Town of Dedham, Massachusetts

Dedham Square Area

OPERATIONAL ASSESSMENTS
TRAFFIC SIGNALS – FIVE LOCATIONS

Prepared by:

BETA
ENGINEERING SUCCESS **TOGETHER**
315 Norwood Park South
2nd Floor
Norwood, MA 02062
T: 781.255.1982

December 2013

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

The purpose of this study is to review traffic signal operations in the Dedham Square area following completion of the Dedham Square Improvements project. Dedham Square serves as the Town's central business district and is located directly off Providence Highway, as shown in **Figure 1**. In addition to numerous eateries and other shops, notable properties in the Square include the Dedham Police Station, US Post Office, Superior Court, District Court and the Registry of Deeds.

The recent project included the upgrade of the signalized intersection at High Street and Washington Street, and installation of a new traffic signal at High Street and Eastern Avenue. This evaluation provides a post construction assessment of these two locations, as well as three other signalized locations in the Square area: High Street at Court Street and Ames Street, High Street at Harris Street and East Street, and High Street at East Street and Harvard Street. Operations at these intersections impact operation along High Street through the Dedham Square area.

This report presents the findings of BETA's evaluation of post-construction conditions, and recommends improvement strategies to address remaining deficiencies. **The intersection of High Street at Court Street and Ames Street is the location that requires the most attention.**

BETA
ENGINEERING SUCCESS TOGETHER

Dedham Square
Dedham, MA

FIgure 1

Location Map

O:\4200s\4227 – Dedham Square Const Services\Drawing Files\Figures\Figure 1 – Location Map.dwg Dec 02,2013 1:26pm

2.0 EXISTING POST CONSTRUCTION CONDITIONS

2.1 Physical Characteristics

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. High Street eastbound widens at Harris Street to provide an exclusive right turn lane, which serves vehicles wishing to continue on High Street towards East Dedham.

High Street at Court Street and Ames Street

This intersection was not part of the recent Dedham Square project. It is a four-way, signalized intersection at the western edge of the Dedham Square central business district, and serves as a gateway for traffic entering Dedham Square from the west and northwest. Court Street approaches High Street from the south and Ames Street approaches from the north, as can be seen in **Figure 1**. On-street parking is provided on both sides of High Street west of the intersection, on both sides of Court Street south of the intersection, and on the north side of High Street east of the intersection. No on-street parking is provided on Ames Street. Each approach is marked to provide a single approach and departure lane at the intersection, although the southbound Ames Street approach operates, in practice, as a two lane approach with a left turn lane and a shared through/right turn lane.

Ames Street north of the intersection is part of a continuous arterial route to I-95/Route 128 via the Exit 18 interchange at Great Plain Avenue in Needham. This creates a heavy right-turn flow from High Street westbound to Ames Street in the morning peak period, and a heavy left-turn flow from Ames Street southbound to High Street in the afternoon peak period. The existing traffic signal at the intersection provides an advance exclusive phase for southbound traffic, likely introduced to accommodate the southbound left turn demand.

The existing traffic signal provides a four phase, fully actuated operation: a phase for High Street through traffic in both directions, with permissive turns; a pushbutton-actuated exclusive pedestrian phase; the advance phase for Ames Street, which provides protected southbound left turns; and a phase for Court Street and Ames Street, with permissive turns allowed from both approaches. Recent utility work damaged the loops on Ames Street and on the westbound lane of High Street; these loops have since been replaced.

Sidewalks are provided on both sides of all approaches, and crosswalks are provided across all four legs of the intersection. Wheelchair ramps are provided on all four corners, but do not appear to meet current ADA/AAB standards.

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 recent construction project, traffic signal control at the intersection was provided by a seriously 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 at the intersection adjusted the Washington Street approaches so that they are more directly aligned with each other, and added 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. All on-street parking in the limits of the Dedham Square improvements project is two-hour parking, metered by pay stations located throughout the Square.

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 new 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.

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. A new traffic signal was installed as part of the recent 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 new traffic signal provides four phase operation 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; and a phase for Eastern Avenue which also operates concurrently with the Washington Street phase. A right-turn overlap is provided for the Eastern Avenue right turn in conjunction with the advance phase for westbound left turns.

Field observations were made once the traffic signal at this intersection was activated in August 2013, and adjustments have been made to traffic signal timing. One key adjustment is the introduction of 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.

High Street at Harris Street/East Street
High Street at East Street/Harvard Avenue
(Lower Square)

The intersections of High Street at Harris Street and East Street, and High Street at East Street and Harvard Avenue operate in tandem and form Dedham's Lower Square area. The intersections were reconstructed as part of the Providence Highway project, which reconstructed the overpass of Providence Highway over High Street. The Lower Square intersections form the gateway to Dedham Square from the east and from East Street.

High Street forms the south and east legs of the intersection of High Street, Harris Street and East Street; with Harris Street forming the west leg and East Street forming the north leg. High Street provides two lanes: a left lane for turns to Harris Street and East Street, and a right turn lane for

vehicles wishing to turn right to continue on High Street. Harris Street provides two general purpose lanes at High Street, with turns accommodated from lanes shared with through vehicles to High Street eastbound. East Street provides a single approach lane at High Street and Harris Street, but only allows southbound travel for approximately 400 feet to provide access to the Lower Square from commercial properties along the west side of East Street. East Street is a one-way northbound roadway north of these businesses.

The segment of High Street between the two Lower Square intersections is approximately 200 feet long and provides two lanes in each direction, with on-street parking on the north side adjacent to a strip of commercial properties. No other on-street parking is provided in the Lower Square, but a municipal lot is located on the south side of High Street with access to High Street and to the eastern segment of East Street. High Street eastbound provides a shared left turn/through lane and a right turn lane to the eastern segment of East Street. High Street westbound provides a left turn lane to continue along High Street towards Dedham Square, and a shared lane for Harris Street and for right turns to the western segment of East Street.

As previously discussed, the eastern segment of East Street is a significant connector roadway, providing access to the Lower Square from I-95/Route 128. East Street approaching High Street provides a short left turn lane and a shared through/right turn lane. Harvard Street provides a single approach lane, as does High Street westbound approaching the Lower Square.

Sidewalks are provided on both sides of all roadways within the Lower Square, and crosswalks are provided across all four legs of both intersections. Wheelchair ramps were recently constructed and appear to meet current ADA/AAB standards.

Traffic signal operation is maintained by one controller serving both Lower Square intersections, with phasing integrated between the two intersections. Traffic signal operations take advantage of turn overlaps to maintain the "through" movement on High Street in both directions, despite the fact that the geometry requires turns to maintain the High Street through movement at the western Lower Square intersection. Pedestrians are accommodated with an exclusive phase at both intersections.

2.2 Traffic Volumes

Manual Turning Movement (MTM) counts were collected on Wednesday, September 18th, 2013 at the intersections of High Street at Court Street and Ames Street, High Street at Harris Street and East Street, and High Street at East Street and Harvard Street from 7:00 AM to 9:00 AM and from 4:00 PM to 6:00 PM. Passenger cars, heavy vehicles, pedestrians and bicycles were counted. The overall peak hours based on the data were determined to be 7:15 AM to 8:15 AM and 5:00 PM to 6:00 PM.

MTM counts were collected in September of 2009 for the traffic study accompanying the Dedham Square Improvements project at the intersections of High Street at Washington Street, High Street at Eastern Avenue, and High Street at Harris Street and East Street. 2013 and 2009 data were compared at the High Street/Harris Street/East Street intersection and revealed a decrease in traffic over the four year period. The comparison revealed a 5% decrease (1% per year) in the morning peak

volumes, and an 8% decrease (2% per year) in the afternoon peak hours. Given this decrease, 2009 data with no adjustments were utilized to represent 2013 existing conditions at the intersections of High Street at Washington Street and High Street at Eastern Avenue. The peak hours of the 2009 data match those determined by the 2013 data.

Once the peak hours were determined, the traffic volumes were examined to evaluate the need for seasonal adjustment. A review of the historical traffic growth data maintained by MassDOT Highway Division indicated that the average month traffic volume in September for an urban arterial/collector is approximately 8% higher than the average-month traffic volume. However, for a more conservative analysis, the September data were not adjusted.

2.3 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, "A"-"F", have been established with "A" representing very good operation and "F" representing very poor operation. For both signalized and unsignalized 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 1**.

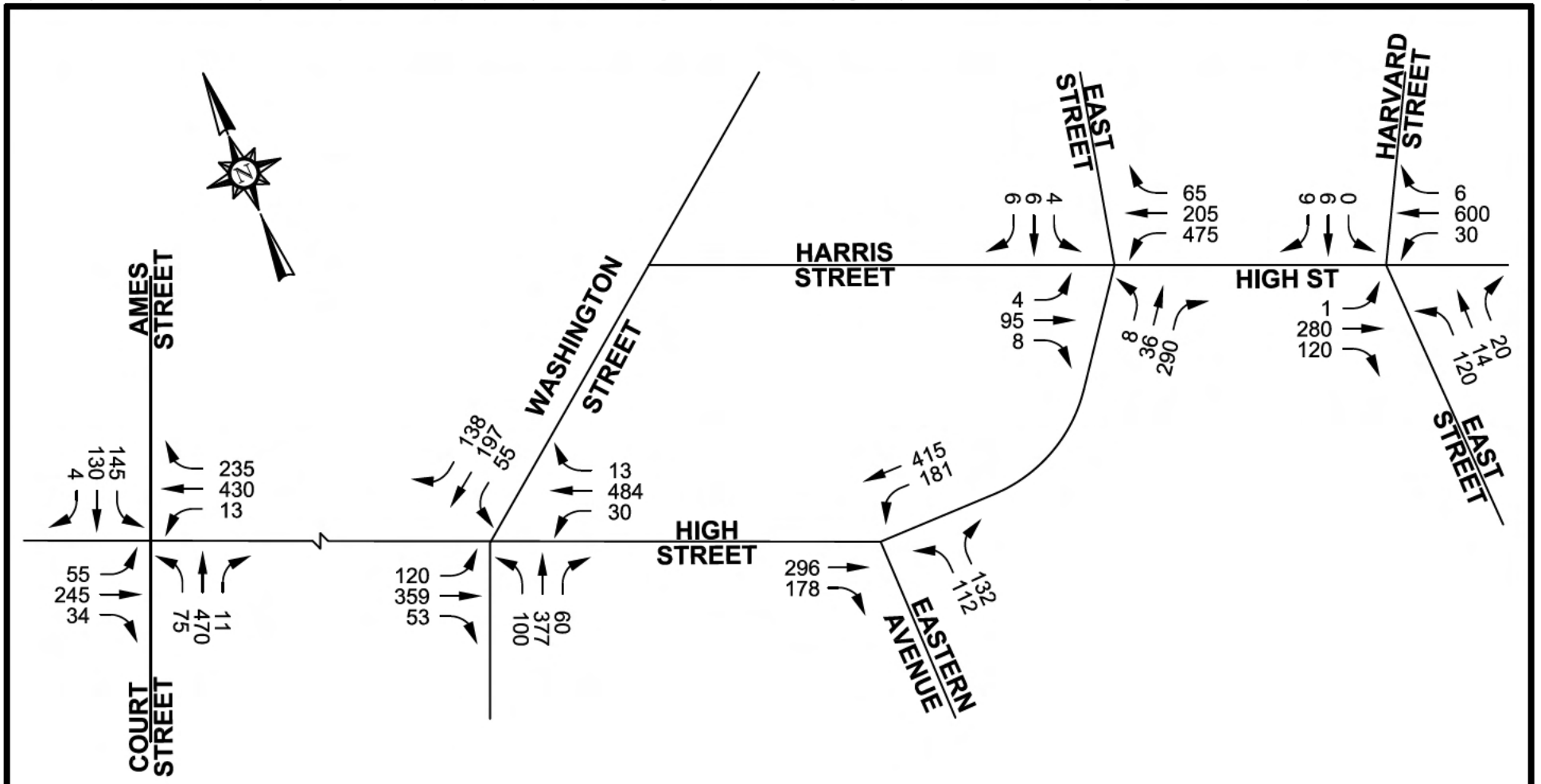
Table 1 – Level of Service Criteria (Signalized Intersections)

LOS	Control 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 key project signalized and unsignalized intersections using Synchro 8.

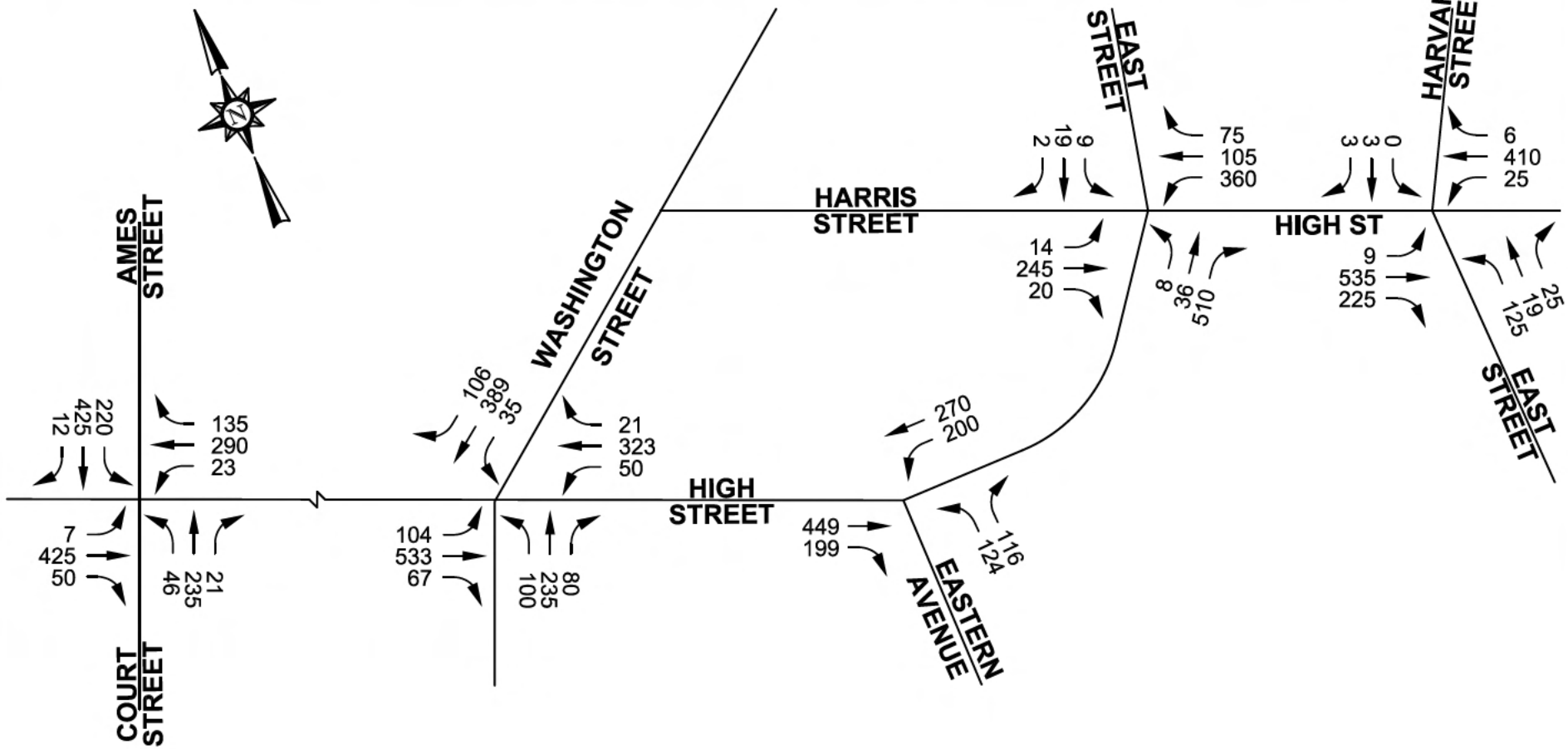
A summary of the results of the capacity analysis are shown in **Table 2**. Complete analysis results are shown in the Appendix.



BETA Group, Inc.
Engineers•Planners•Landscape Architects•Scientists
315 Norwood Park South
Norwood, MA 02062
781.255.1982
email: BETA@BETA-Inc.com

Dedham Square
Dedham, MA

Figure 2
2013 Existing Volumes
AM Peak Hour



BETA Group, Inc.
Engineers•Planners•Landscape Architects•Scientists
315 Norwood Park South
Norwood, MA 02062
781.255.1982
email: BETA@BETA-Inc.com

Dedham Square
Dedham, MA

Figure 3
2013 Existing Volumes
PM Peak Hour

Table 2 – Level of Service Results – Existing Conditions (2013)

INTERSECTION	AM Peak Hour				PM Peak Hour			
	LOS	Delay*	50th % Queue	95th % Queue	LOS	Delay*	50th % Queue	95th % Queue
High Street at Court Street and Ames Street								
High Street EB	C	29.9	181’	405’#	C	30.7	262’	553’
High Street WB	E	64.6	385’	830’#	C	33.4	256’	502’#
Court Street NB	F	178.5	423’	797’#	D	43.2	177’	407’#
Ames Street SB LT	C	22.5	52’	123’	B	19.2	79’	179’
Ames St SB TH/RT	B	17.9	49’	116’	C	20.3	192’	396’
Overall Intersection	**F**	**84.3**	**-**	**-**	**C**	**29.7**	**-**	**-**
High Street at Washington Street								
High Street EB	C	28.0	180’	267’	C	28.0	216’	288’
High Street WB	A	9.0	106’	202’	B	10.6	105’	379’
Washington St NB LT	C	23.7	57’	118’	C	24.5	43’	103’
Wash. St NB TH/RT	C	29.6	279’	423’	C	23.1	158’	242’
Washington St SB LT	C	22.6	31’	71’	B	19.5	16’	40’
Wash. St SB TH/RT	C	26.4	218’	320’	C	32.6	319’	462’
Overall Intersection	**C**	**22.8**	**-**	**-**	**C**	**24.7**	**-**	**-**
High Street at Eastern Avenue								
High Street EB	B	17.4	102’	127’	B	16.5	193’	207’
High Street WB LT	C	28.3	96’	165’	D	36.7	108’	213’#
High Street WB TH	C	34.8	273’	433’	C	25.5	156’	240’
Eastern Ave NB LT	C	33.3	91’	143’	C	33.0	91’	152’
Eastern Ave NB RT	C	21.4	0	33’	C	22.5	0	39’
Overall Intersection	**C**	**26.3**	**-**	**-**	**C**	**23.4**	**-**	**-**
High Street at Harris Street and East Street								
Harris Street EB	D	39.2	32’	78’	C	33.2	78’	177’
High Street WB LT	A	2.9	34’	17’	A	7.2	32’	240’
High St WB TH/RT	A	1.4	15’	5’	A	2.6	0	32’
High St NB LT/TH	D	36.6	21’	78’	C	30.5	19’	73’
High Street NB RT	B	14.9	0	34’	B	19.5	0	49’
East Street SB	D	35.7	6’	32’	C	30.3	15’	50’
Overall Intersection	**B**	**10.3**	**-**	**-**	**B**	**18.1**	**-**	**-**
High Street at East Street and Harvard Street								
High Street EB LT/TH	A	5.2	38’	61’	A	6.4	72’	403’
High Street EB RT	A	0.1	0	0	A	0.2	0	0
High Street WB	C	27.4	312’	868’#	C	20.2	167’	467’
East Street NB LT	D	43.1	88’	158’	C	34.2	67’	174’
East Street NB TH/RT	C	32.3	9’	33’	C	28.9	9’	46’
Harvard Street SB	C	32.0	5’	15’	C	28.3	2’	14’
Overall Intersection	**C**	**22.4**	**-**	**-**	**B**	**13.5**	**-**	**-**

* Delay is expressed in seconds per vehicle

95th percentile queue exceeds capacity, queue may be longer

3.0 FINDINGS

3.1 Intersection Results and Observations

High Street at Court Street and Ames Street

As seen in Table 2, the intersection of High Street at Court Street and Ames Street is the only intersection included in this study that operates at an unacceptable level of service, with an overall LOS F during the AM peak hour. The Court Street approach operates at LOS F with a 95th percentile queue approaching 800 feet, while the High Street westbound approach operates at LOS E with a 95th percentile queue exceeding 800 feet. Both approaches experience heavy demand in the AM peak from commuters traveling north on Ames Street.

The extensive queue on High Street westbound approaching Court Street is of significant concern because it exceeds the 780 feet of available storage between Court Street and Washington Street. Field observations confirm the calculated queue values, and included observation of queues extending from Court Street through the intersection of High Street and Washington Street. This has impacts the operations of the High Street/Washington Street and High Street/Eastern Avenue intersections, "clogging" these intersections, which then has the potential to create further delays along High Street westbound. Minor timing adjustments were made in the field during September 2013 in an attempt to alleviate queuing at the intersection of High Street, Court Street and Ames Street, with more extensive modifications to be considered as part of this study. Traffic was observed backed up from Court Street through the Square into the Lower Square on at least one occasion; however, it should be noted that this observation was made prior to timing adjustments. 2013 LOS results presented in **Table 2** represent operation following the September 2013 timing adjustments.

High Street at Washington Street
High Street at Eastern Avenue
(Dedham Square)

As can be seen in **Table 2,** the two signalized intersections at the heart of Dedham Square operate at favorable levels of service. Both intersections operate at an overall LOS C during both the AM and PM peak hours, with all approaches operating at LOS C or better except for the High Street westbound left turn lane, which operates at a still acceptable LOS D during the PM peak hour.

Field observations were conducted during both peak periods on multiple days during September 2013. Initially, vehicles traveling along High Street between the two intersections were forced to stop at the second intersection in their direction of travel, if they entered at the end of the green phase of the first intersection in their direction of travel. An overlap trailing green was introduced to allow vehicles to clear between the two intersections, allowing room for additional passage and/or stacking of vehicles during subsequent phases as designed. 2013 LOS results presented in **Table 2** include this adjustment.

High Street at Harris Street/East Street
High Street at East Street/Harvard Street
(Lower Square)

As can be seen in **Table 2**, the Dedham Lower Square intersections operate at favorable LOS during both the AM and PM peak hours. The intersection of High Street at Harris Street and East Street operates at LOS B during both peak hours, with LOS D or better on all approaches in the AM peak hour and LOS C or better on all approaches during the PM peak hour. It should be noted that the through movement of High Street operates at LOS A in both directions in both peak hours.

The intersection of High Street at East Street and Harvard Street operates at LOS C during the AM peak hour and at LOS B during the PM peak hour. All approaches operate at LOS C or better during both peak periods, with the exception of the East Street left turn to High Street which operates at LOS D during the AM peak hour. High Street westbound experiences lengthy queues at this intersection, with a 95^{th} percentile queue approaching 900 feet in the AM peak hour and approaching 500 feet in the PM peak hour. Field observations confirm that the intersections operate favorably, but that westbound queues can be excessive approaching from East Dedham.

3.2 Evaluation of Dedham Square Improvements

The post-construction LOS results were compared to existing conditions prior to the Dedham Square improvements project as reported in the 2009 study, and are presented in **Tables 3 and 4**.

Table 3 – Comparison of 2009 and 2013 Results – AM Peak Hour

	AM Peak Hour							
	2009				2013			
Approach	LOS	Delay*	50th % Queue	95th % Queue	LOS	Delay*	50th % Queue	95th % Queue
High Street at Washington Street								
High Street EB LT	D	36.8	66’	157’	C	28.0	180’	267’
High Street EB TH/RT	C	28.9	231’	348’				
High Street WB	C	34.0	303’	456’	A	9.0	106’	202’
Washington St NB LT	C	24.6	47’	98’	C	23.7	57’	118’
Wash. St NB TH/RT	C	29.4	242’	362’	C	29.6	279’	423’
Washington St SB LT	E	65.5	275’	457’	C	22.6	31’	71’
Wash. St SB TH/RT					C	26.4	218’	320’
Overall Intersection	**D**	**38.1**	-	-	**C**	**22.8**	-	-
High Street at Eastern Avenue**								
High Street EB	-	-	-	-	B	17.4	102’	127’
High Street WB LT	A	5.1	N/A	20’	C	28.3	96’	165’
High Street WB TH	-	-	-	-	C	34.8	273’	433’
Eastern Ave NB LT	F	72.2	N/A	126’	C	33.3	91’	143’
Eastern Ave NB RT	B	14.1	N/A	30’	C	21.4	0	33’
Overall Intersection	-	-	-	-	**C**	**26.3**	-	-

* Delay is expressed in seconds per vehicle
# 95th percentile queue exceeds capacity, queue may be longer
** Intersection was unsignalized in 2009; results are only available for stop-controlled approaches and for permissive turns.

Signal improvements at the intersection of High Street and Washington Street result in an overall improvement from LOS D to LOS C in the AM peak hour, and significant queue reductions on the High Street approaches in both directions. Also of note is an improvement from LOS E to LOS C for Washington Street northbound, created by the introduction of a dedicated left turn lane.

Improvements realized by the recent project extend beyond operational improvements. Vehicular safety and aesthetics are improved with modern traffic signals mounted overhead on ornamental mast arms. Vehicular safety is also improved with the provision of dedicated left turn lanes on Washington Street. Pedestrian safety is improved with the provision of modern pedestrian signal indications with countdown displays, as well as the introduction of a leading pedestrian interval.

A comparison of LOS results at the intersection of High Street and Eastern Avenue shows an improvement from LOS F to LOS C for the Eastern Avenue left turn to High Street. Overall results are not available from the 2009 study because overall results are not calculated for unsignalized intersections. In addition to the operational improvements illustrated in **Table 3,** the intersection of

High Street and Eastern Avenue has experienced significant safety improvements with the introduction of protected turn phases for the westbound left turn and the Eastern Avenue approach, as well as the introduction of an exclusive pedestrian phase.

Table 4 – Comparison of 2009 and 2013 Results – PM Peak Hour

	PM Peak Hour							
	2009				2013			
Approach	LOS	Delay*	50th % Queue	95th % Queue	LOS	Delay*	50th % Queue	95th % Queue
High Street at Washington Street								
High Street EB LT	C	22.5	42’	89’	C	28.0	216’	288’
High Street EB TH/RT	D	42.2	321’	534’				
High Street WB	E	70.5	232’	534’	B	10.6	105’	379’
Washington St NB LT	C	24.2	32’	75’	C	24.5	43’	103’
Wash. St NB TH/RT	C	22.2	135’	213’	C	23.1	158’	242’
Washington St SB LT	D	38.7	286’	489’	B	19.5	16’	40’
Wash. St SB TH/RT					C	32.6	319’	462’
Overall Intersection	**D**	**42.1**	**-**	**-**	**C**	**24.7**	**-**	**-**
High Street at Eastern Avenue**								
High Street EB	-	-	-	-	B	16.5	193’	207’
High Street WB LT	A	8.0	N/A	33’	D	36.7	108’	213’#
High Street WB TH	-	-	-	-	C	25.5	156’	240’
Eastern Ave NB LT	F	151.5	N/A	190’	C	33.0	91’	152’
Eastern Ave NB RT	C	16.2	N/A	30’	C	22.5	0	39’
Overall Intersection	**-**	**-**	**-**	**-**	**C**	**23.4**	**-**	**-**

* Delay is expressed in seconds per vehicle
# 95th percentile queue exceeds capacity, queue may be longer
** Intersection was unsignalized in 2009; results are only available for stop-controlled approaches and for permissive turns.

A comparison of results for the PM peak hour reveal improvements similar to those experienced in the AM peak hour. The intersection of High Street and Washington Street sees an overall improvement from LOS D to LOS C, and significant queue reductions on the High Street approaches. Of note is an improvement from LOS E to LOS B for the High Street westbound approach, and LOS D to LOS B/C for the Washington Street northbound approach.

The intersection of High Street and Eastern Avenue sees improvement due to the introduction of signalized control. The Eastern Avenue left turn improves from LOS F to LOS C in the PM peak hour, similar to the improvement seen in the AM peak hour.

4.0 IMPROVEMENT STRATEGIES

The analysis results presented and discussed herein illustrate generally acceptable operation with sporadic events of concern. Improvement strategies have been developed in an attempt to address these concerns. Strategies consider a range from individual intersection recommendations to system-wide considerations.

4.1 Intersection Modifications

High Street at Court Street and Ames Street

The intersection of High Street at Court Street and Ames Street currently operates at LOS F in the AM peak hour, and queuing along High Street westbound impacts operations throughout the study area. Two separate improvement strategies have been considered to improve traffic flow and reduce queues on High Street westbound, which in turn will reduce impacts on the intersections at Washington Street and Eastern Avenue.

Option 1

This option considers whether improvements can be realized with **timing and phasing adjustments** at the intersection. As previously discussed, timing adjustments were made in September aimed at reducing queues on High Street westbound.

Pedestrian timing adjustments are required to meet the requirements of Section 4E.06 of the 2009 Manual on Uniform Traffic Control Devices. These adjustments increase the required total pedestrian phase time, which has an adverse affect on overall capacity.

Further timing and phasing adjustments were developed aimed at improving operations and reducing the westbound queue at the intersection. As can be seen in **Table 5,** Option 1 improves the overall intersection operation in the AM peak hour from LOS F to LOS E, and reduces delay on the Court Street northbound approach although this approach remains LOS F. However, Option 1 fails to reduce queue lengths and will in fact lead to longer queue lengths on High Street westbound in the AM peak hour due to the adverse effects of the increased pedestrian time.

A modified version of Option 1 was developed intending to reduce queuing on High Street westbound in the AM peak hour by providing unbalanced timing favoring High Street. This modification resulted in only minor reductions in queue length on High Street, significant levels of delay on Court Street and overall failure of the intersection. This modification is not feasible and is not recommended.

One of the timing improvements recommended in Option 1 is a reduction in the green time for the southbound advance phase to a minimum value of six seconds. Improvements could be realized on other approaches if the advance phase was eliminated, but this is not recommended due to the adverse safety effects of eliminating the protected left turn.

Option 2

Option 2 explores what further improvements that can be realized with **lane changes and minor geometric improvements** including elimination of three parking spaces on High Street.

The right turn volume on High Street westbound in the AM peak hour significantly impacts operations of this approach and the intersection as a whole. Improvements aimed at improving capacity for this right turn will effectively reduce the queue length, and reduce the impact on other intersections within Dedham Square. A short right turn lane can be accommodated by eliminating three on-street parking spaces west of the crosswalk in front of the Norfolk County Registry of Deeds. Vehicles were observed using this area as a right turn lane today early in the morning commuting period before on-street parking spaces are occupied. Formalizing this use will require eliminating three parking spaces, but will greatly reduce queuing and improve operations on this approach, as can be seen in **Table 5.**

Table 5 – Comparison of Improvement Alternatives –
High Street at Court Street and Ames Street

	AM Peak Hour								
	2013 Existing			**Option 1**			**Option 2**		
Approach	LOS	Delay*	95th % Queue	LOS	Delay*	95th % Queue	LOS	Delay*	95th % Queue
High St EB	C	29.9	405'#	D	35.6	444'#	E	58.0	492'#
High St WB	E	64.6	830'#	E	69.3	905'#	C	30.1	474'#
High St WB RT	-	-	-	-	-	-	B	19.0	120'
Court St NB	F	178.5	797'#	F	90.3	797'#	E	73.2	753'#
Ames St SB LT	C	22.5	123'	C	34.5	169'#	C	27.8	147'#
Ames St SB TH/RT	B	17.9	116'	C	21.7	134'	B	19.4	126'
Overall	**F**	**84.3**	**-**	**E**	**62.6**	**-**	**D**	**45.8**	**-**
	PM Peak Hour								
	2013 Existing			**Option 1**			**Option 2**		
Approach	LOS	Delay*	95th % Queue	LOS	Delay*	95th % Queue	LOS	Delay*	95th % Queue
High St EB	C	30.7	553'	C	30.2	530'#	D	37.4	530'#
High St WB	C	33.4	502'#	C	33.0	479'#	C	25.0	285'
High St WB RT	-	-	-	-	-	-	B	15.0	29'
Court St NB	D	43.2	407'#	C	34.2	368'#	C	28.4	360'#
Ames St SB LT	B	19.2	179'	C	31.9	242'#	C	25.1	234'#
Ames St SB TH/RT	C	20.3	396'	C	24.7	451'#	C	21.3	451'#
Overall	**C**	**29.7**	**-**	**C**	**30.5**	**-**	**C**	**27.1**	**-**

* Delay is expressed in seconds per vehicle
# 95th percentile queue exceeds capacity, queue may be longer

Analysis results show that the 95th percentile queue for High Street westbound is effectively cut in half in the AM peak hour by the introduction of the westbound right turn lane. One concern with

expected results is that queues in the High Street westbound through lane will block entry to the newly created right turn lane, reducing its effectiveness. The AM peak period was analyzed for both Option 1 and Option 2 using the SimTraffic simulation software, which analyzes on a macroscopic level and considers the effect of storage lengths, blocking and spillback on queuing. A comparison of queuing results by model is presented in **Table 6**.

Table 6 – Comparison of Queue Projections – High Street at Court Street and Ames Street

	AM Peak Hour							
	Option 1				Option 2			
	Synchro		SimTraffic		Synchro		SimTraffic	
Approach	50th % Queue	95th % Queue	50th % Queue	95th % Queue	50th % Queue	95th % Queue	50th % Queue	95th % Queue
High St WB	413’	905’	585’	969’	221’	474’	350’	641’
High St WB RT	-	-	-	-	36’	120’	93’	136’

As can be seen in **Table 6**, the SimTraffic simulation model predicts longer queues in the High Street westbound through lane as a result of blockage of the proposed right turn lane; however, the resultant 95th percentile queue is still within the storage provided between Court Street and Washington Street. The inclusion of the westbound right turn lane will eliminate occurrences where the queue spills back through the intersection at Washington Street. The reduced capacity demand in the through lane created by the introduction of the right turn lane allows other timing improvements that could improve the overall intersection to LOS D and improve the Court Street approach from LOS F to LOS E, as can be seen in **Table 5**. Minor improvements in LOS and queue are achieved in the PM peak hour as well.

Option 3

This option was developed to further explore the potential for operational improvements by considering more significant geometric improvements at the intersection. As can be seen in **Table 5**, the Court Street approach experiences the greatest delay during the AM and PM peak periods under existing conditions, as well as in the Option 1 and Option 2 improvements. Option 3 increases capacity by widening this approach to provide two northbound through lanes, and formally establishes the Ames Street southbound left turn lane, while maintaining the High Street westbound right turn lane proposed in Option 2. The real added benefit to the improvements on Court Street/ Ames Street is the ability to reduce green time to these approaches and reallocate this time to High Street and therefore reduce the queue on High Street which impacts the Square. The results of Option 3 are presented in **Table 7**.

Analysis results reveal that Option 3 results in queue and operational improvements in the AM peak hour, with minor improvements realized in the PM peak hour as well.

The conceptual design proposed under Option 3 is shown in **Figure 4**. Conceptual improvements are summarized as follows:

- Provide short right turn lane for High Street westbound (impact 3 parking spaces)
- Provide a two lane approach for Court Street northbound (impact 7 parking spaces, with potential for parking during off-peak periods)
- Widen Ames Street to provide a two lane departure and formalize the existing left turn lane
- Property taking /impacts on the northwest corner
- Potential property impacts on the southeast corner to allow an increased turn radius, accommodating right turns from Court Street

A preliminary cost estimate was developed for the conceptual design. The total cost of construction and design is estimated at $484,000, broken down as follows:

Construction Cost	$360,000
Survey Fee	$10,000
Planning/Design Engineering	$60,000
Right-of-Way	$5,000
Utility Relocation	$5,000
SUBTOTAL	$440,000
Contingencies (10%)	$44,000
TOTAL	**$484,000**

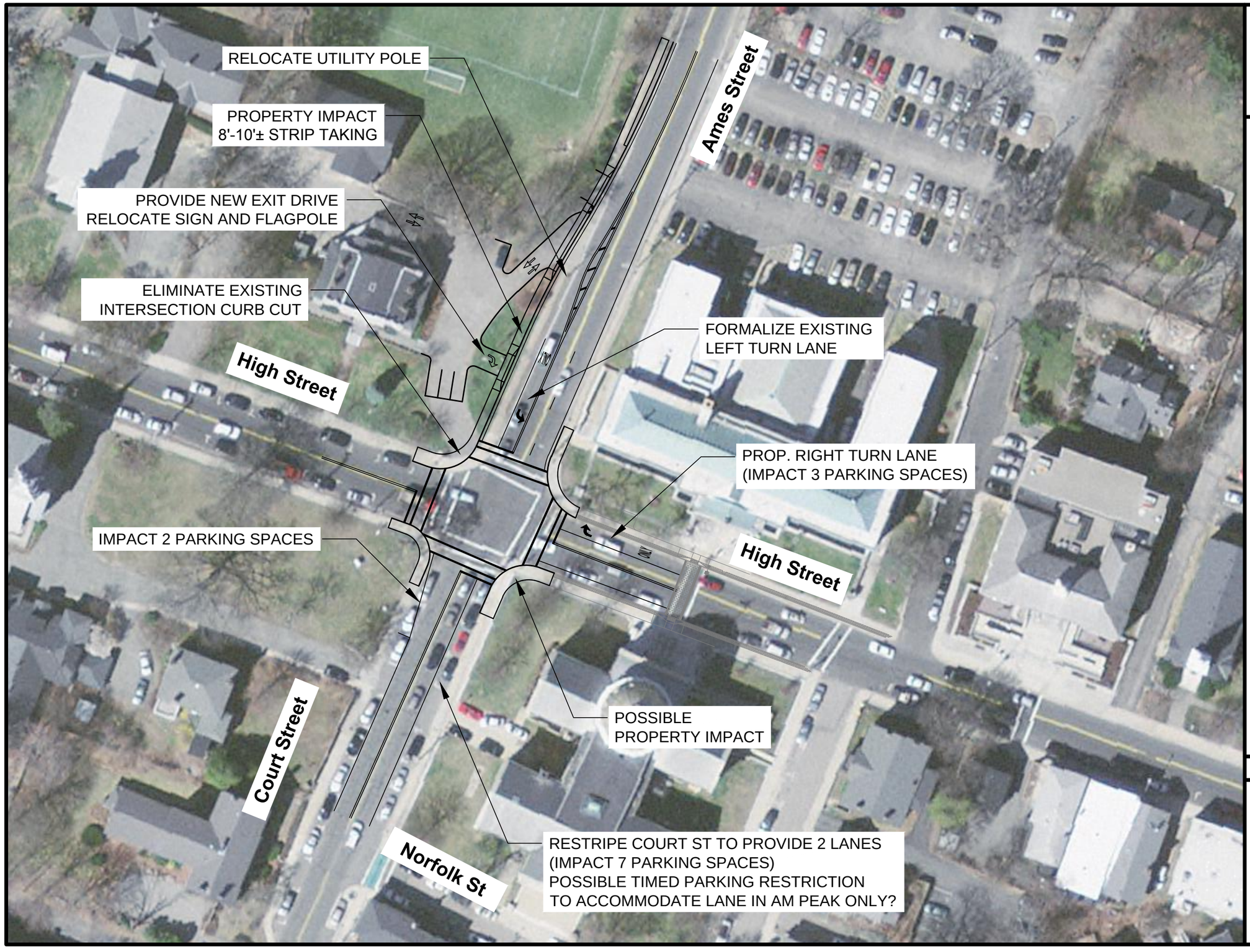
It should be noted that the cost estimate does note include costs associated with necessary land takings.

Table 7 – Comparison of Improvement Alternatives – High Street at Court Street and Ames Street

	AM Peak Hour											
	2013 Existing			**Option 1**			**Option 2**			**Option 3**		
Approach	LOS	Delay*	95th % Queue	LOS	Delay*	95th % Queue	LOS	Delay*	95th % Queue	LOS	Delay*	95th % Queue
High St EB	C	29.9	405'#	D	35.6	444'#	E	58.0	492'#	C	25.5	390'#
High St WB	E	64.6	830'#	E	69.3	905'#	C	30.1	474'#	C	22.1	414'
High St WB RT	-	-	-	-	-	-	B	19.0	120'	B	12.1	86'
Court St NB	F	178.5	797'#	F	90.3	797'#	E	73.2	753'#	D	43.4	311'#
Ames St SB LT	C	22.5	123'	C	34.5	169'#	C	27.8	147'#	C	26.8	135'#
Ames St SB TH/RT	B	17.9	116'	C	21.7	134'	B	19.4	126'	C	21.5	127'
Overall	**F**	**84.3**	**-**	**E**	**62.6**	**-**	**D**	**45.8**	**-**	**C**	**28.1**	
	PM Peak Hour											
	2013 Existing			**Option 1**			**Option 2**			**Option 3**		
Approach	LOS	Delay*	95th % Queue	LOS	Delay*	95th % Queue	LOS	Delay*	95th % Queue	LOS	Delay*	95th % Queue
High St EB	C	30.7	553'	C	30.2	530'#	D	37.4	530'#	C	27.6	512'#
High St WB	C	33.4	502'#	C	33.0	479'#	C	25.0	285'	B	19.7	277'
High St WB RT	-	-	-	-	-	-	B	15.0	29'	B	10.8	28'
Court St NB	D	43.2	407'#	C	34.2	368'#	C	28.4	360'#	C	25.8	145'
Ames St SB LT	B	19.2	179'	C	31.9	242'#	C	25.1	234'#	C	21.6	229'#
Ames St SB TH/RT	C	20.3	396'	C	24.7	451'#	C	21.3	451'#	C	25.5	471'#
Overall	**C**	**29.7**	**-**	**C**	**30.5**	**-**	**C**	**27.1**	**-**	**C**	**23.5**	

* Delay is expressed in seconds per vehicle

95th percentile queue exceeds capacity, queue may be longer



BETA Group, Inc
Engineers • Planners • Landscape Architect
Lincoln, RI - Norwood, MA - Hartford, C
315 Norwood Park Sout
Norwood, MA 0206
781.255.198
email: BETA@BETA-inc.co

N

Dedham Square

Dedham, MA

Not To Scale

Figure 4

Conceptual Improvements

High Street at Court & Ames Streets

December 2013

High Street at Washington Street
High Street at Eastern Avenue
(Dedham Square)

The two intersections at the heart of Dedham Square operate at favorable levels of service following the completion of the Dedham Square improvements project. Minor adjustments can be implemented which will further improve operations of the Square as a whole.

Timing adjustments can be made to all phases, and the overlap trailing green for High Street westbound at Washington Street and High Street eastbound at Eastern Avenue can be reduced to five seconds. Field observations revealed that the seven seconds of overlap trailing green were not being fully utilized.

A comparison of before and after results is presented in **Tables 8 and 9.**

Table 8 – Comparison of 2013 Results with Timing Modifications – Dedham Square – AM Peak Hour

	AM Peak Hour							
	2013				2013 – Timing Modifications			
Approach	LOS	Delay*	50th % Queue	95th % Queue	LOS	Delay*	50th % Queue	95th % Queue
High Street at Washington Street								
High Street EB TH/RT	C	28.0	180’	267’	C	24.8	161’	226’
High Street WB	A	9.0	106’	202’	A	7.4	99’	125’
Washington St NB LT	C	23.7	57’	118’	C	21.2	52’	108’
Wash. St NB TH/RT	C	29.6	279’	423’	C	26.8	258’	383’
Washington St SB LT	C	22.6	31’	71’	C	20.2	29’	66’
Wash. St SB TH/RT	C	26.4	218’	320’	C	23.8	202’	290’
Overall Intersection	**C**	**22.8**	-	-	**C**	**20.3**	-	-
High Street at Eastern Avenue								
High Street EB	B	17.4	102’	127’	B	14.2	70’	92’
High Street WB LT	C	28.3	96’	165’	C	26.8	87’	143’
High Street WB TH	C	34.8	273’	433’	C	32.0	249’	377’
Eastern Ave NB LT	C	33.3	91’	143’	C	31.4	86’	136’
Eastern Ave NB RT	C	21.4	0	33’	C	21.4	0	35’
Overall Intersection	**C**	**26.3**	-	-	**C**	**23.9**	-	-

* Delay is expressed in seconds per vehicle
# 95th percentile queue exceeds capacity, queue may be longer

Table 9 – Comparison of 2013 Results with Timing Modifications – Dedham Square – PM Peak Hour

	PM Peak Hour							
	2013				2013 – Timing Modifications			
Approach	LOS	Delay*	50th % Queue	95th % Queue	LOS	Delay*	50th % Queue	95th % Queue
High Street at Washington Street								
High Street EB TH/RT	C	28.0	216’	288’	C	26.4	199’	275’
High Street WB	B	10.6	105’	379’	A	9.3	97’	248’
Washington St NB LT	C	24.5	43’	103’	C	23.3	39’	98’
Wash. St NB TH/RT	C	23.1	158’	242’	C	21.5	143’	232’
Washington St SB LT	B	19.5	16’	40’	B	18.1	15’	38’
Wash. St SB TH/RT	C	32.6	319’	462’	C	30.4	289’	446’#
Overall Intersection	**C**	**24.7**	-	-	**C**	**23.0**	-	-
High Street at Eastern Avenue								
High Street EB	B	16.5	193’	207’	B	14.4	149’	171’
High Street WB LT	D	36.7	108’	213’#	D	37.6	100’	211’#
High Street WB TH	C	25.5	156’	240’	C	24.3	145’	231’
Eastern Ave NB LT	C	33.0	91’	152’	C	31.7	85’	148’
Eastern Ave NB RT	C	22.5	0	39’	C	22.3	0	40’
Overall Intersection	**C**	**23.4**	-	-	**C**	**22.2**	-	-

* Delay is expressed in seconds per vehicle
# 95th percentile queue exceeds capacity, queue may be longer

High Street at Harris Street/East Street
High Street at East Street/Harvard Avenue
(Lower Square)

The Lower Square intersections operate at favorable levels of service, but experience queuing on High Street westbound approaching East Street and Harvard Avenue. Adjustments in timing and phasing were considered to improve operations of these intersections.

Pedestrian timing adjustments are required to meet the requirements of Section 4E.06 of the 2009 Manual on Uniform Traffic Control Devices. These adjustments increase the required total pedestrian phase time. Other phase timings were adjusted and the overall cycle length reduced to match the cycle length at Washington Street and at Eastern Avenue. A before and after comparison is shown in **Tables 10 and 11,** and shows a reduction in queue lengths while maintaining similar levels of service.

Table 10 – Comparison of 2013 Results with Timing Modifications – Lower Square – AM Peak Hour

	AM Peak Hour							
	2013				2013 – Timing Modifications			
Approach	LOS	Delay*	50th % Queue	95th % Queue	LOS	Delay*	50th % Queue	95th % Queue
High Street at Harris Street and East Street								
Harris Street EB	D	39.2	32’	78’	C	34.9	26’	62’
High Street WB LT	A	2.9	34’	17’	A	2.4	23’	33’
High St WB TH/RT	A	1.4	15’	5’	A	1.1	10’	0
High St NB LT/TH	D	36.6	21’	78’	D	38.9	19’	67’
High Street NB RT	B	14.9	0	34’	B	18.1	0	41’
East Street SB	D	35.7	6’	32’	D	37.3	5’	28’
Overall Intersection	**B**	**10.3**	**-**	**-**	**B**	**10.5**	**-**	**-**
High Street at East Street and Harvard Street								
High Street EB LT/TH	A	5.2	38’	61’	A	5.5	30’	48’
High Street EB RT	A	0.1	0	0	A	0.1	0	0
High Street WB	C	27.4	312’	868’#	C	29.3	246’	717’#
East Street NB LT	D	43.1	88’	158’	D	46.5	74’	157’
East Street NB TH/RT	C	32.3	9’	33’	C	30.1	8’	32’
Harvard Street SB	C	32.0	5’	15’	C	29.8	4’	15’
Overall Intersection	**C**	**22.4**	**-**	**-**	**C**	**23.7**	**-**	**-**

* Delay is expressed in seconds per vehicle
# 95th percentile queue exceeds capacity, queue may be longer

Table 11 – Comparison of 2013 Results with Timing Modifications – Lower Square – PM Peak Hour

	PM Peak Hour							
	2013				2013 – Timing Modifications			
Approach	LOS	Delay*	50th % Queue	95th % Queue	LOS	Delay*	50th % Queue	95th % Queue
High Street at Harris Street and East Street								
Harris Street EB	C	33.2	78’	177’	C	29.8	64’	144’
High Street WB LT	A	7.2	32’	240’	A	5.1	25’	73’
High St WB TH/RT	A	2.6	0	32’	A	1.6	0	4’
High St NB LT/TH	C	30.5	19’	73’	C	31.0	17’	68’
High Street NB RT	B	19.5	0	49’	C	20.5	0	53’
East Street SB	C	30.3	15’	50’	C	30.8	13’	47’
Overall Intersection	**B**	**18.1**	**-**	**-**	**B**	**17.1**		
High Street at East Street and Harvard Street								
High Street EB LT/TH	A	6.4	72’	403’	A	6.7	56’	331’
High Street EB RT	A	0.2	0	0	A	0.2	0	0
High Street WB	C	20.2	167’	467’	B	18.5	132’	377’
East Street NB LT	C	34.2	67’	174’	C	33.4	57’	176’#
East Street NB TH/RT	C	28.9	9’	46’	C	26.4	8’	43’
Harvard Street SB	C	28.3	2’	14’	C	25.9	1’	13’
Overall Intersection	**B**	**13.5**	**-**	**-**	**B**	**12.8**		

* Delay is expressed in seconds per vehicle
# 95th percentile queue exceeds capacity, queue may be longer

4.2 System-wide Improvements

In addition to individual intersection improvements identified above, overall system-wide improvements were considered for their effectiveness at improving traffic flow throughout the Square. Traffic signal coordination was considered for all five intersections within the study area. Coordination has the potential to improve flow along High Street, which is of particular concern given queuing issues that currently exist on High Street westbound between Washington Street and Court Street in the AM peak hour.

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.

Vehicle origin-destination data was not collected as part of this study, but observations and knowledge of the local roadway network suggest that significant volumes of vehicles traveling through the Dedham Square area may use any one of five roadways to enter the area and travel along

High Street; including Ames Street, Washington Street, Eastern Avenue, East Street or High Street itself. Coordination along High Street benefits drivers entering via High Street, but is a potential detriment to vehicles entering via one of the other significant intersecting streets.

It is important to realize that the clustering of two intersections using one traffic signal controller both in the Square and in the lower Square essentially creates two separate coordinated systems. The consideration to use coordination throughout the study area becomes the consideration of linking the intersection of High Street at Court Street and Ames Street to the Dedham Square intersections, and then linking those to the Lower Square intersections. The traffic backup on westbound High Street from Court Street and Ames Street is compounded, as noted by field observations, by vehicles stopped to let another vehicle enter or exit side streets between Court Street and Washington Street.

Due to this reduced effectiveness, coordination is not recommended between the intersection of High Street, Court Street and Ames Street and the intersections at Washington Street and Eastern Avenue.

Coordination was also considered between the two clustered systems at Dedham Square and the Lower Square. Analysis results reveal no improvement in overall capacity and queue lengths, and slightly degrade side street approach operation. Due to this, coordination is not recommended between these two clustered systems at this time. Timing improvements recommended above will effectively improve operations without the need for coordination. It should be noted that revisions to cycle lengths at both intersections as a result of timing improvements promote the potential to add coordination if queuing problems develop between the two intersections. It should also be noted that a physical, hard-wire connection does exist between the two intersections.

Adaptive signal control was also considered for High Street as a potential improvement strategy. Adaptive signal systems collect traffic data and make real-time adjustments based on computer algorithms to provide green time where demand exists. In simpler terms, it has 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.

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 require reconstructing segments of recently-constructed 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.

To date, adaptive signal control is being evaluated for implementation at several locations throughout the Commonwealth, but has yet to be effectively implemented and evaluated. Due to the increased cost of implementation and the lack of local experience evaluating its effectiveness, adaptive control is not recommended at this time.

4.3 Recommendations

Traffic operations are generally favorable in the Dedham Square area following completion of the Dedham Square improvements project, but additional timing adjustments can be made to further improve traffic flow and reduce queues along High Street and other intersecting roadways. As part of this study, timing adjustments have been developed for the intersections of High Street at Washington Street; High Street at Eastern Avenue; High Street at Harris Street and East Street; and High Street at East Street and Harvard Street that could reduce queues and improve flow.

The intersection of High Street, Court Street and Ames Street experiences queues in the AM peak hour which currently impact High Street throughout the Square. Three improvement options were considered, with both Option 2 and Option 3 showing levels of improvement over existing conditions.

A summary of recommendations and considerations is as follows:

High Street at Court Street:

- Implement Option 2 as a short-term improvement. This requires elimination of three parking spaces to accommodate a right turn lane.
- Consider Option 3 as a longer term improvement. This Option requires geometric modifications to the intersection, which will require property acquisition and will impact 10-12 existing parking spaces.

High Street at Washington Street, High Street at Eastern Avenue (Dedham Square):

- Implement minor timing adjustments for further improvement of operations.

High Street at Harris Street/East Street, High Street at East Street/Harvard Avenue (Lower Square):

- Implement minor timing adjustments, including pedestrian phase time adjustments to meet current standards.

High Street corridor:

- Coordination is not recommended at this time due to the prevailing queue from the Court Street/ Ames Street intersection and the consequences on intersecting streets.
- Adaptive signal control is not recommended due to the cost of implementation and the lack of experience evaluating its effectiveness.