and queueing, and slight degradation of side street operation, and as such coordination was not recommended despite the presence of a physical connection between the two systems. A review of updated analysis also reveals no perceived benefit of coordination for Dedham Square. Slight improvements in queueing for High Street westbound at Eastern Avenue are expected with the implementation of the preferred option, which will reduce the likelihood of queues from Dedham Square extending to and impacting operations in the Lower Square.

6.0 CONCLUSION AND RECOMMENDATIONS

A review of traffic operations and pedestrian safety at the intersections of High Street at Washington Street and High Street at Eastern Avenue in Dedham Square reveals acceptable operations based on HCM criteria and generally safe pedestrian accommodations based on the presence of an exclusive pedestrian phase at Eastern Avenue and a concurrent pedestrian phase with leading pedestrian interval (LPI) at Washington Street.

A comparison of vehicular and pedestrian volume data and crash data from prior studies with recently collected data reveals a slight decrease in vehicular volume from 2009 to 2018 as well as a reduction in crashes. Crash data collected from the Dedham Police Department does show a higher frequency of crashes when compared with historical MassDOT data, but this is attributable to the differences in data collection between the two agencies.

Despite acceptable existing operations, improvement strategies were considered which modify signage and phasing to meet the Town's stated goal of improving pedestrian safety in Dedham Square. Three primary options were considered, along with two supplemental options which present a combination of improvements considered in the three primary options. Option 1 introduces "No Turn on Red" signage on all approaches, while Option 2 and Option 3 both introduce exclusive pedestrian phasing at the intersection of High Street and Washington Street, where concurrent phasing exists today. Option 2A and Option 3A expand upon their respective options by adding "No Turn on Red" signage in conjunction with exclusive phasing. Option 3 generally shows consistency or improvement when compared to existing operations. Option 3A shows only minor increases in delay as a result of "No Turn on Red" signage. **Based on acceptable operational results which improve pedestrian safety in Dedham Square, Option 3A is recommended for implementation.**

Implementation of Option 3A will require revisions to existing phasing and should be implemented by a qualified Contractor; however, the implementation of "No Turn on Red" signs can be completed in the short term in advance of phasing improvements. Option 1 analyzes the effect of this short term implementation and shows only minor increases in delay with a "No Turn on Red" restriction when compared to the existing condition.

Post-implementation observations are recommended to verify that the intended benefits to pedestrian safety and vehicle operation have been realized.