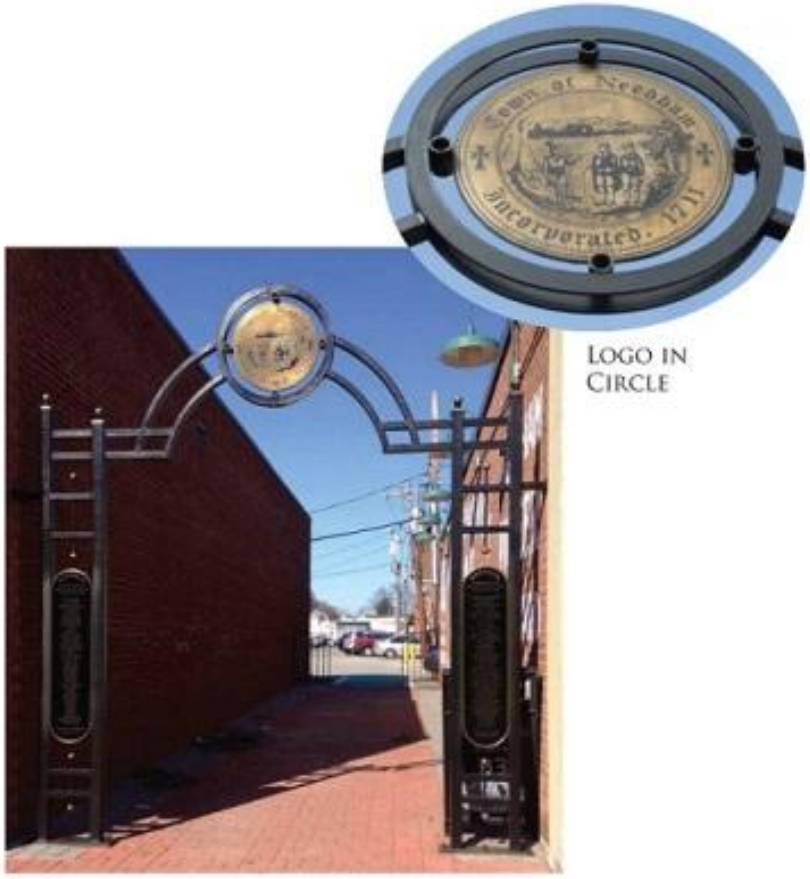
NEEDHAM DOWNTOWN STREETSCAPE PROJECT

DRAFT REPORT



Presented to:
Downtown Streetscape Committee

February 25, 2014

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1.0 INTRODUCTION

1.1 The Project

Needham's Downtown is the geographic and symbolic center of Town. The Town has had and continues to have community based initiatives to revitalize the Downtown for enhancement of its appearance, land-use composition and transportation function.

This project focused on the development of traffic recommendations to alleviate traffic congestion, particularly with commuter rail preemptions, along with development of streetscape concepts within the Downtown area. The Project Team employed a balanced approach to applying "road diet" principles which considered the needs of the various users of the downtown and the transportation functionally of the Downtown. Potential future developments were factored into the analysis to the degree possible. The overall intent of the project was to transform the Downtown roadways into "Complete Streets" which strives to serve all users.

The project area is presented in Figure 1-1 and includes the following roadways:

- Great Plain Avenue between Warren Street and Washburn Avenue,
- Chapel Street between May Street and Lewando's Drycleaners,
- Chestnut Street between Great Plain Avenue and Oak Street,
- Highland Avenue between Great Plain Avenue and May Street,
- Dedham Avenue from Great Plain Avenue to approximately the mid-point between Grant Street and Lincoln Street.

The study area also includes the following intersections:

1. Great Plain Avenue at Chestnut Street/Chapel Street
2. Great Plain Avenue at Dedham Avenue/Highland Avenue
3. Chestnut Street at Oak Street
4. Chestnut Street at School Street
5. Highland Avenue/Chapel Street at May Street

1.2 Downtown Issues

The major issue in the Downtown is the traffic situation that is exacerbated by the commuter rail crossing. Long traffic queues form quickly when the commuter rail train crosses, particularly during rush hour. Route 135 passes through the heart of the Downtown which generates a large volume of traffic. This traffic impacts commuters, pedestrians and businesses.

There are pedestrian crossings within the Downtown that do not lend to providing very safe crossings. On-street parking can partially block driver's vision of pedestrians entering the crosswalk. There are also relatively long crosswalks, particularly at Dedham Avenue and Great Plain Avenue, which require longer traffic cycles to accommodate pedestrians to travel from one corner to the next.

On-street parking is a premium in the Downtown as well as off-street parking. There is a separate effort ongoing within the Town that specifically addresses parking in the Downtown. This plan was coordinated with those parking effort.

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Figure 1-1

Project Area

1.3 Goal of Plan

There are essentially three goals for this plan. The first goal is to alleviate traffic congestion problems caused by the existing traffic controllers. Current controllers need to be updated. Updating the controllers will result in better coordination with major intersection controllers and improved traffic movements during railroad preemptions.

The second goal is to improve safety and visibility of pedestrians to allow for improved safety crossings. Currently there are crosswalks with on-street parking very close that diminish driver visibility with regard to pedestrians. There is also one crosswalk (across Dedham Ave at Great Plain Ave) that is very long, particularly for elderly to cross within a pedestrian cycle. Reconfiguring crosswalks will help improve safety.

Finally, the third goal is to update the look and functionality of the Downtown through sidewalk widening, adding furniture and trees, adding gateways, replacing streetlights so all lights are consistent throughout the Downtown, and providing functional areas (seating, etc.).

The combination of these goals will provide the Town of Needham with an improved, already robust, downtown that draws its citizens and guests to its center.

2.0 BACKGROUND

2.1 Traffic issue/signals

The current traffic signals do not operate efficiently. This has caused angst for both commuters and business within the Downtown. Existing controllers are outdated and there are issues with the detector loops. Further, the commuter rail crossing brings the Downtown to a halt. Because of these issues, the Town provides a police officer during rush hour to mitigate traffic issues.

New traffic control technologies will be investigated and recommended for alleviating this problem.

2.2 Parking

Available parking within the Downtown is paramount to the survival and success of the local businesses. On-street parking is affected directly by this plan. This effort will try to strike a balance between bump outs/safety improvements and on-street parking.

2.3 Streetscape/ Previous Work, Reports

This project is a continuation of the Town's ongoing evaluation of the Downtown that began with 2009 Needham Center Development Plan.

2.4 Scope

The following presents the scope of this effort.

2.4.1 *Data collection*

- Conduct Kick off Meeting with the Project Team.
- Conduct Research and review available information including past initiatives and undertakings (plans, reports) in the project area, as well as known public and private projects/developments identified by the Town that would influence the effort.
- Compile Base Plan from available GIS / Aerial Mapping.
- Collect Traffic Volume Data for the key project locations.
- Perform Auxiliary Counts/Observations.
- Prepare Existing (2013) Traffic Volume Diagrams (AM / PM Peaks) to facilitate subsequent operational analysis.
- Collect Historical Accident Data from the Needham Police Department and/or MassDOT for key locations and the corridor, in general.
- Perform Initial Field Reconnaissance to record prevailing roadway features (lanes, crosswalks, turn lanes, loading zones) and generally observe the nature of traffic conditions along the project corridor.

2.4.2 *Traffic analysis*

- Perform Level of Service (LOS) Analysis for the five key signalized intersections based existing volumes.
- Categorize Accident History by location, occurrence type and severity in a tabular format. Findings will be evaluated to identify apparent contributing roadway and/or intersection deficiencies.

2.4.3 *Traffic Operations Analysis – Future No Build / Build*

- Modify Volume Diagrams to reflect the Future Year (2018).
- Conduct Future Year No Build Analysis for AM and PM Peak hours at the five signalized locations (LOS, Delay, Queuing).
- Assess Roadway Alternatives.

2.4.4 *Roadway layout*

- Make Recommendations with regard to roadway / sidewalk widths and lane use within the project area within the available right of way.
- Make Recommendations with regard to Great Plain Traffic Signals, including preliminary phasing, coordination strategies and layout of signal equipment.
- Prepare Graphic(s) depicting recommendations using available GIS and / or aerial mapping. This plan will be used to support streetscape development.

2.4.5 *Conceptual Streetscape design*

- Identify Opportunities for Streetscape and Enhancement based on the proposed sidewalk areas identified by the traffic evaluations.
- Investigate and Present General Streetscape and Landscape Treatments.
- Develop Initial Concept(s) (up to 5 options) applying the preferred themes and treatments identified in prior tasks.
- Identify Potential Issues to be reconciled during the preliminary design phase, when detailed field survey will be available.
- Develop Illustrative Graphics to depict proposed improvements.
- Prepare Overall Master Conceptual Plan based on preferred options/alternatives and treatments.
- Develop Budgetary Construction Cost Estimates for the approved Master Concept Plan.

2.4.6 *Field survey*

- Compile Right-of-Way Information.
- Collect Underground Utilities information from the Town, involved state agencies and private companies on their respective facilities.
- Establish Control.
- Perform Detailed Field Survey to locate existing physical surface features within and adjacent to Project Streets.
- Obtain/Develop Cross-Sections at 50-foot intervals to the extent of topographical survey.
- Perform Office Calculations and electronically plot survey information. The work will include the development of a TIN.
- Prepare Base Plans - scale 1”=20’.

2.4.7 *Preliminary design plan*

Following the approval of the preferred concept plan and completion of the field survey / base plan, the preliminary design will be undertaken. The purpose of this phase will be to apply the Conceptual design to a more detail base plan and modify its layout as may be necessary. The effort will review utility locations, general grading issues for ADA compliance, pavement thickness at key locations such as proposed curb extensions and location and vertical features of building doorways.

- Perform Subsurface Explorations.
- Set Horizontal Alignment and Intersection Geometrics based on the approved Concept Plan.
- Review Sidewalk Cross slopes and Gutter Gradients.
- Identify / Layout Modifications to existing drainage collection facilities to meet with the proposed design.
- Depict Traffic Improvement Measures including pavement markings, signing: regulatory, guide, advisory, and the signal layouts at Dedham Avenue /Highland Avenue and Chapel Street/Chestnut Street.
- Apply Master Concept Plan and advance the layout of streetscape elements including period lighting to the base plan.
- Perform Preliminary Lighting Layout.
- Prepare Preliminary Plans. Plans will depict the general nature of proposed improvements.
- Prepare Budgetary Estimate of probable construction cost with a breakdown by major elements.
- Make Phasing Recommendations for the project based on operational, funding and traffic management considerations. Prepare an overall phasing plan with associated budgetary costs.

2.4.8 *Project Meetings / Working Sessions / Public Meetings*

- Attend Periodic Project Status Meetings with Town Staff.
- Attend Monthly Meetings of the Downtown Streetscape Working Group.
- Conduct Public Meetings.
- Make Presentations at Town Meeting or Town Department/Board Meetings.

3.0 TRAFFIC

3.1 Existing Traffic Conditions

This section will present a description of existing intersection geometry, traffic volumes and traffic operations at the study area intersections.

3.1.1 *Roadway Classification*

Dedham Avenue, Highland Avenue, Chapel Street and the section of Great Plain Avenue west of the Highland Avenue/Dedham Avenue intersection are classified as Urban Principal Arterials. Chestnut Street and the section of Great Plain Avenue east of the Highland Avenue/Dedham Avenue intersection are classified as Urban Minor Arterials. May and Oak Streets are classified as Urban Collectors, and all other roads in the project area are classified as local roads.

3.1.2 *Existing Intersection Geometry/Traffic Control*

Existing geometry and traffic control measures at each project intersection are described below:

1. Great Plain Avenue at Chestnut Street/Chapel Street

This four-way, signalized intersection operates with four vehicle-actuated phases and a push-button activated exclusive pedestrian phase. The vehicle phases consist of a leading westbound left turn on Great Plain Avenue, eastbound and westbound through phases on Great Plain Avenue, a leading northbound left-turn on Chestnut Street and through phases on Chestnut and Chapel Street. The Great Plain Avenue through phase at this intersection is coordinated with the traffic signal operations at the intersection of Great Plain Avenue at Dedham Avenue/Highland Avenue.

The MBTA Commuter railroad line runs parallel to Chestnut and Chapel Streets and crosses Great Plain Avenue approximately 200 feet west of this intersection. Traffic signal operations at this intersection are preempted during all railroad crossings. During the railroad preemption period, only the Great Plain Avenue eastbound approach is provided a green indication. All other intersection approaches are stopped for the entire duration of the railroad preemption.

The Chestnut Street northbound approach consists of a 10-foot exclusive left-turn lane and a 10-foot shared through/right-turn lane. The Chapel Street southbound approach consists of a 12-foot exclusive right-turn lane and an 11-foot through lane. Left-turns from Chapel Street southbound to Great Plain Avenue Eastbound are prohibited. The Great Plain Avenue eastbound approach consists of a shared 10-foot left-turn/through lane and a 10-foot shared through/right-turn lane. The Great Plain Avenue westbound approach consists of a 13-foot shared through/left-turn lane and an 11-foot shared through/right-turn lane. On-street parking is provided along each side of Great Pain Avenue in the vicinity of the intersection. Pedestrian crosswalks are painted across each leg of the intersection. MBTA bus stops are located on the departure legs of both Chestnut and Chapel Streets.

2. Great Plain Avenue at Dedham Avenue/Highland Avenue

This four-legged, signalized intersection operates with three vehicle-actuated phases and a push-button activated exclusive pedestrian phase. The vehicle phases consist of an eastbound and westbound through phase serving Great Plain Avenue, and two signal

phases that serve the Dedham Avenue northbound and the Highland Avenue southbound approaches separately. This intersection serves as the master traffic signal which controls the coordination of the signal phases between this intersection and the Great Plain Avenue at Chestnut Street/Chapel Street intersection. This traffic signal operates on the fixed 130 second cycle length.

Traffic signal operations at this intersection are preempted when all trains cross Great Plain Avenue. During the railroad preemption period, only the Highland Avenue southbound approach is provided with a green indication. All other intersection approaches are stopped for the entire duration of the railroad preemption.

The Highland Avenue southbound approach consists of a 10-foot exclusive right-turn lane and 10-foot shared left-turn/through lane. The Dedham Avenue northbound approach consists of an 11-foot exclusive left-turn lane and 10-foot shared through/right-turn lane which flairs to a width of 40 feet at the intersection. The approach and departure lanes on Dedham Avenue are separated by a 7 foot wide, 35 foot long, raised median constructed of granite curbing and a bituminous concrete surface. The Great Plain Avenue eastbound approach consists of two 10-foot shared travel lanes and an 8-foot parking lane. The Great Plain Avenue eastbound approach also consists of two 10-foot travel lanes and an 8-foot parking lane. Eastbound left-turns from Great Plain Avenue to Dedham Avenue are prohibited. On-street parking is also provided along all four departing roadways. Painted crosswalks are provided across Great Plain Avenue from the west, Highland Avenue, and Dedham Avenue. A diagonal crosswalk is provided from the northeast corner of Highland Avenue and Great Plain Avenue to the southwest corner of Dedham Avenue and Great Plain Avenue. The pedestrian crossing spanning Dedham Avenue is 125 feet long.

3. Chestnut Street at Oak Street

This four-legged, signalized intersection operates with two vehicle phases and a push-button activated exclusive pedestrian phase. The signal operations at this intersection are coordinated with the signal operations at the intersection of Chestnut Street at School Street.

The MBTA Commuter railroad line runs parallel to Chestnut Street and crosses Oak Street approximately 300 feet west of this intersection. Traffic signal operations at this intersection are not preempted by railroad activities.

The driveway serving the Needham Campus of the Beth Israel Deaconess Hospital approaches the intersection from east and consists of one 11-foot approach lane and one 11-foot departure lane. The Oak Street eastbound approach consists of a 12-foot approach lane. The Chestnut Street southbound approach consists of a 10-foot exclusive right-turn lane and 10-foot shared through/left-turn lane. The Chestnut Street northbound approach consists of a 10-foot exclusive left-turn lane and a 9-foot shared through/right-turn lane. Painted crosswalks are provided across each of the intersecting roadways. No on-street parking is provided in the immediate vicinity of the intersection.

4. Chestnut Street at School Street

This four-legged, signalized intersection operates with three vehicle phases and a push-button activated exclusive pedestrian phase. The vehicle phases consist of a leading chestnut street southbound left-turn phase, a Chestnut Street northbound and southbound through phase, and a phase to serve School Street. The signal operations at this intersection are coordinated with the signal operations at the intersection of Chestnut

Street at Oak Street. This intersection is also connected to the fire station located in the northeast corner of the intersection. Preemption of the traffic signals is provided during the dispatch of emergency vehicles from the fire station.

Traffic signal operations at this intersection are not preempted during railroad crossings in the surrounding area.

The Chestnut Street northbound approach consists of a 10-foot exclusive left-turn lane and a 13-foot shared through/right-turn lane. The School Street westbound approach consists of a 10-foot through-left lane and 12-foot exclusive right-turn lane. The Chestnut Street southbound approach consists of a 10-foot exclusive left-turn lane and 12-foot shared through/right-turn lane. The western leg of the intersection is a shared commercial driveway consisting of a two 12-foot departure lanes. Marked crosswalks are provided across Chestnut Street north of the intersection and across School Street. No on-street parking is provided in the vicinity of the intersection.

5. Highland Avenue/Chapel Street at May Street

This five-legged, signalized intersection lies approximately 1,000 feet north of Great Plain Avenue and operates with 4 vehicle phases and a push-button activated exclusive pedestrian phase. The intersection consists of May Street running in the east-west direction, Highland Avenue running in the north-south direction and Chapel Street running in the northeast-southwest direction. The vehicle phases consist of a leading left turn from Chapel Street to May Street, a through phase on Chapel Street that also runs with an overlapping right-turn from Highland Avenue Southbound, a phase serving all May Street traffic and a phase serving Highland Avenue traffic.

The MBTA Commuter Railroad line runs parallel to Chapel Street and crosses May Street approximately 250 feet west of this intersection. Traffic signal operations at this intersection are not preempted by railroad activities.

The Highland Avenue northbound approach consists of a single 15-foot approach lane. The highland Avenue southbound approach consists of an 11-foot exclusive right-turn lane and an 11-foot shared through/left-turn lane. The May Street eastbound approach consists of a single 15-foot lane. The May Street westbound approach consists of a single 11-foot travel lane and an 8-foot parking lane. The northeast bound Chapel Street approach consists of a 12-foot exclusive left-turn lane and a 12-foot shared through/right-turn lane. A planted median island is provided between Chapel Street and Highland Avenue. Pedestrian crosswalks are provided on the north, east and west legs of the intersection.

3.1.3 *Existing Traffic Volumes*

Daily traffic volumes were collected using Automatic Traffic Recorders (ATR) at four locations over a 48-hour period between Tuesday, March 12 and Wednesday, March 13, 2013. ATR volumes were collected at the following locations:

- Great Plain Avenue east of Highland Avenue
- Dedham Avenue south of Grant Street
- Chestnut Street north of School Street
- Highland Avenue north of May Street.

The collected data were supplemented by previous counts provided by the Town. Daily traffic volumes are presented in Figure 3-1, and peak hour directional traffic distributions are presented in Figure 3-2.

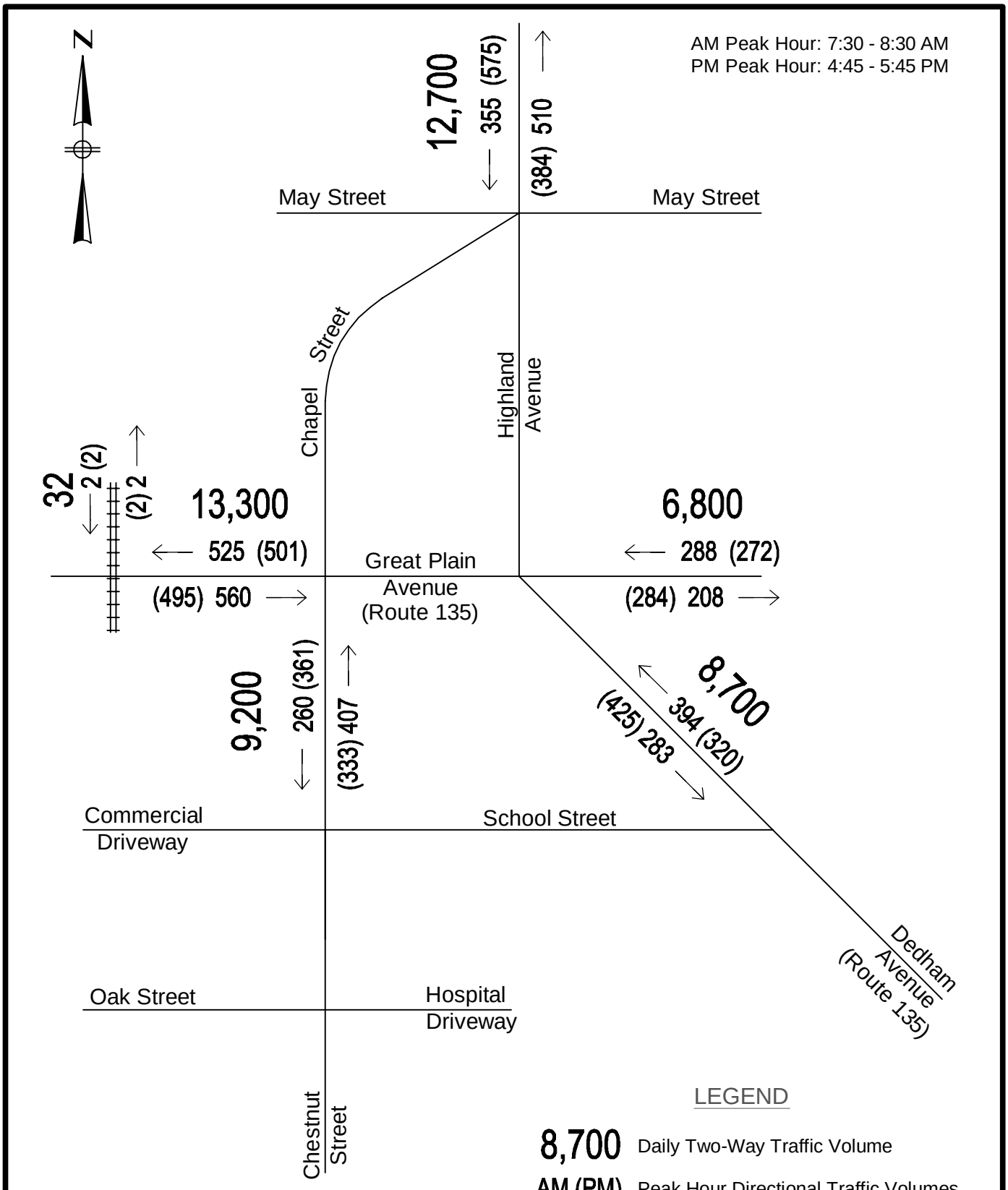

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Figure 3-1

Existing (2013)
Automatic Traffic Recorder Counts

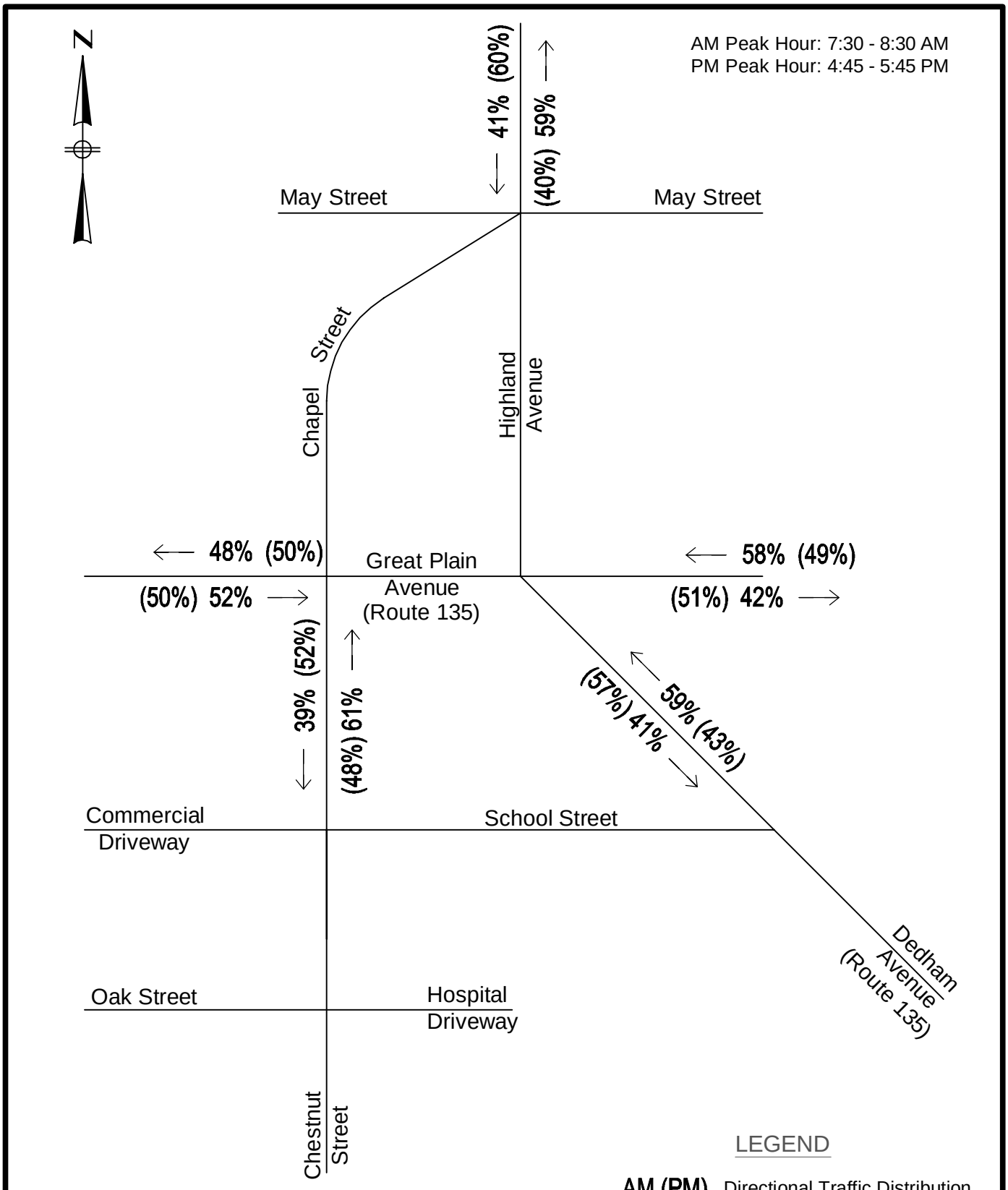

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Figure 3-2

Existing (2013) Peak Hour Directional Traffic Distributions

Intersection Turning Movement Counts (TMC) were conducted on Tuesday, March 12, 2013 between 7 AM and 6 PM at the intersections of Great Plain Avenue/Chestnut Street/Chapel Street and Great Plain Avenue/Highland Avenue/Dedham Avenue. Additionally, TMCs were collected between 7 AM and 9 AM and 4 PM and 6 PM at the remaining three project intersections.

Turning movement data were reviewed and it was determined that the morning peak hour occurs between 7:30 and 8:30 AM and the afternoon peak hour occurs between 4:45 and 5:45 PM. Traffic volumes entering and exiting adjacent intersections have been balanced where appropriate.

TMC data for the morning and afternoon peak hours are presented in Figure 3-3, Figure 3-4, and Figure 3-5.

3.1.4 *Existing Traffic Operations*

The following section will provide a description of the methodology used to evaluate existing traffic conditions and the results of the Level of Service analysis.

3.1.4.1 Analysis Methodology

Intersection operations at the project intersections were evaluated using the SYNCHRO software package (Version 6, Build 614). This software package is based on methodologies contained in the 2000 Highway Capacity Manual. Traffic operations are defined by Level of Service (LOS), which is a qualitative measure that associates LOS with vehicle delays. The criteria for unsignalized intersections are different than for signalized intersections because drivers expect different performance levels from each type of intersection. The relationship between LOS and delay is summarized in Table 3-1 for signalized and unsignalized intersections.

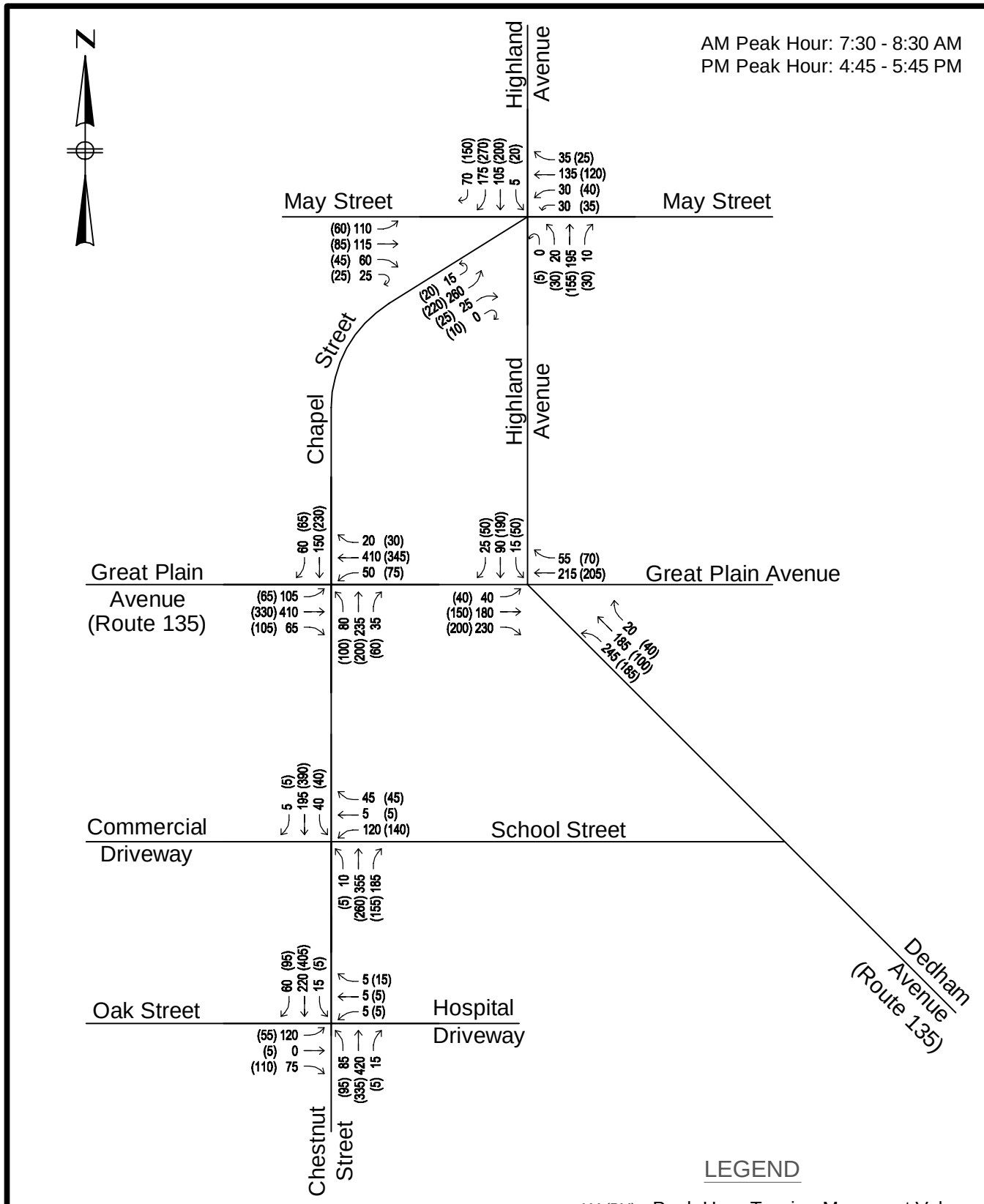
Table 3-1 - Level of Service Criteria

LOS	Unsignalized Intersection Criteria Average Total Delay (Seconds per Vehicle)	Signalized Intersection Criteria Average Total Delay (Seconds per Vehicle)
A	< 10.0	< 10.0
B	10.1 to 15.0	10.1 to 20.0
C	15.1 to 25.0	20.1 to 35.0
D	25.1 to 35.0	35.1 to 55.0
E	35.1 to 50.0	55.1 to 80.0
F	> 50.0	> 80.0

Source: Highway Capacity Manual, Transportation Research Board; Washington, DC; 2000

3.1.4.2 Existing Conditions Analysis Results

The following section presents the results of the Level of Service analysis for existing conditions during the weekday morning and afternoon peak hours. The analysis results at the two Great Plain Avenue intersections include the average delay experienced during the peak hours when MBTA Commuter trains preempt the traffic signals. Analysis results are summarized below in Table 3-2 for the morning peak hour, Table 3-3 for the afternoon peak hour and Figure 3-6 for both peak hours.



Count Date: Tuesday March 12, 2013

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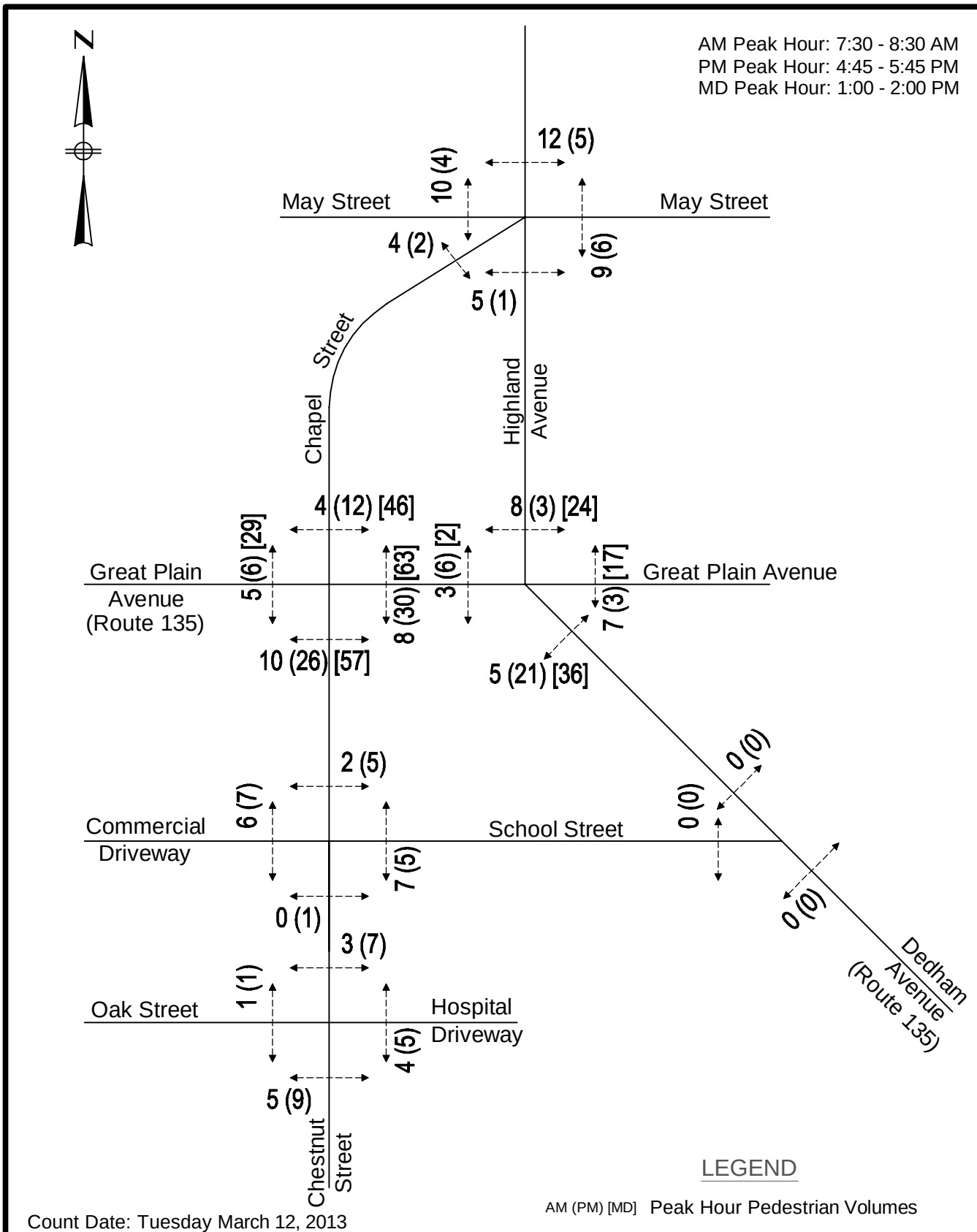
Figure 3-3

Existing (2013) Peak Hour Turning Movement Volumes



Count Date: Tuesday March 12, 2013

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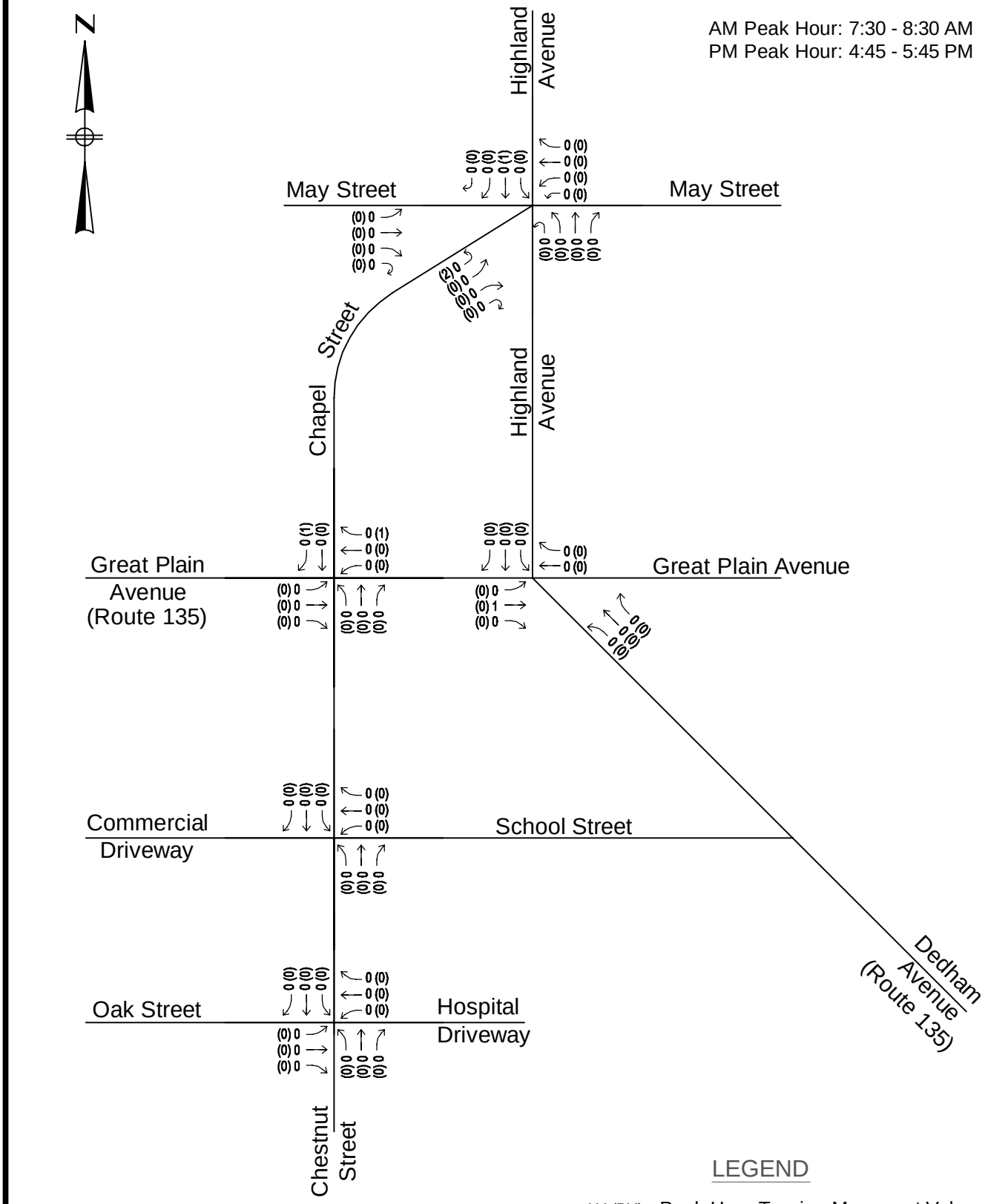
Figure 3-4

Existing (2013) Peak Hour Pedestrian Volumes



Count Date: Tuesday March 12, 2013

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Figure 3-5

Existing (2013) Peak Hour Bicycle Volumes

Table 3-2 - Level of Service Analysis Results
Morning Peak Hour

		Existing			No Build			Alternative 1 - Train Preemption			Alternative 2A - Two TS Coord. Groups			Alternative 2B - One TS Coord. Group			Alternative 3A - GPA WB Lane-use			Alternative 3B - GPA EB Lane-use			Alternative 4A - Dedham Ave Curb			Alternative 4B - Dedham Ave Island			Alternative 5 - Chapel St Left-Turn			Alternative 6 - Alts 1, 2B, 3B, 4B, 5		
		LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)
1. Great Plain Avenue at Chapel Street/Chestnut Street																																		
Great Plan Ave EB	L/T/R	D	38.9	#430	D	42.2	#485	D	48.0	#422	C	31.4	#365	C	31.4	#365	C	32.2	#367	C	32.2	#367	B	10.6	157	C	28.4	#331	E	64.9	#381	D	39.8	#412
Great Plan Ave WB	L/T/R	C	23.3	m265	C	24.4	m259	B	16.3	m#227	A	5.7	68	A	5.7	68	B	11.3	m134	A	5.8	m65	A	6.3	m7	A	7.8	m22	A	8.7	m95	A	9.8	m92
Chestnut St NB	Left-turn	D	45.4	104	D	44.8	108	C	24.4	73	C	29.0	79	B	13.3	35	C	28.5	78	C	28.5	78	C	34.3	99	C	27.0	81	C	25.7	85	B	14.8	28
	T/R	E	67.2	355	E	70.8	381	C	28.5	253	D	43.6	#305	C	29.1	#301	D	41.9	#300	D	41.9	#300	E	56.9	#387	E	55.5	#328	D	49.4	#404	E	65.0	#376
Chapel St SB	Thru	F	80.8	#241	F	85.6	#271	C	31.9	164	D	49.3	#204	D	40.4	m#195	D	47.9	#202	D	47.9	#202	E	58.1	#240	E	78.9	#234						
	Right-turn	D	53.9	101	D	53.4	104	C	28.5	70	C	33.5	76	C	24.9	m73	C	33.0	74	C	33.0	74	D	42.5	91	C	34.6	78						
	Left-turn																												C	25.9	56	B	14.2	m38
	T/R																												D	39.9	#300	D	39.2	m#264
OVERALL		D	43.8		D	46.4		C	32.0		C	27.5		C	22.5		C	29.0		C	27.3		C	23.9		C	31.6		D	40.0		C	33.3	
2. Great Plain Avenue at HighlandAvenue/Dedham Avenue																																		
Great Plan Ave EB	L/T/R	B	12.6	m83	B	13.7	m87	A	7.8	m#247	A	5.6	m#24	A	5.6	m#24	A	5.5	m#56				F	92.8	m#337	A	8.2	m#34	A	7.6	m52			
	L/T																			A	5.0	m#228										A	9.1	m45
	Right-turn																			A	3.0	m48										A	7.3	m90
Great Plan Ave WB	L/T/R	C	24.9	141	C	25.6	151	C	21.5	124	C	20.1	118	C	20.1	118	C	23.3	#299	B	18.6	118	D	44.4	158	B	19.1	117	C	20.7	129	C	20.3	127
Highland Ave SB	L/T	E	56.7	108	E	57.1	117	D	49.3	#111	D	54.0	#159	D	43.2	m#137	E	61.9	#166	D	53.6	#156	D	38.1	#162	D	45.2	#171	E	56.4	#141	D	44.7	m97
	Right-turn	D	51.4	20	D	50.6	20	D	37.6	16	D	36.5	26	C	20.5	m18	D	36.7	26	D	36.1	25	C	34.7	20	D	35.7	26	D	45.5	29	C	28.1	m21
Dedham Ave NB	Left-turn	F	94.4	#424	F	110.4	#467	E	60.2	#318	D	46.3	#285	D	46.3	#285	D	52.6	#290	D	50.6	#280	F	94.0	#404	D	45.2	#293	D	54.7	#293	D	51.3	#292
	T/R	F	82.5	#349	F	97.6	#400	D	52.6	#271	D	43.9	#240	D	43.9	#240	D	46.6	#246	D	45.3	#237	F	80.6	#347	D	41.7	#251	D	50.6	247	D	47.6	#238
OVERALL		D	45.8		D	52.2		C	31.7		C	27.0		C	25.8		C	30.0		C	27.2		E	75.5		C	26.4		C	29.6		C	27.5	
3. Chestnut Street at Oak Street																																		
Oak St EB	L/T/R	D	47.7	#224	D	50.9	#243	D	50.9	#243	D	40.4	212	D	40.5	#206	D	50.9	#243	D	50.9	#243	D	50.9	#243	D	50.9	#243	D	50.9	#243	D	41.4	214
Hospital Drive WB	L/T/R	C	27.6	20	C	27.6	20	C	27.6	20	C	26.0	19	C	24.9	19	C	27.6	20	C	27.6	20	C	27.6	20	C	27.6	20	C	27.6	20	C	26.4	20
Chestnut St NB	Left-turn	B	10.7	62	B	11.1	65	B	11.1	65	B	14.1	71	B	10.7	69	B	11.1	65	B	11.1	65	B	11.1	65	B	11.1	65	B	11.1	65	B	14.0	71
	T/R	B	12.1	321	B	12.5	350	B	12.5	350	B	15.7	389	B	14.8	373	B	12.5	350	B	12.5	350	B	12.5	350	B	12.5	350	B	12.5	350	B	15.6	388
Chestnut St SB	L/T	B	14.5	147	B	15.2	167	B	15.2	167	B	16.4	m171	B	14.9	m100	B	15.2	167	B	15.2	167	B	14.1	167	B	14.1	167	B	15.2	167	B	11.4	140
	Right-turn	A	9.6	m17	B	11.2	m20	B	11.2	m20	A	9.5	m19	B	15.3	m15	B	11.2	m20	B	11.2	m20	B	10.5	m20	B	10.5	m20	B	11.2	m20	B	11.0	m19
OVERALL		B	19.4		C	20.5		C	20.5		C	20.2		B	19.5		C	20.5		C	20.5		C	20.2		C	20.2		C	20.5		B	19.3	
4. Chestnut Street at School Street																																		
School St WB	L/T	D	44.1	139	D	46.2	149	D	46.2	149	D	54.0	#178	E	56.9	#184	D	46.2	149	D	46.2	149	D	46.2	149	D	46.2	149	D	46.2	149	D	51.8	#170
	Right-turn	D	36.0	32	D	35.9	34	D	35.9	34	D	39.1	36	D	37.1	35	D	35.9	34	D	35.9	34	D	35.9	34	D	35.9	34	D	35.9	34	D	39.1	35
Chestnut St NB	Left-turn	A	7.2	m5	A	7.9	m5	A	7.9	m5	A	5.8	m3	A	5.6	m3	A	7.9	m5	A	7.9	m5	A	7.9	m5	A	7.9	m5	A	7.9	m5	A	6.2	m4
	T/R	B	12.3	#194	B	13.7	#266	B	13.7	#266	B	10.8	118	B	10.6	#129	B	13.7	#266	B	13.7	#266	B	14.0	#266	B	14.0	#266	B	13.7	#266	B	11.3	142
Chestnut St SB	Left-turn	B	13.8	32	B	15.3	35	B	15.3	35	B	14.1	34	C	22.1	m31	B	15.3	35	B	15.3	35	B	15.3	35	B	15.3	35	B	15.3	35	C	27.2	m34
	T/R	A	7.1	123	A	7.2	130	A	7.2	130	A	6.7	124	B	10.4	m133	A	7.2	130	A	7.2	130	A	7.2	130	A	7.2	130	A	7.2	130	B	11.9	m192
OVERALL		B	16.5		B	17.8		B	17.8		B	17.2		B	18.5		B	17.8		B	17.8		B	17.9		B	17.9		B	17.8		B	18.8	
5. Highland Avenue/Chapel Street at May Street																																		
May St EB	Left-turn	C	31.6	#160	C	33.7	#175	C	33.7	#175	D	35.8	132	C	32.6	121	C	33.7	#175	C	33.7	#175	C	33.7	#175	C	33.7	#175	C	33.7	#175	C	34.9	129
	T/R	C	30.2	207	C	30.9	216	C	30.9	216	C	33.9	200	C	30.7	183	C	30.9	216	C	30.9	216	C	30.9	216	C	30.9	216	C	30.9	216	C	33.0	196
May St WB	L/T/R	E	66.7	#368	F	98.6	#396	F	98.6	#396	F	83.9	#321	E	77.0	#293	F	98.6	#396	F	98.6	#396	F	98.6	#396	F	98.6	#396	F	98.6	#396	F	81.4	#316
Highland Ave NB	L/T/R	D	42.5	#260	D	46.5	#295	D	46.5	#295	D	43.4	#318	C	25.5	m#296	D	46.5	#295	D	46.5	#295	D	46.5	#295	D	46.5	#295	D	46.5	#295	C	25.8	m#270
Highland Ave SB	L/T	C	32.2	124	C	32.4	134	C	32.4	134	D	36.5	137	C	30.5	129	C	32.4	134	C	32.4	134	C	32.4	134	C	32.4	134	C	32.4	134	C	31.3	133
	Right-turn	C	22.5	196	C	22.7	212	C	22.7	212	C	27.8	239	C	23.5	226	C	22.7	212	C	22.7	212	C	22.7	212	C	22.7	212	C	22.7	212	C	30.1	#262
Chapel St NEB	Left-turn	D	39.3	30	D	39.8	31	D	39.8	31	D	45.7	31	D	40.2	m10	D	39.8	31	D	39.8	31	D	39.8	31	D	39.8	31	D	39.8	31	C	31.5	m6
	T/R	C	34.7	#314	D	37.5	#343	D	37.5	#343	E	70.2	#382	E	65.1	m#313	D	37.5	#343	D	37.5	#343	D	37.5	#343	D	37.5	#343	D	37.5	#343	E	58.7	m#291
OVERALL		D	38.0		D	44.5		D	44.5		D	50.1		D	43.0		D	44.5		D	44.5		D	44.5		D	44.5		D	44.5		D	44.1	

- 95th percentile volume exceeds capacity. Queue may be longer than reported.

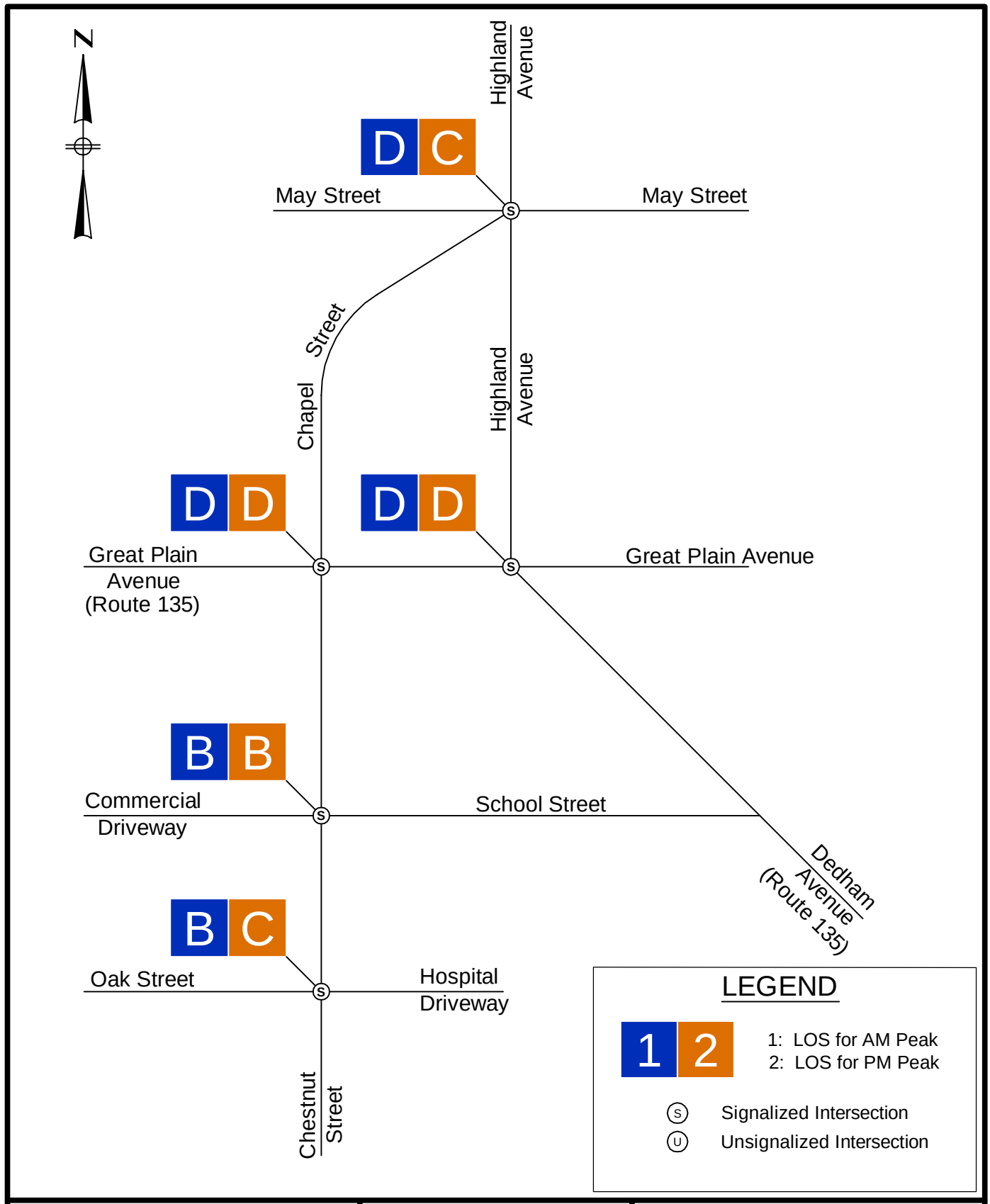
m - Arrival volume metered by upstream signal.

Table 3-3 - Level of Service Analysis Results
Afternoon Peak Hour

		Existing			No Build			Alternative 1 - Train Preemption			Alternative 2A - Two TS Coord. Groups			Alternative 2B - One TS Coord. Group			Alternative 3A - GPA WB Lane-use			Alternative 3B - GPA EB Lane-use			Alternative 4A - Dedham Ave Curb			Alternative 4B - Dedham Ave Island			Alternative 5 - Chapel St Left-Turn			Alternative 6 - Alts 1, 2B, 3B, 4B, 5		
		LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)	LOS	Delay	Queue (95th %)
1. Great Plain Avenue at Chapel Street/Chestnut Street																																		
Great Plan Ave EB	L/T/R	D	49.8	323	D	54.4	#395	E	76.1	#345	D	38.3	#284	D	37.0	#284	D	36.8	#279	D	37.6	#284	B	19.3	189	D	39.3	#284	D	47.2	#304	D	47.9	#343
Great Plan Ave WB	L/T/R	D	40.0	236	D	43.6	#271	C	23.5	m#165	B	10.7	42	B	10.9	44	B	14.6	m83	B	10.2	m41	A	8.3	m23	A	7.5	40	A	8.7	m143	B	13.1	83
Chestnut St NB	Left-turn	D	44.0	121	D	43.7	127	C	24.8	87	C	31.6	97	C	26.6	78	C	32.8	99	C	32.1	98	C	33.6	92	C	28.8	97	C	30.2	96	C	21.0	61
	T/R	D	49.3	321	D	49.8	342	C	26.0	233	D	35.4	261	C	32.8	274	D	36.7	267	D	35.8	264	C	25.5	246	C	34.9	260	E	59.4	#342	D	48.6	#329
Chapel St SB	Thru	F	96.5	#391	F	#####	#422	D	36.1	233	E	63.3	#299	D	49.9	m#290	E	63.5	#301	E	61.4	#296	E	57.7	#238	E	57.8	#286						
	Right-turn	D	53.1	107	D	52.6	111	C	28.8	73	C	35.0	81	C	26.7	m70	D	35.9	83	D	35.4	82	D	39.3	64	C	34.9	81						
	Left-turn																												C	29.0	96	B	18.8	m56
	T/R																												E	70.7	#389	D	53.5	m#357
OVERALL		D	53.5		E	56.5		D	42.4		C	33.0		C	29.7		C	34.0		C	32.5		C	24.3		C	31.4		D	40.8		D	36.4	
2. Great Plain Avenue at Highland Avenue/Dedham Avenue																																		
Great Plan Ave EB	L/T/R	D	39.5	238	D	42.2	270	C	26.4	m86	A	7.1	36	A	7.2	36	A	5.8	36				C	26.7	#286	A	9.8	43	B	13.4	m114			
	L/T																			A	7.3	m35										B	13.1	m64
	Right-turn																			A	1.8	m29										A	6.1	m90
Great Plan Ave WB	L/T/R	D	35.8	162	D	37.4	174	C	26.6	126	C	25.0	124	C	25.3	128	C	29.6	#300	C	24.2	127	C	31.9	154	C	28.0	128	C	25.6	130	C	25.9	128
Highland Ave SB	L/T	E	68.4	213	E	71.0	239	D	53.1	#234	E	57.9	#280	D	42.4	m#239	E	59.1	#293	E	56.7	#278	F	91.5	#295	E	55.6	#282	E	57.5	#181	D	42.2	m#211
	Right-turn	D	47.7	21	D	46.3	21	C	30.0	19	C	30.7	29	B	15.6	m15	C	31.7	30	C	31.2	29	D	38.5	24	C	34.0	31	D	38.1	23	C	21.5	m17
Dedham Ave NB	Left	E	62.0	262	E	65.3	293	E	60.9	#249	D	52.9	#233	D	53.4	#237	E	60.8	#254	D	53.8	#230	F	98.6	#316	D	52.4	#230	D	54.5	#254	D	51.8	216
	TR	E	58.6	193	E	62.1	229	D	48.1	#182	D	47.1	161	D	48.1	166	D	48.7	#184	D	45.0	162	E	70.0	#236	D	54.3	#190	D	54.7	#203	D	45.9	166
OVERALL		D	49.8		D	52.5		D	39.3		C	32.7		C	29.5		C	34.9		C	31.4		E	56.1		C	34.6		C	33.7		C	27.8	
3. Chestnut Street at Oak Street																																		
Oak St EB	L/T/R	D	40.1	#168	D	42.4	#193	D	42.4	#193	D	46.9	210	D	47.3	#204	D	42.4	#193	D	42.4	#193	D	42.4	#193	D	42.4	#193	D	42.4	#193	D	47.5	207
Hospital Drive WB	L/T/R	C	26.5	32	C	26.5	34	C	26.5	34	C	32.6	39	C	31.8	38	C	26.5	34	C	26.5	34	C	26.5	34	C	26.5	34	C	26.5	34	C	32.4	39
Chestnut St NB	Left-turn	B	18.4	66	B	19.9	69	B	19.9	69	C	21.2	75	C	20.3	73	B	19.9	69	B	19.9	69	B	19.9	69	B	19.9	69	B	19.9	69	C	20.6	74
	T/R	B	11.9	226	B	12.2	244	B	12.2	244	B	13.0	267	B	12.5	259	B	12.2	244	B	12.2	244	B	12.2	244	B	12.2	244	B	12.2	244	B	12.7	263
Chestnut St SB	L/T	C	28.0	#392	C	29.3	#430	C	29.3	#430	B	20.0	214	B	16.6	136	C	29.3	#430	C	29.3	#430	C	28.2	#430	C	28.2	#430	C	29.3	#430	B	12.6	136
	Right-turn	C	27.4	m69	C	27.4	m75	C	27.4	m75	B	12.4	m35	A	9.2	m22	C	27.4	m75	C	27.4	m75	C	27.0	m75	C	27.0	m75	C	27.4	m75	A	8.4	m22
OVERALL		C	24.1		C	25.1		C	25.1		C	21.7		B	20.0		C	25.1		C	25.1		C	24.7		C	24.7		C	25.1		B	18.6	
4. Chestnut Street at School Street																																		
School St WB	L/T	D	39.2	140	D	41.0	#153	D	41.0	#153	D	50.6	182	D	48.0	175	D	41.0	#153	D	41.0	#153	D	41.0	#153	D	41.0	#153	D	41.0	#153	D	49.3	178
	Right-turn	C	31.1	29	C	30.9	3	C	30.9	3	D	39.6	35	D	37.7	34	C	30.9	31	C	30.9	31	C	30.9	31	C	30.9	31	C	30.9	31	D	38.8	34
Chestnut St NB	Left-turn	A	6.5	m2	A	7.1	m2	A	7.1	m2	A	6.5	m2	A	6.4	m2	A	7.1	m2	A	7.1	m2	A	7.1	m2	A	7.1	m2	A	7.1	m2	A	6.3	m2
	T/R	A	9.1	#135	B	10.2	#185	B	10.2	#185	A	8.9	124	A	8.8	121	B	10.2	#185	B	10.2	#185	B	10.1	#185	B	10.1	#185	B	10.2	#185	A	9.1	120
Chestnut St SB	Left-turn	B	11.9	34	B	13.0	36	B	13.0	36	B	12.5	38	A	5.6	m28	B	13.0	36	B	13.0	36	B	13.0	36	B	13.0	36	B	13.0	36	A	6.8	m25
	T/R	A	9.4	259	A	9.8	276	A	9.8	276	A	9.2	295	A	6.9	m311	A	9.8	276	A	9.8	276	A	9.8	276	A	9.8	276	A	9.8	276	A	8.2	m313
OVERALL		B	14.3		B	15.4		B	15.4		B	16.4		B	14.7		B	15.4		B	15.4		B	15.4		B	15.4		B	15.4		B	15.7	
5. Highland Avenue/Chapel Street at May Street																																		
May St EB	Left-turn	C	28.6	79	C	30.3	82	C	30.3	82	C	33.1	76	C	32.3	74	C	30.3	82	C	30.3	82	C	30.3	82	C	30.3	82	C	30.3	82	C	33.5	77
	T/R	C	29.2	162	C	30.8	169	C	30.8	169	C	33.6	158	C	32.9	154	C	30.8	169	C	30.8	169	C	30.8	169	C	30.8	169	C	30.8	169	C	34.1	160
May St WB	L/T/R	E	55.5	#340	F	92.2	#367	F	92.2	#367	F	82.1	#310	E	73.9	#293	F	92.2	#367	F	92.2	#367	F	92.2	#367	F	92.2	#367	F	92.2	#367	E	79.2	#309
Highland Ave NB	L/T/R	D	43.2	#286	D	43.4	#339	D	43.4	#339	C	27.9	#304	B	13.4	#314	D	43.4	#339	D	43.4	#339	D	43.4	#339	D	43.4	#339	D	43.4	#339	B	14.5	216
Highland Ave SB	L/T	D	37.1	#250	D	36.8	#292	D	36.8	#292	C	29.8	#256	C	29.4	#274	D	36.8	#292	D	36.8	#292	D	36.8	#292	D	36.8	#292	D	36.8	#292	C	31.6	#292
	Right-turn	C	24.0	369	C	24.1	396	C	24.1	396	C	25.8	#479	C	24.4	#472	C	24.1	396	C	24.1	396	C	24.1	396	C	24.1	396	C	24.1	396	C	23.9	#462
Chapel St NEB	Left-turn	D	39.9	41	D	41.2	43	D	41.2	43	D	46.4	42	D	38.8	m20	D	41.2	43	D	41.2	43	D	41.2	43	D	41.2	43	D	41.2	43	D	40.1	m17
	T/R	C	26.7	241	C	28.6	257	C	28.6	257	E	58.5	#325	D	46.8	#339	C	28.6	257	C	28.6	257	C	28.6	257	C	28.6	257	C	28.6	257	C	33.7	m237
OVERALL		C	34.3		D	40.0		D	40.0		D	41.0		D	35.3		D	40.0		D	40.0		D	40.0		D	40.0		D	40.0		C	34.5	

- 95th percentile volume exceeds capacity. Queue may be longer than reported.

m - Arrival volume metered by upstream signal.



BETA ENGINEERING SUCCESS TOGETHER

Downtown Streetscape Project
Needham, MA

Figure 3-6

Existing (2013) Peak Hour Intersection Level of Service Analysis Results

Needham, MA

Morning Peak Hour

All intersections within the study area operate at LOS D or better during the morning peak hour. The following individual intersection approaches operate at LOS E or LOS F during the morning peak hour:

1. Great Plain Avenue at Chestnut/Chapel Streets
   - Chestnut Street northbound through/right-turn (LOS E - 67 seconds of delay)
   - Chapel Street southbound through movement (LOS F - 81 seconds of delay)
2. Great Plain Avenue at Highland/Dedham Avenues
   - Highland Avenue southbound left-turn/through (LOS E - 57 seconds of delay)
   - Dedham Avenue northbound left-turn (LOS F - 94 seconds of delay)
   - Dedham Avenue northbound through/right-turn (LOS F - 83 seconds of delay)
3. Chestnut Street at Oak Street/Hospital Driveway
   - None
4. Chestnut Street at School Street
   - None
5. Highland Avenue at Chapel/May Streets
   - May Street westbound approach (LOS E - 67 seconds of delay)

Afternoon Peak Hour

All intersections within the study area operate at LOS D or better during the afternoon peak hour. The following individual intersection approaches operate at LOS E or LOS F during the afternoon peak hour:

1. Great Plain Avenue at Chestnut/Chapel Streets
   - Chapel Street southbound through movement (LOS F - 97 seconds of delay)
2. Great Plain Avenue at Highland/Dedham Avenues
   - Highland Avenue southbound left-turn/through lane (LOS E - 68 seconds of delay)
   - Dedham Avenue northbound left-turn lane (LOS E - 62 seconds of delay)
   - Dedham Avenue northbound through/right-turn lane (LOS E - 59 seconds of delay)
3. Chestnut Street at Oak Street/Hospital Driveway
   - None
4. Chestnut Street at School Street
   - None
5. Highland Avenue at Chapel/May Streets
   - May Street westbound approach (LOS E - 56 seconds of delay)

3.1.5 *Crash History*

The project area crash records provided by the Massachusetts Registry of Motor Vehicles, through the MassDOT Highway Safety Unit, were reviewed for the three most recently available years (2008 – 2010, inclusive). The collected crash data are summarized in Table 3-4 and Table 3-5.

Table 3-4 - Intersection Crash Rate Summary

Intersection	Traffic Control	Total Crashes[1]	Average Crashes Per Year
1. Great Plain Avenue at Chapel/Chestnut Streets	Signalized	24	8.0
2. Great Plain Avenue at Highland/Dedham Avenues	Signalized	12	4.0
3. Chestnut Street at Oak Street/ Hospital Driveway	Signalized	5	1.7
4. Chestnut Street at School Street	Signalized	5	1.7
5. Highland Avenue at Chapel/May Streets	Signalized	15	5.0

1 - 3 year period (January 1, 2008 to December 31, 2010)

3.1.5.1 Study Intersection Crash History

A total of 59 crashes occurred at the study area intersections during the three year period reviewed. Crashes at the five project area intersections were primarily angle (44%), rear-end (22%), and sideswipe (15%) collisions with a majority of the crashes occurring during clear weather conditions (80%) and daylight hours (76%). No fatalities occurred at the study area intersections during the three years reviewed; however, eight non-fatal injury crashes occurred. The remaining crashes were property damage only collisions.

3.1.5.2 Study Area Crash History

A total of 130 crashes occurred within the study area (including the 59 crashes which occurred at study intersections). No fatalities were reported, but 24 crashes involved injuries. Three crashes involving pedestrians and seven crashes involving bicycles were reported.

It was brought to the project team's attention that a fatal crash occurred on Great Plain Avenue at the Nehoiden Street intersection. The data available from MassDOT indicate that the crash occurred prior to the three year period reviewed (Wednesday, November 28, 2007 at approximately 6 PM). The vehicle was traveling westbound on Great Plain Avenue and stuck the pedestrian in the crosswalk.

Table 3-5 - Intersection Crash Data Summary

Year	Collision Type							Crash Type				Ambient Light					Weather						Total Crashes
	Rear End	Angle	Head On	Sideswipe (Same Direction)	Sideswipe (Opposite Direction)	Single Vehicle Crash	Unknown	Property Damage Only	Non-Fatal Injury	Fatal Injury	Not Reported	Daylight	Dark Roadway	Dark Lighted Roadway	Dusk	Not Reported	Clear	Sleet	Rain	Snow	Cloudy	Other	
1: Great Plain Avenue (Route 135) at Chestnut Street/Chapel Street																							
2008	1	4	0	1	0	1	1	6	0	0	2	6	0	2	0	0	6	0	1	0	0	1	8
2009	1	6	0	4	0	0	0	9	2	0	0	7	0	3	1	0	9	0	0	0	2	0	11
2010	1	3	1	0	0	0	0	4	1	0	0	3	0	2	0	0	5	0	0	0	0	0	5
																						TOTAL	24
2: Great Plain Avenue (Route 135) at Dedham Avenue (Route 135)/Highland Avenue																							
2008	1	0	0	0	1	0	0	2	0	0	0	2	0	0	0	0	1	0	0	0	1	0	2
2009	2	0	0	1	0	0	0	3	0	0	0	2	0	1	0	0	3	0	0	0	0	0	3
2010	2	0	0	2	0	1	1	5	1	0	0	5	0	0	0	1	2	0	2	0	1	1	6
																						TOTAL	11
3: Chestnut Street at Hospital Driveway/Oak Street																							
2008	0	1	0	0	0	0	1	1	0	0	1	1	0	0	0	1	1	0	1	0	0	0	2
2009	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	1
2010	1	0	0	1	0	0	0	1	0	0	1	2	0	0	0	0	2	0	0	0	0	0	2
																						TOTAL	5
4: Chestnut Street at School Street																							
2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2009	2	1	0	0	0	0	0	2	1	0	0	3	0	0	0	0	2	0	1	0	0	0	3
2010	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1
																						TOTAL	4
5: Highland Avenue at Chapel Street/May Street																							
2008	1	5	0	0	0	0	2	8	0	0	0	8	0	0	0	0	6	0	1	0	1	0	8
2009	0	2	0	0	0	1	0	2	1	0	0	2	0	1	0	0	2	0	0	1	0	0	3
2010	0	3	0	0	0	0	1	3	1	0	0	2	0	2	0	0	4	0	0	0	0	0	4
																						TOTAL	15

3.1.6 *On-Street Parking Supply*

On-street parking is provided along each side of Great Plain Avenue, and along sections of Chestnut Street, Chapel Street, Highland Avenue and Dedham Avenue. The number of existing on-street parking spaces is summarized in Table 3-6 and Figure 3-7.

Table 3-6 - Summary of Existing On-Street Parking Supply

Roadway	Number of Existing On-Street Parking Spaces
Great Plain Avenue	102
Chapel Street	34
Chestnut Street	6
Highland Avenue	25
Dedham Avenue	6
TOTAL	**173**

3.2 Future traffic Conditions

In this section the analysis of future conditions will be presented first without transportation improvements (No-Build Alternative) and then with multiple improvement alternatives (Build Alternatives).

3.2.1 *Future Traffic Volumes*

A review of historic traffic volumes along Route 135 indicated that traffic volumes have declined over the past ten years. The potential exists, however, for redevelopment of underutilized space in the future to increase traffic levels. To account for general background traffic growth, existing traffic volumes were factored by 1.0% per year, compounded annually, for 5 years.

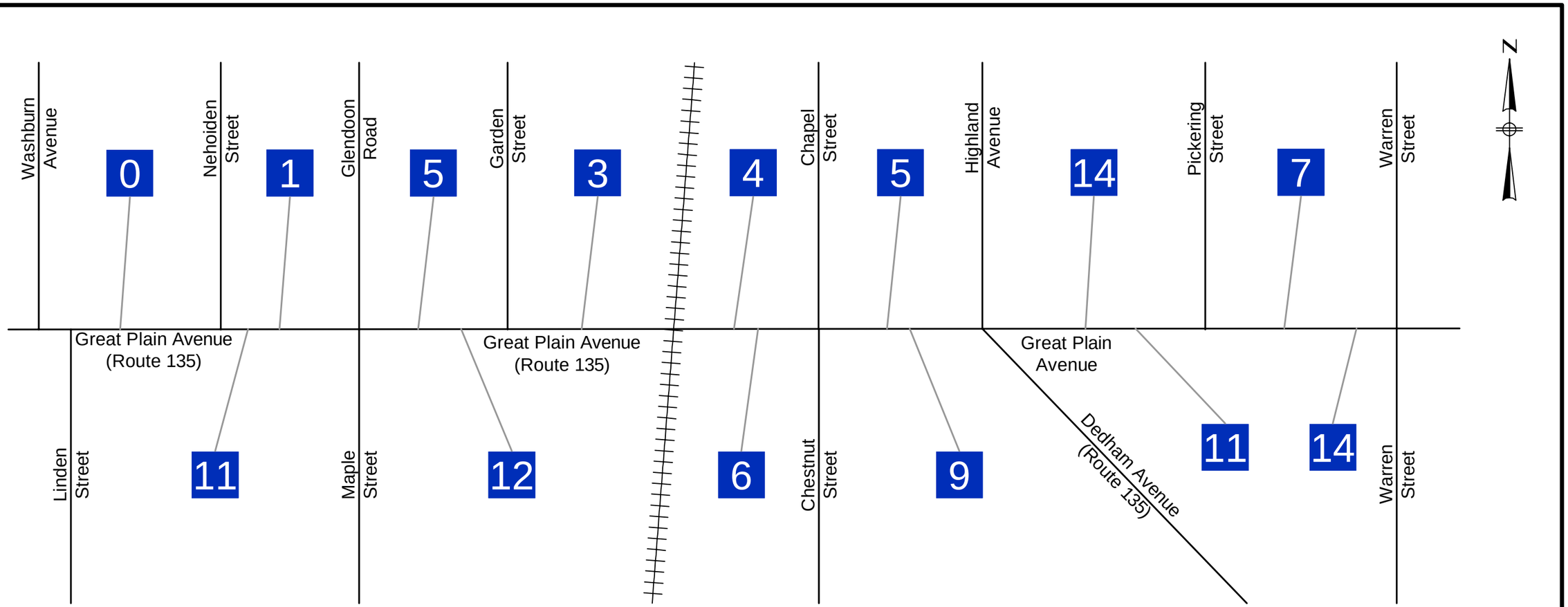
In addition, traffic impact studies submitted to the Town in support of the following three developments were reviewed for background growth factors and projected new trips:

1. Relocated Needham Senior Center located on Hillside Avenue
2. Beth Israel Deaconess Hospital - Phase II Expansion/Renovation located on Chestnut Street
3. 916 Great Plain Avenue

The new project trips generated by these three developments have been included in the Future No-Build traffic volume network presented in Figure 3-8.

3.2.2 *No-Build Traffic Analysis Results*

The following section presents the Level of Service analysis results for future conditions during the weekday morning and afternoon peak hours if no improvements are made to the Downtown intersections. Analysis results are presented above in Table 3-2 for the morning peak hour, Table 3-3 for the afternoon peak hour, and below in Figure 3-9 for both peak hours. Analysis output is included in Appendix C of this report.



Total

102 Existing Parking Spaces

LEGEND

1 Existing Number of On-Street Parking Spaces per Block

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Figure 3-7

Existing On-Street Parking Supply along Great Plain Avenue

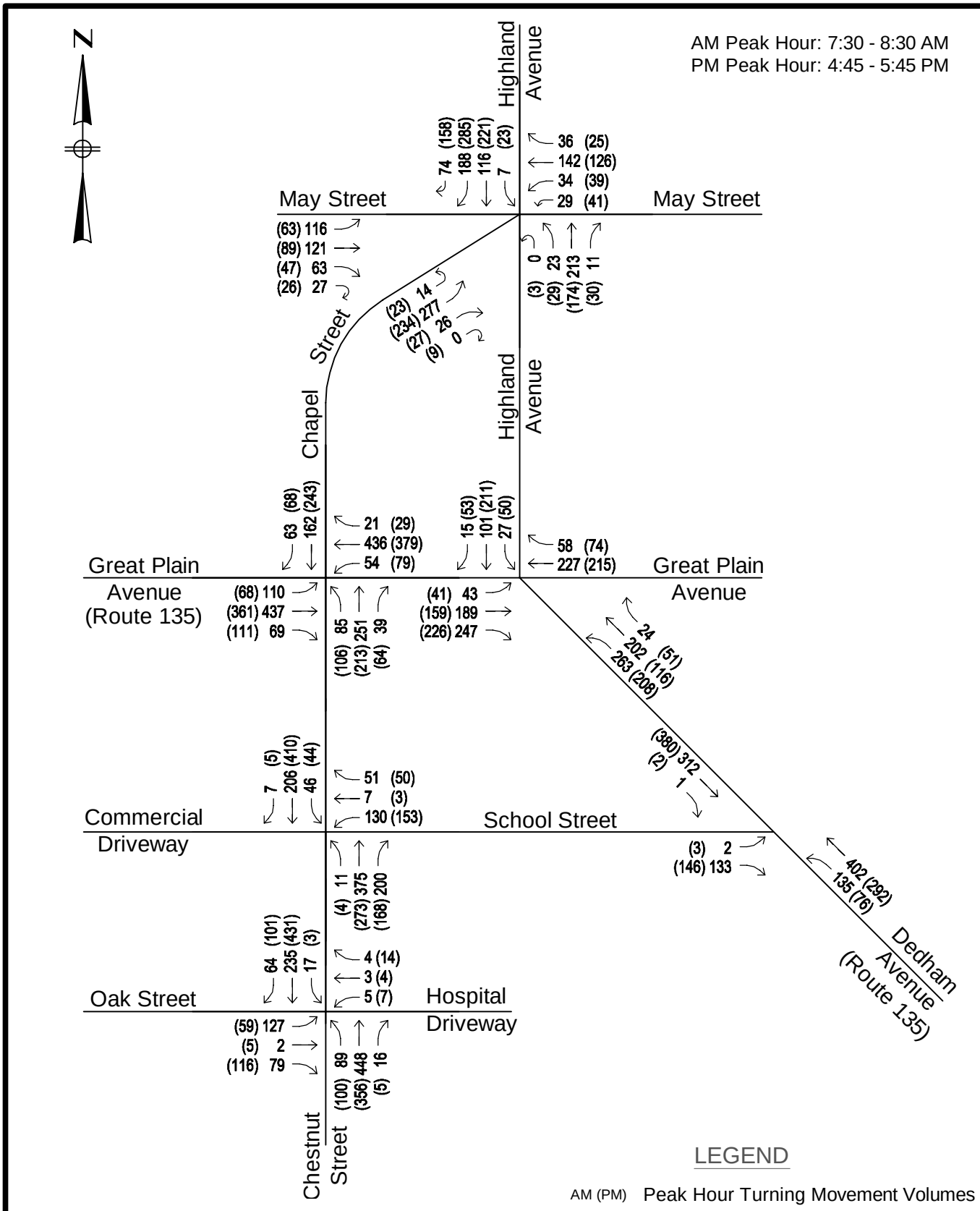

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Figure 3-8

Future No-Build (2018) Peak Hour Turning Movement Volumes

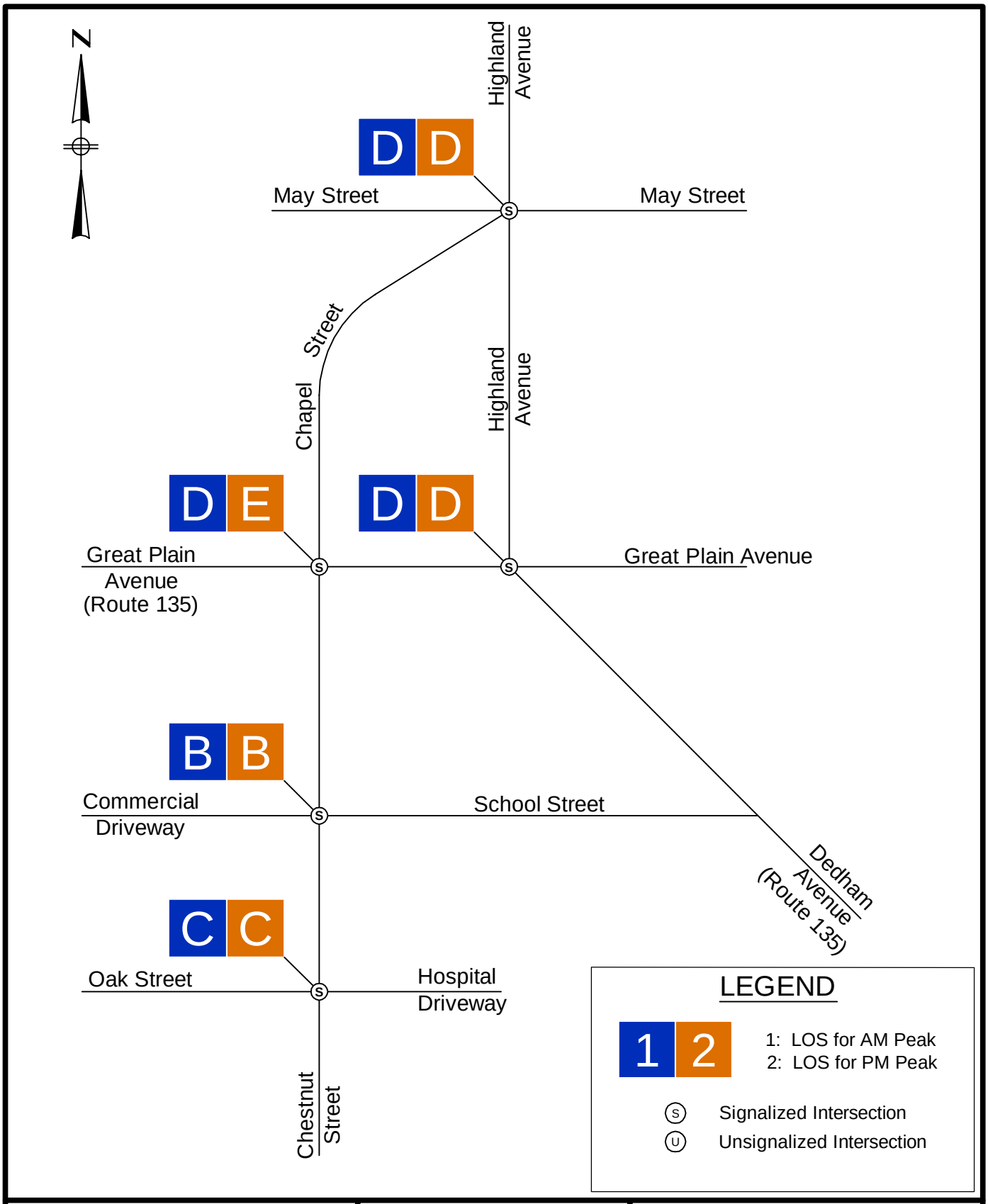

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Figure 3-9

Future No-Build (2018) Peak Hour Intersection Level of Service Analysis Results

Morning Peak Hour

Level of service analysis results for the No-Build Alternative would be unchanged from existing conditions at four of the five study intersections during the morning peak hour. The intersection of Chestnut Street and Oak Street would degrade from LOS B to LOS C.

Afternoon Peak Hour

During the afternoon peak hour, level of service analysis results for the No-Build Alternative would be unchanged from existing conditions at three of the five study intersections. The intersection of Great Plain Avenue/Chestnut Street/Chapel Street would degrade from LOS D to LOS E, and the intersection of Highland Avenue/Chapel Street/May Street would degrade from LOS C to LOS D.

3.2.3 *Improvement Alternatives*

Five improvement alternatives are under consideration by this project. The following sections provide descriptions and analysis results for each improvement alternative.

3.2.3.1 Description of Future Build Options

Alternative 1: Improve Traffic Signal Phasing During Railroad Preemption

The traffic signals at the Great Plain Avenue/Chestnut Street/Chapel Street intersection and the Great Plain Avenue/Dedham Avenue/Highland Avenue intersection current hold in one signal phase for the duration of a railroad preemption event. The typical duration of a railroad preemption event at this crossing is 90 to 120 seconds.

During railroad preemptions, the Great Plain Avenue/Chestnut Street/Chapel Street intersection provides green indications to traffic on Great Plain Avenue eastbound. This allows traffic between the tracks and the intersection to clear, while all other movements are stopped. The Great Plain Avenue/Dedham Avenue/Highland Avenue intersection provides a green indication to the Highland Avenue southbound approach, while all other movements are stopped. The existing traffic signal phasing for each intersection is presented in Figure 3-10.

The existing traffic signal control equipment does not have the ability to provide other phasing options during railroad preemption, but a modern traffic signal controller would provide the ability for a special phasing sequence to be run during railroad preemption events.

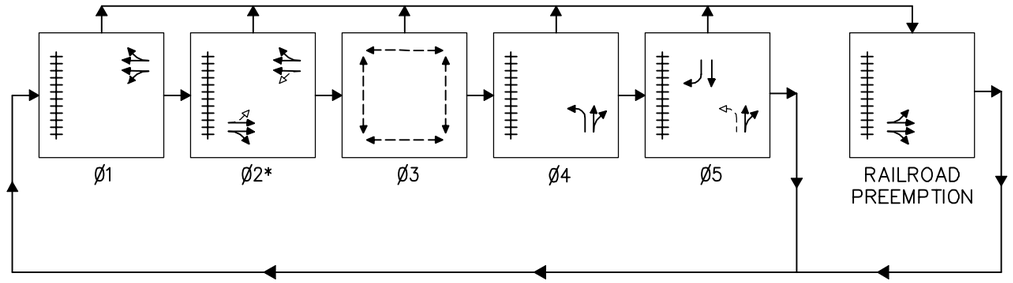
The proposed traffic signal phasing diagrams are presented in Figure 3-10.

The proposed traffic signal phasing at the Great Plain Avenue/Chestnut Street/Chapel Street intersection would provide the Great Plain Avenue eastbound approach approximately 20 seconds of green time at the start of the railroad preemption. This period would allow vehicles between the tracks and the signal to clear that roadway link. The signal would then provide green time to the Chestnut Street and Chapel Street approaches for the remainder of the rail road preemption.

The proposed traffic signal phasing at the Great Plain Avenue/Dedham Avenue/Highland Avenue intersection would also start with a green period for Great Plain Avenue eastbound traffic. This period would allow vehicles between the Chestnut Street/Chapel Street intersection and the Dedham Avenue/Highland Avenue intersection to clear that roadway link. The signal would then provide a green indication to the Highland Avenue southbound approach. The signal could then provide alternative periods of green on the

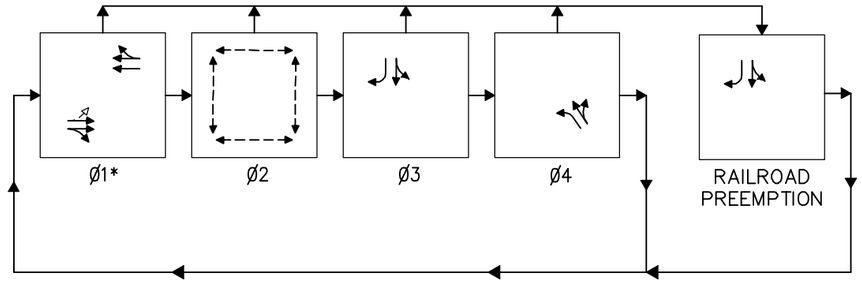
EXISTING TRAFFIC SIGNAL PHASING

GREAT PLAIN AVENUE AT CHAPEL/CHESNUT STREETS



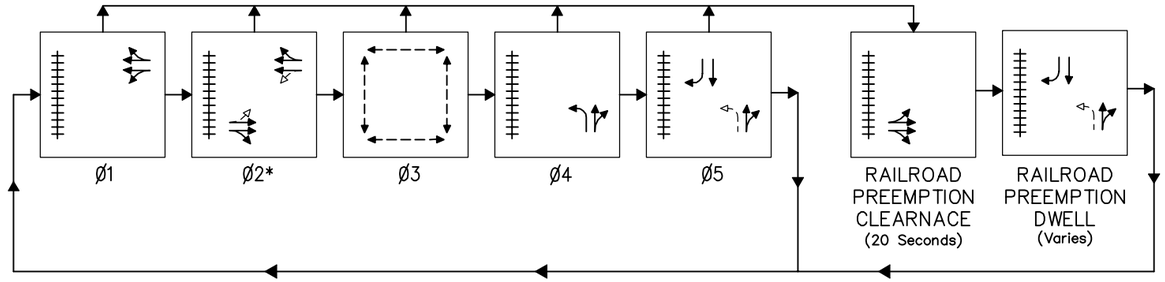
EXISTING TRAFFIC SIGNAL PHASING

GREAT PLAIN AVENUE AT HIGHLAND/DEDHAM AVENUES



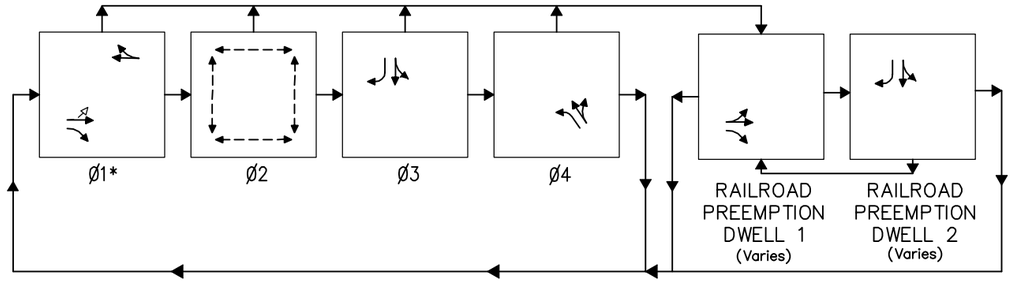
TRAFFIC SIGNAL PHASING FOR ALTERNATIVE 1

GREAT PLAIN AVENUE AT CHAPEL/CHESNUT STREETS



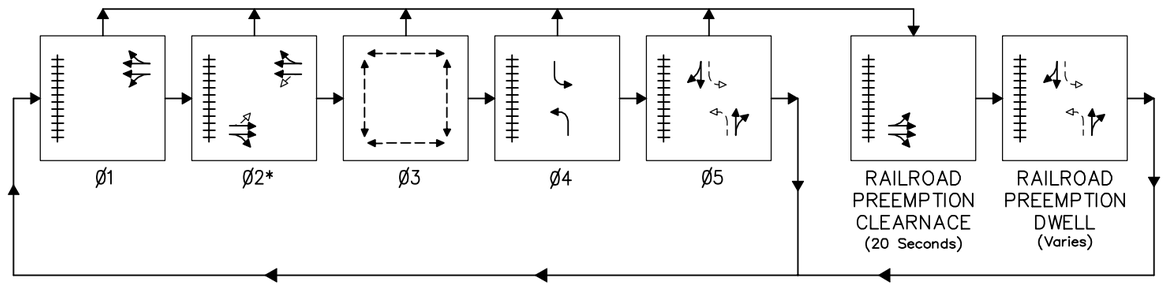
TRAFFIC SIGNAL PHASING FOR ALTERNATIVES 1 & 5

GREAT PLAIN AVENUE AT HIGHLAND/DEDHAM AVENUES



TRAFFIC SIGNAL PHASING FOR ALTERNATIVE 5

GREAT PLAIN AVENUE AT CHAPEL/CHESNUT STREETS



* COORDINATION REFERENCE PHASE (BEGINNING OF YELLOW)

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Figure 3-10

Existing and Proposed
Traffic Signal Phasing

Great Plain Avenue eastbound approach and the Highland Avenue southbound approach as the presence of vehicles on these approaches requires.

Alternative 2: Evaluate Traffic Signal Coordination

A cluster of intersections that operate with coordinated traffic signal timing and phasing is called a traffic signal coordination group. Currently the Downtown operates with the following traffic signal coordination groups:

- Group 1
  - Great Plain Avenue at Chestnut Street/Chapel Street
  - Great Plain Avenue at Dedham Avenue/Highland Avenue
- Group 2
  - Chestnut Street at Oak Street
  - Chestnut Street at School Street
- Independent (no coordination)
  - Highland Avenue/Chapel Street at May Street

Traffic signal coordination has many benefits which include:

- Improved mobility and access to adjacent lane-uses
- Improved emergency response
- Reduced motorist frustration and road rage
- Reduced vehicular accidents
- Reduced energy and fuel consumption
- Reduced vehicle emissions
- Reduced vehicle wear
- Increased control of travel speeds
- Reduced diversionary flows in neighborhoods

The following alternatives were reviewed with respect to coordination within the Downtown.

Alternative 2A - Two Coordination Groups

This alternative would add the Highland Avenue/Chapel Street/May Street intersection, which is currently operating independently, to Group 1. Group 2 would remain as it is currently configured.

Alterative 2B - One Coordination Group

This Alternative would combine all five study intersections into a single coordinated group.

Alternative 3: Evaluate Great Plain Avenue Lane-Use at the Great Plain Avenue/Dedham Avenue/Highland Avenue Intersection

The sub-alternatives propose to eliminate travel lanes along Great Plain Avenue or change the use of the lanes that exist today.

Alternative 3A: Great Plain Avenue Westbound Lane Reduction East of Dedham Avenue

The reduction of travel lanes east of Dedham Avenue would provide the opportunity to increase the width of sidewalks where new street furniture and plantings could be provided. This Alternative would reduce the existing two Great Plain Avenue westbound travel lanes to one travel lane and while maintaining the existing two eastbound travel lanes and not negatively impact traffic flow.

Alternative 3B: Great Plain Avenue Eastbound Lane-Use Change

This alternative would maintain the existing two lanes on Great Plain Avenue that approach the Dedham Avenue/Highland Avenue intersection from the west, but would modify how those lanes are used. The existing lane use consists of a shared left-turn and through lane and a shared through and right-turn lane. The proposed lane-use would maintain the existing shared left-turn/through lane but would change the right lane to an exclusive right-turn lane. This lane-use change would serve two purposes:

1. The predominant movement on this approach is right turn movement to Dedham Avenue. Vehicles are allowed to move with a right turn arrow during the Dedham Avenue northbound traffic signal phase. Through vehicles frequently block this movement with the existing lane-use. The proposed lane-use would place all through vehicles in the adjacent lane, which would increase the efficiency of the right turn movement during the Dedham Avenue signal phase.
2. Reducing the eastbound through movement to one lane allows the section of Great Plain Avenue to the east of Dedham Avenue to be reduced to one eastbound travel lane. This reduction of travel lanes on Great Plain Avenue would provide the opportunity to increase the width of sidewalks where new street furniture and plantings could be provided.

Alternative 4: Reduce Pedestrian Crossing Distance on Dedham Avenue

The existing cross walk across Dedham Avenue is approximately 125-feet long. The Dedham Avenue northbound approach currently consists of an exclusive left-turn lane and a shared through/right-turn lane. The exclusive left-turn lane and the departure lane are separated by a 7-foot wide raised median island.

Alternative 4A - Reduced Southeast Curb Radius

The curb line radius in the southeast corner of the intersection was examined under this sub-alternative to determine if the pedestrian crossing distance could be reduced.

Alternative 4A - Southeast Corner Splitter Island

This alternative proposes to remove the existing raised island to better align the through movement from Dedham Avenue to Highland Avenue. A new raised splitter island would be constructed in the southeast corner of the intersection adjacent to the Dedham Avenue through lane. This island would permit pedestrians to make a two-stage crossing. Pedestrians would cross from the curb to the splitter island in one stage and then from the splitter island to the opposite curb line in a second stage.

Alternative 5: Reintroduce the Southbound Left-Turn Movement on Chapel Street

The southbound left-turn movement from Chapel Street to Great Plain Avenue is currently prohibited. This movement prohibition is actively enforced by the Needham Police Department during the peak hours, because vehicles attempt to make the move daily.

A general objective at an intersection is to provide all turning movements that have demand and can be safely accommodated.

The existing intersection geometry provides an exclusive left-turn lane and a shared through/right-turn lane on Chestnut Street and an exclusive right-turn lane and a thought lane on Chapel Street. The Chapel Street through lane and the Chestnut Street exclusive left-turn lanes are directly aligned with each other, which require a through vehicle on Chapel Street to shift to their right as they progress through the intersection. The crash data collected for this project show that one head-on crash and 13 angle crashes occurred at this intersection between 2008 and 2010.

This alternative proposes that the existing Chapel Street through lane be changed to an exclusive left turn lane and the existing exclusive right-turn lane be changed to a shared through/right-turn lane. This modification would provide left-turn lanes in the northbound and southbound direction that align with each other. Proposed traffic signal equipment could provide protected and permitted movement of both left-turns. Introducing a left turn movement can be accomplished without creating a noticeable impact on the level of service for this intersection.

The proposed traffic signal phasing for Alternative 4 is provided in Figure 3-10.

Alternative 6: Combination of Alternatives 1 through 5

This alternative combines Alternatives 1, 2B, 3B, 4 and 5 together to evaluate the compatibility of these alternatives.

3.2.4 *Build Traffic Volumes*

The Future No-Build traffic volumes, presented above in Figure 3-8, were used to evaluate most of the improvement alternatives. A modified traffic volume network was used to evaluate Alternative 2, which reintroduces the southbound left-turn on Chapel Street. This modified traffic volume network is presented below in Figure 3-11.

3.2.5 *Traffic Analysis Results for Improvement Alternatives*

The following section presents the Level of Service analysis results for future build conditions during the weekday morning and afternoon peak hours. Analysis results are presented below in Table 3-2 for the morning peak hour and Table 3-3 for the afternoon peak hour. Analysis output is included in Appendix C of this report.

3.2.5.1 Alternative 1: Improve Traffic Signal Phasing During Railroad Preemption

This alternative only applies to the two study intersections along Great Plain Avenue as these are the only two study intersections that are preempted during commuter rail train crossings.

Morning Peak Hour

Level of service at the Great Plain Avenue/Chestnut Street/Chapel Street intersection would improve from LOS D (46 seconds of delay) under No-Build conditions to LOS C (32 seconds of delay) during the morning peak hour. Level of service at the Great Plain Avenue/Highland Avenue/Dedham Avenue intersection would also improve from LOS D (52 seconds of delay) to LOS C (32 seconds of delay).

Afternoon Peak Hour

Level of service at the Great Plain Avenue/Chestnut Street/Chapel Street intersection would improve from LOS E (57 seconds of delay) under No-Build conditions to LOS D

(42 seconds of delay). The intersection of Great Plain Avenue/Highland Avenue/Dedham Avenue would remain at LOS D but delay would be reduced from 53 seconds to 39 seconds during the afternoon peak hour.

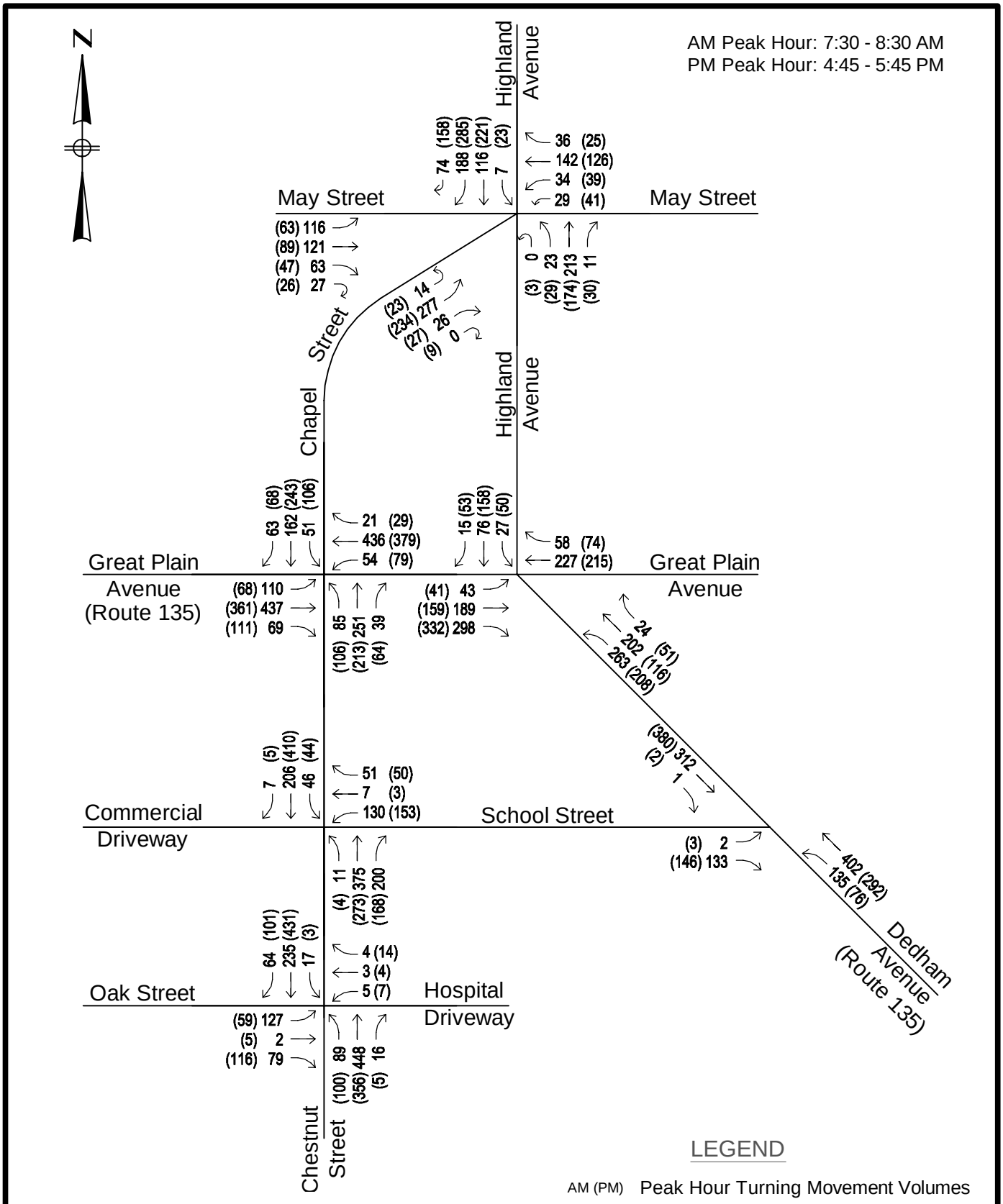

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Figure 3-11

Future Build (2018) Peak Hour Turning Movement Volumes

3.2.5.2 Alternative 2: Evaluate Traffic Signal Coordination

Alternative 2A - Two Coordination Groups

The two study intersections along Great Plain Avenue and the intersection of Highland Avenue/Chapel Street/May Street are the only intersections that would be effected by this sub-alternative. This discussion of results will only focus on the three effected intersections.

Morning Peak Hour

The following level of service changes would occur during the morning peak hour:

- Great Plain Avenue/Chestnut Street/Chapel Street: Improvement from LOS D (46 seconds of delay) under No-Build conditions to LOS C (28 seconds of delay).
- Great Plain Avenue/Highland Avenue/Dedham Avenue: Improvement from LOS D (52 seconds of delay) to LOS C (32 seconds of delay).
- Highland Avenue/Chapel Street/May Street: Remain at LOS D, but delay would increase from 45 seconds to 50 seconds.

Afternoon Peak Hour

The following level of service changes would occur during the afternoon peak hour:

- Great Plain Avenue/Chestnut Street/Chapel Street: Improvement from LOS E (57 seconds of delay) to LOS C (33 seconds of delay).
- Great Plain Avenue/Highland Avenue/Dedham Avenue: Improvement from LOS D (53 seconds of delay) to LOS C (33 seconds of delay).
- Highland Avenue/Chapel Street/May Street: Remain at LOS D, and delay would increase slightly from 40 seconds to 41 seconds.

Alternative 2B - One Coordination Group

Under this alternative, all five study intersections would be combined into a single coordination group.

Morning Peak Hour

The following level of service changes would occur during the morning peak hour:

- Great Plain Avenue/Chestnut Street/Chapel Street: Improvement from LOS D (46 seconds of delay) under No-Build conditions to LOS C (23 seconds of delay).
- Great Plain Avenue/Highland Avenue/Dedham Avenue: Improvement from LOS D (52 seconds of delay) to LOS C (26 seconds of delay).
- Chestnut Street at Oak Street: Remain at a border line LOS B/C (slight delay reduction from 21 seconds to 20 seconds).
- Chestnut Street at School Street: Remain at LOS B.
- Highland Avenue/Chapel Street/May Street: Remain at LOS D.

Afternoon Peak Hour

The following level of service changes would occur during the afternoon peak hour:

- Great Plain Avenue/Chestnut Street/Chapel Street: Improvement from LOS E (57 seconds of delay) to LOS C (30 seconds of delay).
- Great Plain Avenue/Highland Avenue/Dedham Avenue: Improvement from LOS D (53 seconds of delay) to LOS C (30 seconds of delay).

- Chestnut Street at Oak Street: Improvement from LOS C to a border line LOS B/C (slight delay reduction from 25 seconds to 20 seconds).
- Chestnut Street at School Street: Remain at LOS B.
- Highland Avenue/Chapel Street/May Street: Remain at LOS D, and delay would reduce slightly from 40 seconds to 35 seconds.

3.2.5.3 Alternative 3: Great Plain Avenue Lane Reduction east of Dedham Avenue

Alternative 3A: Great Plain Avenue Westbound Lane Reduction East of Dedham Avenue

The two study intersections along Great Plain Avenue are the only intersections that would be effected by this sub-alternative. This discussion of results will only focus on the two effected intersections.

Morning Peak Hour

The following level of service changes would occur during the morning peak hour:

- Great Plain Avenue/Chestnut Street/Chapel Street: Improvement from LOS D (46 seconds of delay) to LOS C (29 seconds of delay). While the level of service would improve the vehicle queue on the westbound approach would increase from 151 feet under No-Build conditions to #299 feet. The # sign indicates that the approach volume would exceed the capacity of the single lane and the reported queue could be longer.
- Great Plain Avenue/Highland Avenue/Dedham Avenue: Improvement from LOS D (52 seconds of delay) to LOS C (30 seconds of delay).

Afternoon Peak Hour

The following level of service changes would occur during the afternoon peak hour:

- Great Plain Avenue/Chestnut Street/Chapel Street: Improvement from LOS E (57 seconds of delay) to LOS C (34 seconds of delay). While the level of service would improve the vehicle queue on the westbound approach would increase from 174 feet under No-Build conditions to #300 feet. The # sign indicates that the approach volume would exceed the capacity of the single lane and the reported queue could be longer.
- Great Plain Avenue/Highland Avenue/Dedham Avenue: Improvement from LOS D (53 seconds of delay) to LOS C (35 seconds of delay).

Alternative 3B: Great Plain Avenue Eastbound Lane-Use Change

The two study intersections along Great Plain Avenue are the only intersections that would be effected by this sub-alternative. This discussion of results will only focus on the two effected intersections.

Morning Peak Hour

The following level of service changes would occur during the morning peak hour:

- Great Plain Avenue/Chestnut Street/Chapel Street: Improvement from LOS D (46 seconds of delay) under No-Build conditions to LOS C (27 seconds of delay).
- Great Plain Avenue/Highland Avenue/Dedham Avenue: Improvement from LOS D (52 seconds of delay) to LOS C (27 seconds of delay).

Afternoon Peak Hour

The following level of service changes would occur during the afternoon peak hour:

- Great Plain Avenue/Chestnut Street/Chapel Street: Improvement from LOS E (57 seconds of delay) to LOS C (33 seconds of delay).
- Great Plain Avenue/Highland Avenue/Dedham Avenue: Improvement from LOS D (53 seconds of delay) to LOS C (31 seconds of delay).

3.2.5.4 Alternative 4: Reduce Pedestrian Crossing Distance on Dedham Avenue

Alternative 4A - Reduced Southeast Curb Radius.

The two study intersections along Great Plain Avenue are the only intersections that would be effected by this sub-alternative. This discussion of results will only focus on the two effected intersections.

Morning Peak Hour

The following level of service changes would occur during the morning peak hour:

- Great Plain Avenue/Chestnut Street/Chapel Street: Improvement from LOS D (46 seconds of delay) under No-Build conditions to LOS C (24 seconds of delay).
- Great Plain Avenue/Highland Avenue/Dedham Avenue: Degradation from LOS D (52 seconds of delay) to LOS C (75 seconds of delay).

Afternoon Peak Hour

The following level of service changes would occur during the afternoon peak hour:

- Great Plain Avenue/Chestnut Street/Chapel Street: Improvement from LOS E (57 seconds of delay) to LOS C (24 seconds of delay).
- Great Plain Avenue/Highland Avenue/Dedham Avenue: Degradation from LOS D (53 seconds of delay) to LOS E (56 seconds of delay).

Alternative 4B - Southeast Corner Splitter Island

The two study intersections along Great Plain Avenue are the only intersections that would be effected by this sub-alternative. This discussion of results will only focus on the two effected intersections.

Morning Peak Hour

The following level of service changes would occur during the morning peak hour:

- Great Plain Avenue/Chestnut Street/Chapel Street: Improvement from LOS D (46 seconds of delay) under No-Build conditions to LOS C (32 seconds of delay).
- Great Plain Avenue/Highland Avenue/Dedham Avenue: Improvement from LOS D (52 seconds of delay) to LOS C (26 seconds of delay).

Afternoon Peak Hour

The following level of service changes would occur during the afternoon peak hour:

- Great Plain Avenue/Chestnut Street/Chapel Street: Improvement from LOS E (57 seconds of delay) to LOS C (31 seconds of delay).
- Great Plain Avenue/Highland Avenue/Dedham Avenue: Improvement from LOS D (53 seconds of delay) to LOS C (35 seconds of delay).

3.2.5.5 Alternative 5: Reintroduce the Southbound Left-Turn Movement on Chapel Street

The two study intersections along Great Plain Avenue are the primary intersections effected by this alternative. The discussion of results will only focus on the two effected intersections.

Morning Peak Hour

The following level of service changes would occur during the morning peak hour:

- Great Plain Avenue/Chestnut Street/Chapel Street: Remain at LOS D (delay would be reduced from 46 seconds to 40 seconds).
- Great Plain Avenue/Highland Avenue/Dedham Avenue: Improvement from LOS D (52 seconds of delay) to LOS C (30 seconds of delay).

Afternoon Peak Hour

The following level of service changes would occur during the afternoon peak hour:

- Great Plain Avenue/Chestnut Street/Chapel Street: Improvement from LOS E (57 seconds of delay) to LOS D (41 seconds of delay).
- Great Plain Avenue/Highland Avenue/Dedham Avenue: Improvement from LOS D (53 seconds of delay) to LOS C (34 seconds of delay).

3.2.5.6 Alternative 6: Combination of Alternatives 1 through 5

All five study intersections would be effected by this alternative.

Morning Peak Hour

The following level of service changes would occur during the morning peak hour:

- Great Plain Avenue/Chestnut Street/Chapel Street: Improvement from LOS D (46 seconds of delay) under No-Build conditions to LOS C (33 seconds of delay).
- Great Plain Avenue/Highland Avenue/Dedham Avenue: Improvement from LOS D (52 seconds of delay) to LOS C (28 seconds of delay).
- Chestnut Street at Oak Street: Remain at a border line LOS B/C (slight delay reduction from 21 seconds to 19 seconds).
- Chestnut Street at School Street: Remain at LOS B.
- Highland Avenue/Chapel Street/May Street: Remain at LOS D.

Afternoon Peak Hour

The following level of service changes would occur during the afternoon peak hour:

- Great Plain Avenue/Chestnut Street/Chapel Street: Improvement from LOS E (57 seconds of delay) to border line LOS C/D (36 seconds of delay).
- Great Plain Avenue/Highland Avenue/Dedham Avenue: Improvement from LOS D (53 seconds of delay) to LOS C (28 seconds of delay).
- Chestnut Street at Oak Street: Improvement from LOS C to a border line LOS B/C (slight delay reduction from 25 seconds to 19 seconds).
- Chestnut Street at School Street: Remain at LOS B.

- Highland Avenue/Chapel Street/May Street: Improvement from LOS D (40 second of delay) to a border line LOS C/D (35 seconds of delay).

3.2.6 *On-Street Parking Changes*

The corners of each intersection were evaluated during the roadway design process to determine if curb extensions could be constructed. Curb extensions, also known as bulb-outs, are areas where the sidewalk is extended into the roadway to reduce the pedestrian crosswalk distance. Curb extensions often affect adjacent on-street parking because the corner of the intersection increases in size and reduces the area available for parking. Throughout the design process, every effort has been made to minimize the impact to on-street parking while also improving the pedestrian environment in the downtown.

On-street parking supply changes are summarized for the entire project area in Table 3-7. The existing and proposed parking supply as well as the change in on-street parking supply along Great Plain Avenue is presented in Figure 3-12.

Table 3-7 - Summary of Existing and Proposed On-Street Parking Supply

Roadway	Number of Existing On-Street Parking Spaces	Number of Proposed On-Street Parking Spaces	Gain(+)/Loss(-)
Great Plain Avenue	102	95	-7
Chapel Street	34	34	0
Chestnut Street	6	7	+1
Highland Avenue	25	29	+4
Dedham Avenue	6	7	+1
TOTAL	**173**	**172**	**-1**

It should be noted that the proposed loss of seven spaces along Great Plain Avenue could be reduced by two spaces by modifying the roadway/sidewalk design at the eastern project limit. Two spaces have been eliminated along the south side of Great Plain Avenue at the approach to Warren Street to provide an eleven foot wide travel lane, a four foot wide bicycle lane and a six foot wide sidewalk along Great Plain Avenue. Providing the additional two parking spaces would require the sidewalk to be placed on private property. These two spaces could be regained if the Town and the Church located at the corner of Great Plain Avenue and Warren Street could work out an easement for the sidewalk.

3.3 Traffic Conclusions

Upgrading traffic signal equipment in the Downtown can realize significant operational improvements over Existing and No-Build conditions. Most of the Alternatives evaluated maintained or improved level of service at the study intersections.

3.3.1.1 Alternative 1: Improve Traffic Signal Phasing During Railroad Preemption

Improvement of the traffic signal phasing during the commuter rail preemption period would serve to improve operations at the two Great Plain Avenue intersections during the morning and afternoon peak hours.

3.3.1.2 Alternative 2: Evaluate Traffic Signal Coordination

Alternative 2A - Two Coordination Groups

Improvements to operations could be realized at the two Great Plain Avenue intersections while operations would remain unchanged at the Highland Avenue/Chapel Street/May Street intersection.

Alternative 2B - One Coordination Group

Intersection operations could be further improved from Alterative 2A at the two Great Plain Avenue intersections and operations at all other intersections could be improved by including all five study intersections in one coordinated system.

3.3.1.3 Alternative 3: Great Plain Avenue Lane Reduction east of Dedham Avenue

Alternative 3A: Great Plain Avenue Westbound Lane Reduction East of Dedham Avenue

This alternative could improve level of service during both peak hours; but vehicle queues would increase significantly. Queuing vehicles could cause safety problems at the Great Plain Avenue/Pickering Street intersection.

Alternative 3B: Great Plain Avenue Eastbound Lane-use Change

This alternative would improve intersection operations at the two intersections along Great Plain Avenue. Vehicle queues along Great Plain Avenue between Chestnut Street/Chapel Street and Highland Avenue/Dedham Avenue would be adequately accommodated during each peak hour.

3.3.1.4 Alternative 4: Reduce Pedestrian Crossing Distance on Dedham Avenue

Alternative 4A - Reduced Southeast Curb Radius

This is the only alternative evaluated which would increase delay from No-Build conditions. This Alternative would change the curb line in the southeast corner of the Great Plain Avenue/Highland Avenue/Dedham Avenue intersection to reduce the pedestrian crossing distance. This Alternative would reduce the crossing distance by approximately 5 feet, but the crossing would require a longer pedestrian signal phase. The current pedestrian signal phase is based on an old requirement for pedestrian crossing speed of 4.0 feet/second. Federal regulations now require that a pedestrian crossing speed of 3.5 feet/second be used. The reduced crossing speed requires a longer crossing phase, which negatively effects intersection level of service.

Alternative 4B - Southeast Corner Splitter Island

This alternative would improve intersection operations at the two study intersections along Great Plain Avenue. The proposed splitter island would allow pedestrians to cross Dedham Avenue in two stages. This two-stage approach would require less crossing time because the crossing distance would be shorter than the existing case and Alternative 4A.

3.3.1.5 Alternative 5: Reintroduce the Southbound Left-Turn Movement on Chapel Street

Reintroducing the southbound left-turn movement would serve a present demand. While the intersections could operate with slightly less delay without the left-turn movement; the difference would be insignificant and would not be perceptible to motorists.

Vehicle queues between the two Great Plain Avenue intersections would be adequately accommodated by the available queue storage space both with and without the Chapel Street left-turn movement. The proposed southbound exclusive left-turn lane would also adequately accommodate the 95% percentile left-turn queue.

Beyond the analysis results, the Chapel Street lane-use change would provide improved intersection geometry. Vehicles are currently required to shift to the right as they cross the intersection from Chapel Street to Chestnut Street. Restriping the approach would eliminate the shift through the intersection, and would align the northbound and southbound left-turn lanes with each other. These changes would have a positive effect on vehicle safety.

3.3.1.6 Alternative 6: Combination of Alternatives 1 through 5

This alternative would significantly improve intersection operations within the Downtown. All intersections would operate at LOS D or better (with most intersections operating at LOS C or LOS B) during both the morning and afternoon peak hours.

This alternative would:

- Improve operations on Chestnut Street/Chapel Street during the commuter railroad crossing.
- Pedestrian crossings would be improved across Dedham Avenue by the proposed splitter island.
- The southbound left-turn from Chapel Street could be accommodated.

Delay would be changed at each intersection as follows:

Morning Peak Hour

- Great Plain Avenue/Chestnut Street/Chapel Street: 13 second improvement (46 seconds to 33 seconds)
- Great Plain Avenue/Highland Avenue/Dedham Avenue: 24 second improvement (52 seconds to 28 seconds)
- Chestnut Street at Oak Street: Delay would remain virtually unchanged
- Chestnut Street at School Street: Delay would remain virtually unchanged
- Highland Avenue/Chapel Street/May Street: Delay would remain virtually unchanged

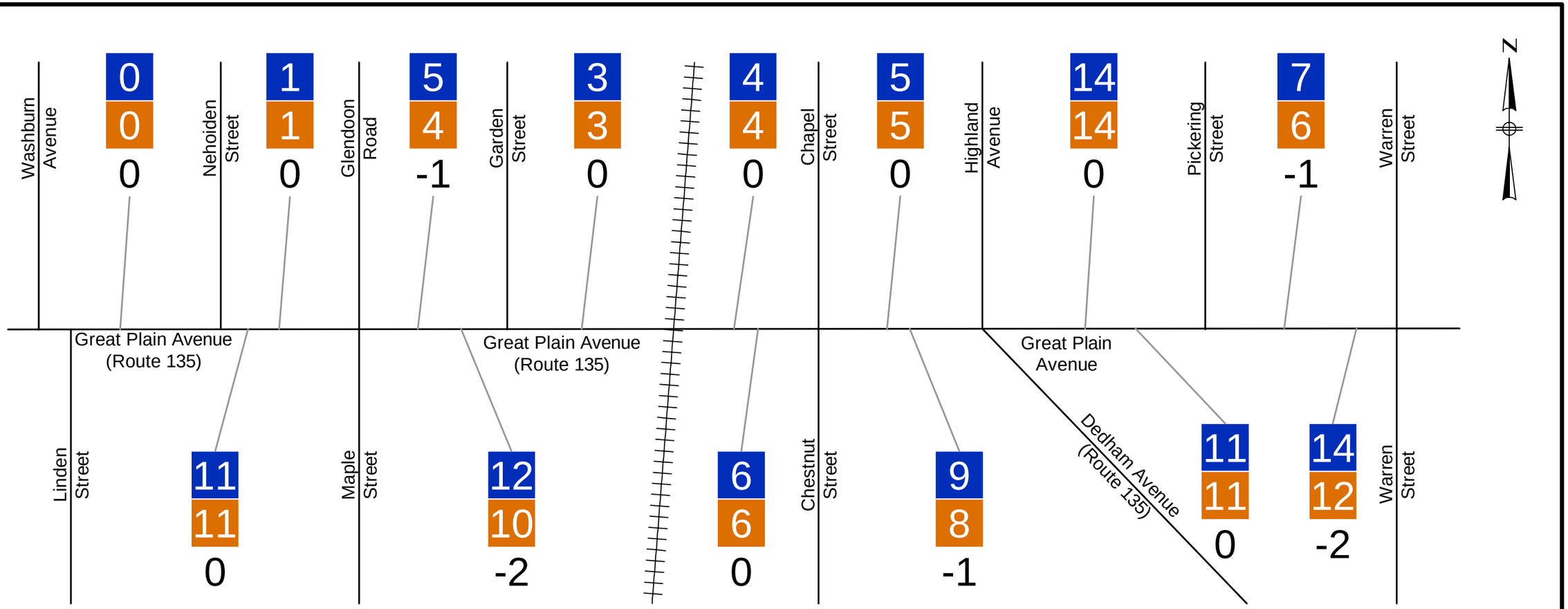
Afternoon Peak Hour

- Great Plain Avenue/Chestnut Street/Chapel Street: 20 second improvement (56 seconds to 36 seconds)
- Great Plain Avenue/Highland Avenue/Dedham Avenue: 25 second improvement (53 seconds to 28 seconds)
- Chestnut Street at Oak Street: 6 second improvement (25 seconds to 19 seconds)
- Chestnut Street at School Street: Delay would remain virtually unchanged

- Highland Avenue/Chapel Street/May Street: 5 second improvement (40 seconds to 35 seconds)

3.4 Traffic Recommendations

It is recommended that Alternative 6 - Combination of Alternatives 1, 2B, 3B, and 5 (improving signal phasing during railroad preemption, providing one coordinated group of signals for the 5 study intersections, changing the eastbound lane use on Great Plain Avenue, and reintroducing the left turn movement from Chapel Street onto Great Plain Avenue); be implemented by the Downtown Streetscape Project because it improves pedestrian safety, reduces vehicle delay and queues and permits an expansion of the existing sidewalk on the south side of Great Plain Avenue to the east of Dedham Avenue.



Total

102	Existing On-Street Parking Spaces
95	Proposed On-Street Parking Spaces
-7	On-Street Parking Space Reduction

LEGEND

1	Existing Number of On-Street Parking Spaces per Block
2	Proposed Number of On-Street Parking Spaces per Block
+/- #	Number of On-Street Spaces Gained/Lost per Block

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Downtown Streetscape Project
Needham, MA

Figure 3-12

Existing and Proposed On-Street Parking along Great Plain Avenue

4.0 STREETSCAPE

4.1 Existing Streetscape Elements

A photographic inventory was taken of existing streetscape elements on Chapel Street, Highland Avenue, Great Plain Avenue and Chestnut Street. The elements were then divided into the categories listed below and handed out to committee members (See Appendix D).

4.1.1 *Pavement*

Sidewalk pavements include concrete, exposed aggregate, colored stamped concrete in a brick pattern, stamped concrete in a bluestone pattern, concrete pavers, brick, granite pavers and asphalt. Detectable warning plates are concrete, granite or rubber. Two crosswalks are paved with granite pavers at the Town Common. The rest are designated by a painted line on both sides of the crosswalk, some are filled in with green paint.

4.1.2 *Site Furnishings*

Site Furnishings include benches, tables and chairs, trash receptacles, bike racks, drinking fountain, bollards, bollard and chain, fence/screen, gate, gateway arch, arbor/pergola, flag pole, planter, bus shelter, and art/sculpture.

4.1.3 *Street Lighting and Parking Meters*

Street lighting consists of cobra head street lights on aluminum poles, exposed aggregate poles and concrete poles and ornamental post top lights with banner arms on the posts. Parking meters are single meter on post, double meter on post, and single meter attached to ornamental light post.

4.1.4 *Street Tree Treatment*

Most trees are in mulched tree pits. Some trees have pavers in the tree pit and others have metal tree grates. There are a number of planters with trees that have granite curbing around them.

4.2 Existing Elements to Use in Streetscape Design

During the design process, existing elements were chosen to carry forward in the streetscape improvements. Reasons for choosing the elements are described under each category below. The following goals were considered when choosing elements (see Appendix E):

- Unifying the streetscape.
- Building on successful Chapel Street improvements.
- Building on existing elements that give Needham its unique character.

4.2.1 *Pavement*

4.2.1.1 Broom Finish Concrete and Exposed Aggregate Concrete

It was agreed that the main pedestrian zone of the sidewalks should be either broom finish concrete or exposed aggregate concrete. This is the pavement predominantly used in Downtown Needham today. Highland Avenue and Chestnut Street will have concrete with a broom finish. This will be a continuation of the broom swept concrete on Chapel Street. Exposed aggregate concrete will be used on Great Plain Avenue. The aggregate in

the concrete gives a softer, more natural color than a standard concrete. The aggregate would be lightly exposed to give a texture but not so much as to make the surface bumpy.

4.2.1.2 Stamped Concrete

Stamped Colored Concrete is currently used in a few locations to designate special areas and pedestrian connections. The first, at the archway on the north side of Great Plain Avenue (between the railroad and Chapel St.), is colored and stamped to look like brick. The second, at the north western part of Chapel Street, is stamped in a bluestone pattern. Pavement materials should not be used to look like other pavements but rather be used to appear as the material that they are. The existing stamped concrete that looks like brick has faded over time giving a more "fake" appearance. Concrete stamped in a bluestone pattern is a color natural to concrete and therefor more acceptable.

4.2.1.3 Concrete Pavers

Concrete pavers have been installed as an edging behind the curb on Chapel Street. It also denotes the site furnishing zone as it continues around light poles and planter bases. This is an element that the committee agreed to carry forward on Great Plain Avenue, Highland Avenue, Chestnut Avenue, Dedham Avenue, and Chapel Street. Concrete pavers will also be used instead of stamped concrete to designate special pedestrian connections that link to municipal parking, public places, and street crossings. A concrete paver formulated specifically for streets and vehicular loads would be used when in roadways.

4.2.1.4 Brick

Brick is used at the entry to the Town Hall addition and other small areas in the Town Common. They are in various patterns and in various stages of disrepair. The brick walkway patches in the Common will eventually be removed when the Common is improved. The brick at semicircular space at the Common on Great Plain Avenue will can be replaced with a unifying treatment in this streetscape design. The committee agreed that concrete pavers as a material are more consistent in shape than brick and the material would lend itself to a more even surface than other pavers.

4.2.1.5 Granite

Granite rectangular and square paving is on the sidewalk behind the Town Hall addition and extends to cross Highland Avenue and Chapel Street. The Town plans for the granite walkway to connect the train station with Green's Field. The granite crosswalks are heaving slightly and will be repaired under this project. The committee agreed to keep it as an important pavement relating to the Town Hall and Common and to use it sparingly as a unifying accent in special places such as the front of the Common and at gateways. Granite can also be used as markers or interpretive pavement inserts.

4.2.1.6 Asphalt

Asphalt is without aesthetic appeal for streetscape improvements in Downtown Needham and will not be used except for roadway surfaces.

4.2.1.7 Detectable Warning Plates

Detectable warning plates will be used at all crosswalks. Rubber varieties that exist on Great Plain Avenue will not be used because of their minimal longevity and tendency to fall apart before being replaced. Granite detectable warning plates like those found on

Chapel Street are desirable. However, the domes of the plates must be truncated to meet current ADA standards.

4.2.1.8 Crosswalks

Painted crosswalks, especially those with green paint infill will not be used because of their lack of aesthetic appeal and need to constantly be repainted. Crosswalks need to meet ADA criteria and be durable, maintainable, and visible to drivers. Material aesthetics and maintenance will need to be balanced. Concrete pavers will be the primary material. Pedestrians should feel safe crossing the streets. The use of pedestrian bump outs, widened handicap ramps, lighted bollards, increased street lighting, and a whole box crossing configuration for signalized intersections would all contribute to greater safety at crosswalks.

4.2.2 *Site Furnishings*

4.2.2.1 Benches and Trash Receptacles

Current benches and trash receptacles used as a standard for the Town of Needham are acceptable to carry forward into the streetscape design to maintain continuity. Other options can be considered that will strengthen the design. Important considerations are availability, durability, and the ornamental steel framework should have circular medallions as seen in the metal artwork found in Downtown Needham today.

4.2.2.2 Bike Rack

The bike rack type should comply with the recommendations of regional bicycle advocacy groups. The existing bike racks do not meet this standard and will not be carried forward in the design. Bike racks in single units are preferred with a frame that supports the bicycle on its frame and one or both wheels while keeping the wheels on the ground. The frame must be stable and have a permanent foundation securely anchored in the ground. Bike racks with optional decorative medallion features will add artistic interest and tie into the theme.

4.2.2.3 Bollards

There are only a few metal bollards located on the northwestern end of Chapel Street. Although these were acceptable to carry forward, other options may be considered. Lighted bollards at the crosswalk ramps would help make motorists aware of pedestrians at crossings and make ramps more visible to pedestrians.

4.2.2.4 Ornamental Metalwork

The ornamental metalwork found throughout Downtown Needham is an important artistic yet practical feature that gives Needham a unique identifying quality. All elements including; fencing, gates, gateway arches and sculptures (Examples are the Circle of Peace and Sit by Me sculptures by Gary Lee Price) are to be built upon in the streetscape design. The scrolling and circle/medallion feature found in the metalwork are shapes that can be used in other details of the streetscape design such as pavement inserts and patterns.

4.2.2.5 Flag Pole and Memorial

The flagpole and memorial are focal points in the Common and will remain but can be relocated slightly and updated to work with the new design. The memorial consists of two bronze plaques mounted on a brick wall at the back of the semicircular seating area.

The Committee thought that the memorial could be updated if it is being enhanced. The plan for Great Plain Avenue at the Town Common should be presented to the Historic Commission.

4.2.2.6 Drinking Fountain

The drinking fountain can be relocated to work with the new design but will first need to have its condition assessed before removing or relocating it. .

4.2.3 *Street Lighting and Parking Meters*

4.2.3.1 Street Lighting

All cobra head lights and poles (aluminum, exposed aggregate and concrete) will be removed because of their lack of aesthetic appeal, condition, height and close proximity to the back of the curb (making banner placement difficult). Existing acorn globe luminaire with an ornamental post currently on Chapel St., Chestnut Street and surrounding the Common will be carried forward. Posts can have banner or plant basket arms. Place banners on every other light post and where a particular banner is needed such as the bus stop or at parking lots. Plant baskets are desirable but first a maintenance plan and funding needs to be in place. Light posts will be placed to coincide with the parking layout; spaced every other parking space at 44' on center.

4.2.3.2 Parking Meters

Individual meters on posts can be problematic for snow plowing. Where possible, parking meters will be attached to the ornamental light posts as currently seen on Chapel Street. Single meters or double meters on individual posts will be used if light posts aren't available.

4.2.4 *Street Tree and Plant Treatment*

4.2.4.1 Street Trees

Currently there are many types of treatments at the base of trees including mulch, pavers, metal grates and granite curbed planters. Consensus is there needs to be a uniform solution. Pavers in tree pits are outdated and will often buckle making them non-compliant with ADA guidelines. Pavement buckling can be avoided if structural soil is used as a base under the sidewalk in tree areas. Structural soil should be used sparingly because of its cost. Trunk growth should be considered when using metal tree grates. Grates will be ADA compliant and set so that the grate openings do not fill up with debris. Grates are an opportunity to use decorative metal. Mulched beds will need to be maintained and sized adequately for the health of the tree. Curbed planters are an option if there is adequate room in the sidewalk. Curbed planters protect and define planted areas and are relatively easy to maintain.

4.2.4.2 Above Ground Planters

Planters add color to the streetscape and give seasonal and visual interest. They are however difficult to maintain and water. Funding, a maintenance plan and private/public coordination all need to be in place for planters to be successful. The material for the planter should be aesthetically pleasing and consistent within the downtown area. Pedestrian circulation is important to consider when placing them in the streetscape.

4.3 Unifying Elements and Inspirational Images (New Elements to Consider)

Collages of unifying elements and inspirational images were arranged on various sheets that were used as a visual design tool to assist in decision making and conveying design intent. Final sheets along with perspectives, street sections and illustrative plans become the preliminary design recommendations.

4.3.1 *Unifying Elements*

Unifying elements chosen to be carried forward in the streetscape design were then added to image sheets based the various element categories. Images of new elements were added to the sheets. The sheets and images were then modified throughout the design process and eventually narrowed down to the categories below. They were presented at the October 2013 merchants meeting.

4.3.1.1 Paving

Photos of pavers in combination with concrete were added to the unifying elements of exposed aggregate concrete, concrete, concrete paver edge, granite paver and detectable warning plates. Granite and concrete paving insets were displayed to show a potential layer of detail that can be unique to Needham. Examples of paving insets are; quotes, passages, street numbers and impressions. They can be interpretive to convey past or present uses, history or art. Paving insets can vary slightly to add subtle differences to blocks or streets in Downtown Needham (Figure 4-1).

4.3.1.2 Site Furnishings

Photos of kiosks, bike racks with medallion centers, trash receptacles with colorful inserts, decorative tree grates, ornamental metal tree fences and grates, umbrellas, tables and chairs at sidewalk bump outs and painted or film applied decorative screening for utility boxes were all site furnishing elements set amongst the existing bench, trash receptacle, fencing to carry forward. Subtle differences to the furnishings such as a change in a medallion or color of a trash insert can add interest yet still unify the streetscape (Figure 4-2).

4.3.1.3 Lights, Posts and Artistic Metalwork

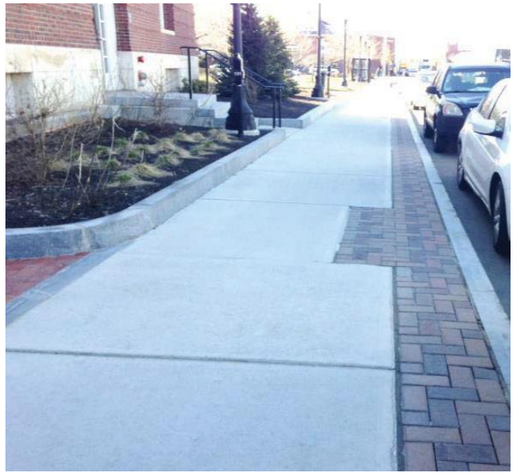
Photos of the ornamental lights, posts, parking meters, bollards and the artistic metalwork (discussed in previous sections) to be carried forward filled most of this sheet. A new addition was a lighted bollard that would blend in with existing bollards and light posts. Of note is the repetitive use of the circle motif seen in the decorative metal, site furnishings (trash receptacles, fencing and proposed bike rack). This motif can also be carried into the paving inserts and patterns. Subtle differences can still be obtained by varying the color of the decorative banding on the globe lights. Currently the globes at the Town Common are all gold while others are bronze or black (Figure 4-3).

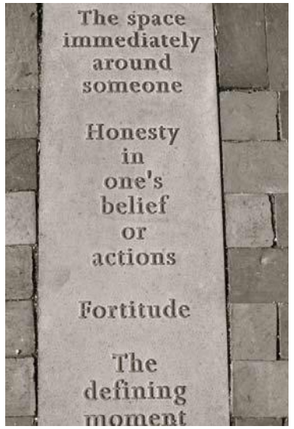
EXPOSED AGGREGATE

BROOM FINISH CONCRETE

DETECTABLE WARNING AREAS
TO HAVE TRUNCATED DOME

USE GRANITE PAVERS AS ACCENT





PAVEMENT MARKER PAVERS

SIGNAGE DURING CONSTRUCTION

CONCRETE ACCENT PAVERS IN
FEATURE AREAS

Repetitive Circle Detail

Existing Trash Receptical

EXISTING SEATING AREA

BRICK KIOSK WITH INTERPRETIVE
SIGN PANEL IN GARDINER, MAINE

RECEPTACLE WITH
COLORED LINER

EXAMPLE OF BIKE RACK WITH LOGO
BIKE RACKS TO MEET STANDARDS

PLANTERS TO DEFINE SEATING AREAS

NEEDHAM TOWN HALL -
KIOSK INSPIRATION

EXAMPLE OF TREE FENCE

TREE GRATES

PLANTERS

CONTROL CABINET WITH
APPLIED GRAPHICS

CONTROL CABINET WITH
PAINTED GRAPHICS

Needham Center Streetscape Improvements

Needham, Massachusetts

October ~ 2013

Site Furnishings

Figure 4-2

BETA ENGINEERING SUCCESS TOGETHER

EXISTING LIGHT

EXISTING PARKING METER
ATTACHED TO LIGHT POST

BOLLARDS WITH LIGHTS
AT CROSSWALKS

EXISTING BOLLARDS

REPETITIVE CIRCLE DETAIL

NEW RAILING AT TOWN HALL

LOGO IN
CIRCLE

GATE AT GREAT PLAIN AVE.

GATE AT TOWN HALL

4.3.2 *Inspirational Images*

Inspirational image sheets were made to spark conversation and ideas for new elements to enhance the streetscape and convey Needham's identity. Photos were gathered of various other streetscapes, crosswalk treatments, architecture elements, kiosks, painted screens for utility boxes, and parking signage and meters.

4.3.2.1 Streetscape Examples (other towns)

Photographs of streetscape examples from other towns were shown on the projector and in image sheets to give both inspiration and precedence to draw from. Some of the towns included Lexington MA, Wayland MA, Wellesley MA, Dedham MA, Carmel IN and a few malls such as Garden City in Cranston, RI and Legacy Place in Dedham MA (Figure 4-4).

4.3.2.2 Architectural Elements

Pergolas, arbors, shade structures, columns, gateways, were all shown in order to reveal the possibilities of incorporating architectural elements into the design at the Town Common/Great Plain Avenue edge and potentially for use at gateways to Downtown Needham (Figure 4-5). Images were shown of Town Hall features such as the cupola, brickwork, gates, railing and building addition with the intention of tying into these features in the new design. The use of architectural elements is discussed in the Town Common options.

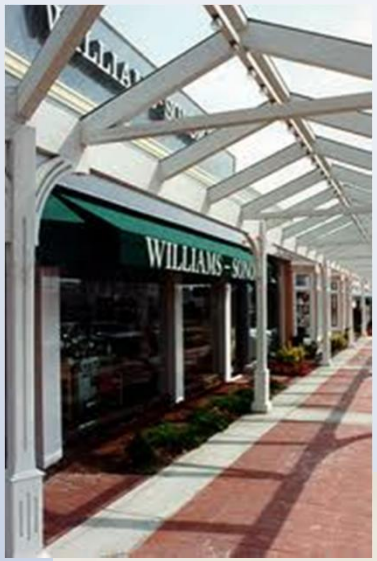
4.3.2.3 Way Finding/Kiosk

This sheet was made in response to the desire for better way finding to business locations once they are parked at the municipal parking lots. Kiosks are also a way to display community signs or events. Structures were shown in various materials such as brick and metal with forms including a domed shaped top reminiscent to the Town Hall cupola. Kiosks can be electronic or have cases for mounting the information (Figure 4-6).

4.3.2.4 Crosswalks

An image sheet for crosswalk materials and configurations (Figure 4-7) and options for the signalized intersections at Chapel St. and Highland Ave. with Great Plain Ave. were prepared (Figure 4-8). The image sheet displayed various ways to use pavers with contrasting colors to make the crosswalk highly visible to motorists and be aesthetically pleasing. An open box configuration allowing crossing at all angles and filled with concrete pavers in the entire box was chosen. This would reinforce the presence of the intersection by visually queuing the driver to be more aware and cautious. The two intersections are significant in terms of their high volume of use by both vehicles and pedestrians and their central location on either side of the Town Hall. An alternate for unifying treatment of Town Common block was shown (Figure 4-9).

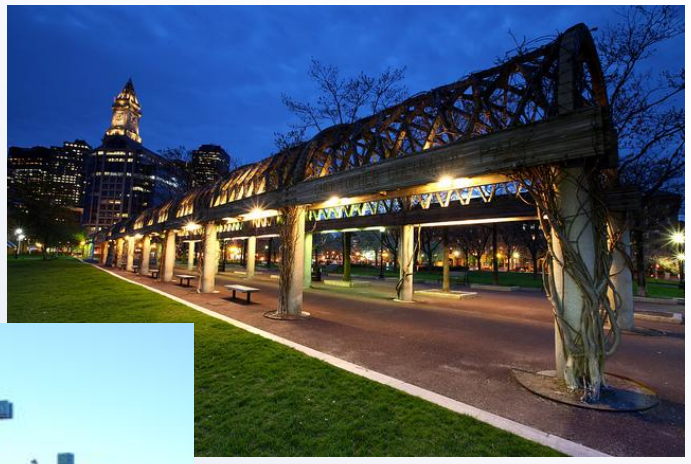
Examples to spark ideas.



BETA

Figure 4-4

Architecture



Custom Trellis

12' F-G-F TRELLIS

BETA

Figure 4-5

Way Finding

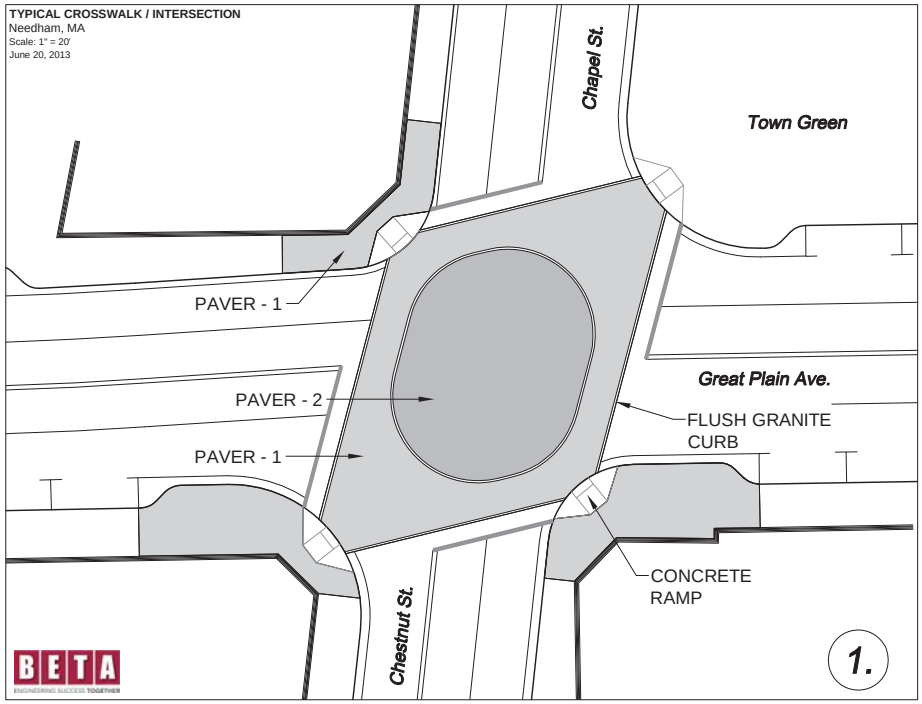
BETA

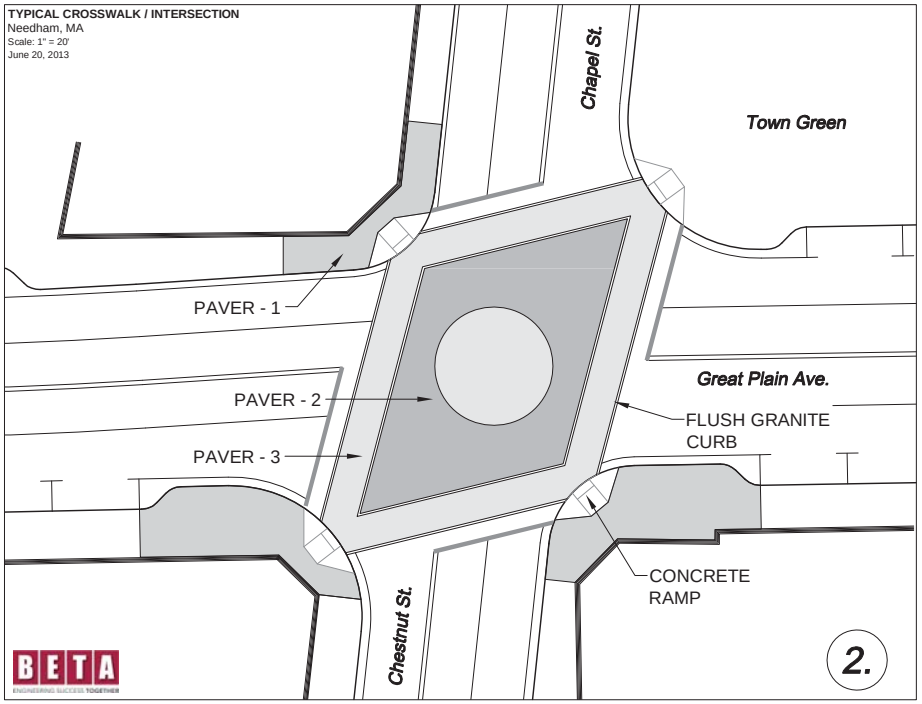
Figure 4-6

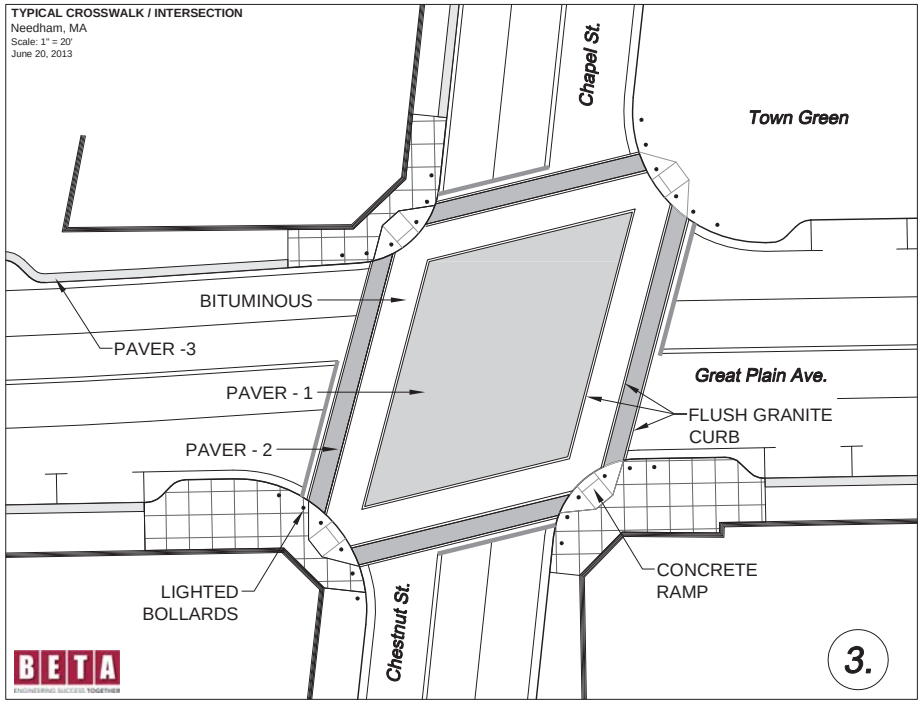
Contrast at Crosswalks

BETA

Figure 4-7


TYPICAL CROSSWALK / INTERSECTION
Needham, MA
Scale: 1" = 20'
June 20, 2013
Chapel St.
Town Green
PAVER - 1
Great Plain Ave.
PAVER - 2
FLUSH GRANITE CURB
PAVER - 1
CONCRETE RAMP
Chestnut St.
BETA
1.


TYPICAL CROSSWALK / INTERSECTION
Needham, MA
Scale: 1" = 20'
June 20, 2013
Chapel St.
Town Green
PAVER - 1
Great Plain Ave.
PAVER - 2
FLUSH GRANITE CURB
PAVER - 3
CONCRETE RAMP
Chestnut St.
BETA
2.


TYPICAL CROSSWALK / INTERSECTION
Needham, MA
Scale: 1" = 20'
June 20, 2013
Chapel St.
Town Green
BITUMINOUS
PAVER -3
Great Plain Ave.
PAVER - 1
FLUSH GRANITE CURB
PAVER - 2
LIGHTED BOLLARDS
CONCRETE RAMP
Chestnut St.
BETA
3.

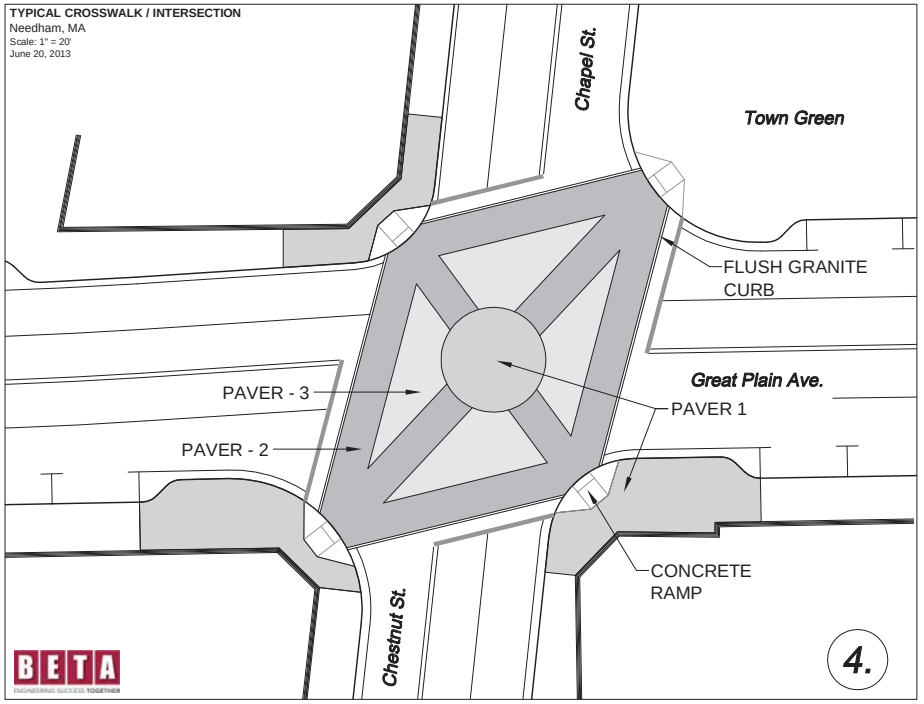

TYPICAL CROSSWALK / INTERSECTION
Needham, MA
Scale: 1" = 20'
June 20, 2013
Chapel St.
Town Green
FLUSH GRANITE CURB
Great Plain Ave.
PAVER - 3
PAVER 1
PAVER - 2
CONCRETE RAMP
Chestnut St.
BETA
4.

Figure 4-8

TYPICAL CROSSWALK / INTERSECTION
RAISED SECTION BETWEEN INTERSECTIONS
Needham, MA
Scale: 1" = 30'
June 20, 2013

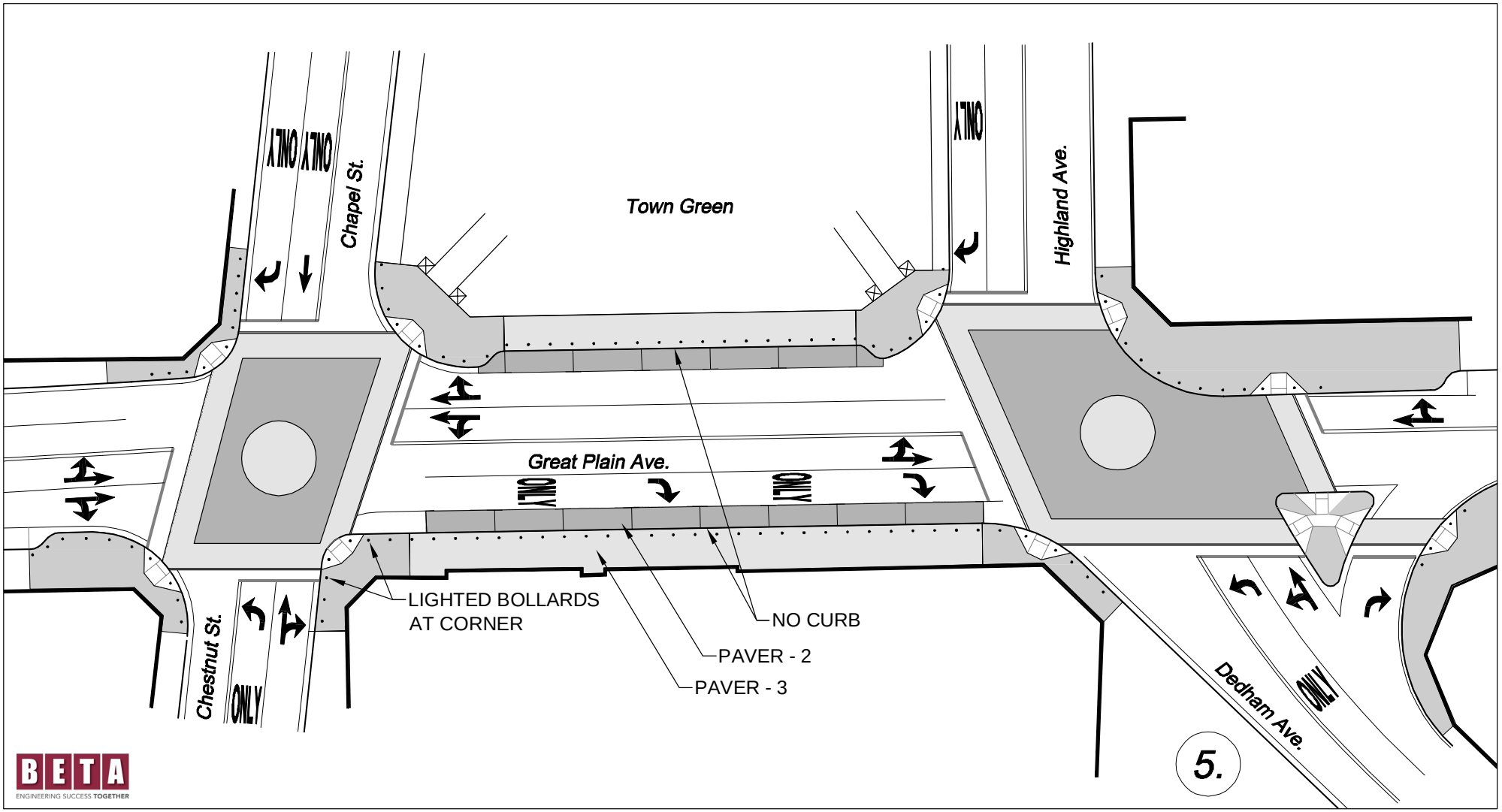


Figure 4-9

4.4 Improvement Alternatives

4.4.1 *Town Common*

Four options were presented for the Great Plain Avenue streetscape in front of the Town Common. This area was viewed the nucleus of the Downtown streetscape. Design goals were to unify the streetscape and create clear pedestrian circulation as well as seating places for the community. There were two important considerations: First was the interface between the Town Hall, the Common, and Great Plain Ave. Currently the street edge turns its back to the common.

The first three options have an open space that is open to both the street and the Common and visually unite Town Hall to the street. The second is the Town Common and streetscape relationship to the corner intersections. Option number four addresses the circulation between the Town Common and adjacent sidewalks. All options widen the sidewalk to accommodate more uses including the Memorial Day Parade ceremony at the flag pole and memorial (See Appendix E).

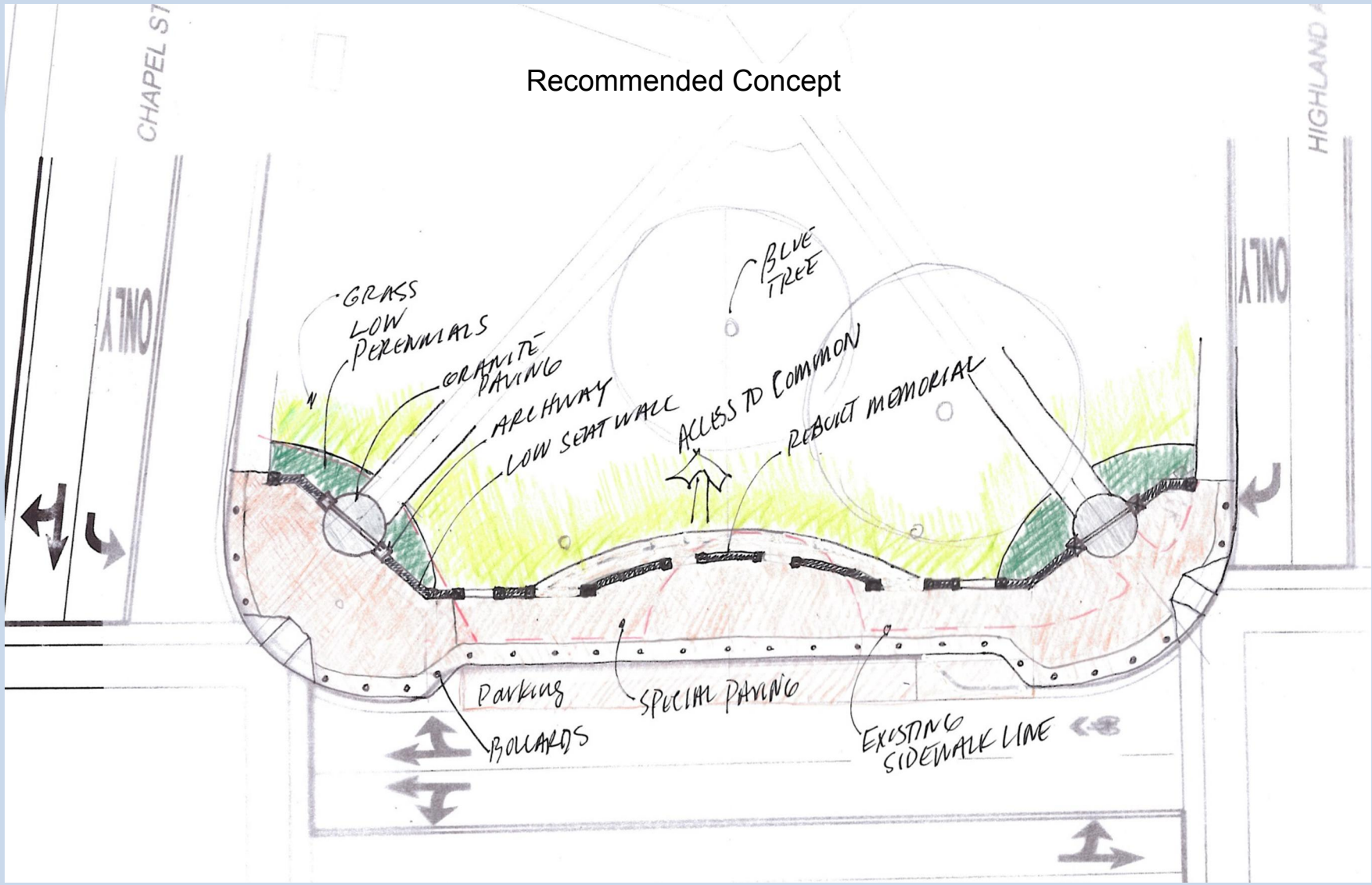
Option 1: Open sitting area and gathering space with tall acrylic panels as a focal point and work of art that draws inspiration from the Town Hall addition connection. Needham information can be etched on the panels. Gathering space has access to the Common and Great Plain Avenue with a low ornamental railing on either side as the edge to the sidewalk. Trees line Chapel St. and Highland Ave.

Option 2: Platform with steps for sitting can be used as gathering space, stage or as a sculpture platform.

Option 3: Trellis Structure (straight and curved alternatives) lined with benches and a gathering space in front of the trellis. An alternate is shown for keeping parking and one removes parking on Great Plain Ave. A community kiosk or sculpture is located at the corner entrances.

Option 4: Bump out areas at corners to create a place, and room for circulation. The two corners are important with regard to connections with crosswalks at Chapel Street/Great Plain Ave and Highland/Great Plain Ave. An archway at the corners reinforces entry to the Common. Options shown for keeping parking vs. remove parking on Great Plain Ave. Keep Existing semicircular wall with Plaques. Install lighted bollards at the bump out handicap ramps.

Recommended Concept: A combination of options 2 and 4 were selected with a few modifications; removing the stairs and platform, reducing the size of the gathering space, and keeping parking in front of the Common. An arc shaped seat wall was added to the gathering space with openings to the common, and the memorial updated and moved to the center of the arched wall (Figure 4-10). Perspective drawings of the concept were then developed (Figure 4-11).



Town Common at Great Plain Ave. Concept Sketch

Needham Center Streetscape Improvements

July 31, 2013

BETA ENGINEERING SUCCESS TOGETHER

Town of Needham Incorporated 1711

Figure 4-10

Perspective #1
Town Common at Great Plain Avenue

Needham Center
Needham, Massachusetts

Streetscape Improvements
October ~ 2013

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Perspective #2
Town Common at Great Plain Avenue

Needham Center
Needham, Massachusetts

Streetscape Improvements
October ~ 2013

BETA
ENGINEERING SUCCESS TOGETHER

Figure 4-11A

Town Common at Great Plain Avenue

Figure 4-11B

4.4.2 *Sidewalk Sections*

4.4.2.1 Sidewalk Zones

Typical sidewalk sections were drawn up that incorporated the recommendations from the design guidelines presented in the 2009 Needham Center Development Plan. The drawings applied the recommended sidewalk widths after the preliminary curb lines were set during the traffic portion of the study. Street sections were organized into the same three zones; the features/planting zone directly behind the curb, the pedestrian travel zone in the middle, and the building frontage zone at the back of the sidewalk or building edge. Widths of the sidewalks were 8', 10'-12', 13.5' and 15' or greater in some bump out areas at the intersections. The recommended 6' pedestrian travel zone width in the design guidelines could not be achieved at trees and lights in sidewalk areas under 11'. The minimum 3' clearance required by the 2010 guidelines was met and a minimum of 4' for the pedestrian zone was achieved on all of the sidewalks (See Figure 4-12 for up to 8 foot wide and 4-13 for greater than 8 foot wide).

4.4.2.2 Public/Private Property Partnership

There are a number of locations where the existing sidewalk is on both public and private property. New pavement will be provided to the back of the existing sidewalk to provide a safe, walkable surface and a unified, aesthetically pleasing streetscape. There are also a few locations on private property noted as areas of potential improvement. These are places where a seating area could be placed. In either case a partnership will be required between the owner and the Town of Needham. Public/private partnerships will be addressed in Preliminary Design.

4.4.3 *Sitting Areas*

4.4.3.1 Tables and chairs

Photograph examples were shown of seating areas located on the curb side of the sidewalk in Carmel IN and the "parklet" in Lexington MA. The committee liked the seating areas near the curb because the location is more in the public realm than when next to a building. Seating in the public realm is inviting to more people. Options were presented for seating at theater block on the south side of Great Plain Avenue between Dedham Ave and Pickering Street (Figure 4-14). The option with planters on the side and an ornamental fence facing the street was chosen. This same configuration was then applied to other blocks on Highland Avenue that had sufficient widths and in the vicinity of eating establishments. A similar configuration but with smaller café tables was located on Great Plain Avenue west of Chapel Street.

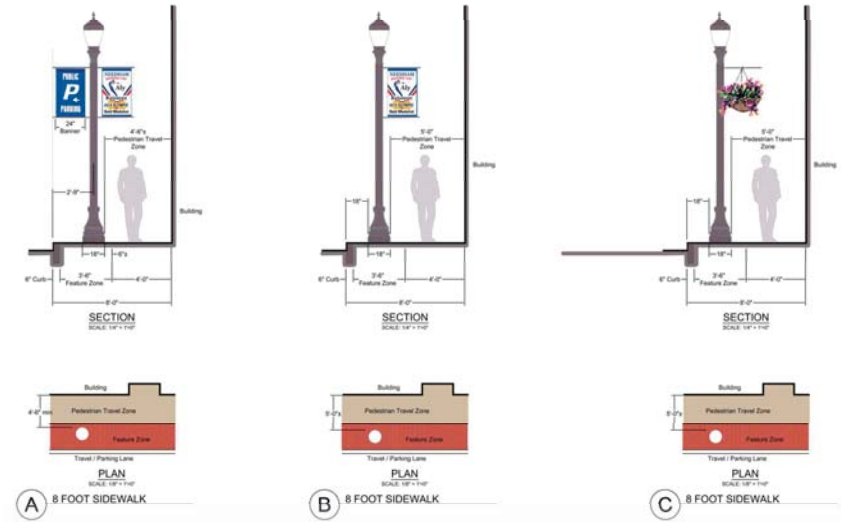
4.4.3.2 Planters with seat walls

Planters with granite curbing on the street side and seat walls on the sidewalk side were added to intersection bump out areas that had sufficient room. Their purpose is to make the streetscape aesthetically pleasing pedestrian friendly with the intention of promoting economic growth by attracting people to come to Needham Center (Figure 4-15). The shortened planter and bump out configuration shown on Perspective B-1 and B-2 were chosen on order to allow for more room for parking and loading. The sizes of the planters were adjusted to fit each individual location.

4.4.3.3 Railroad Crossing

The primary concern at the railroad crossing on Great Plain Avenue was safety. Curbed bump-outs were added along a clear zone where parking is not allowed. This shortens the

distance for pedestrians at the crosswalk and creates visual narrowing of the road to give a traffic calming effect. The crosswalk was placed on the west side of the tracks. The MBTA clear zone was kept clear of site furnishings and planting. Bollards and planters were placed at the ends of the bump-outs to direct pedestrians to cross at the crosswalk (Figure 4-16).


SECTION
PLAN
A 8 FOOT SIDEWALK
SECTION
PLAN
B 8 FOOT SIDEWALK
SECTION
PLAN
C 8 FOOT SIDEWALK

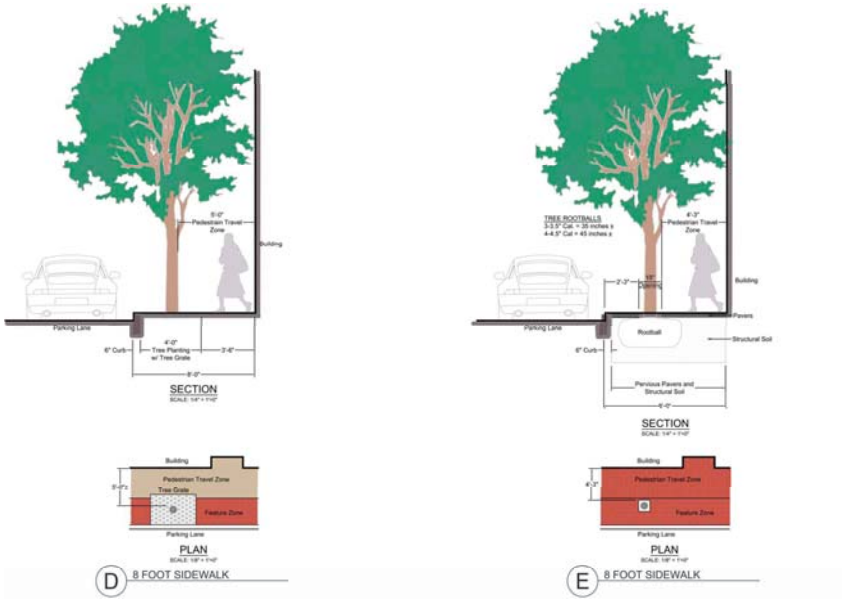
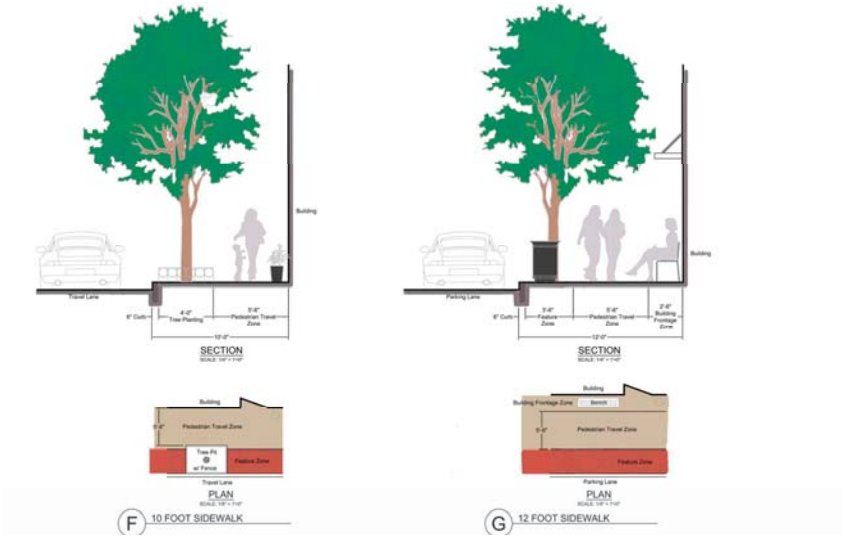

SECTION
PLAN
D 8 FOOT SIDEWALK
SECTION
PLAN
E 8 FOOT SIDEWALK

Figure 4-12


SECTION
PLAN
F 10 FOOT SIDEWALK
SECTION
PLAN
G 12 FOOT SIDEWALK

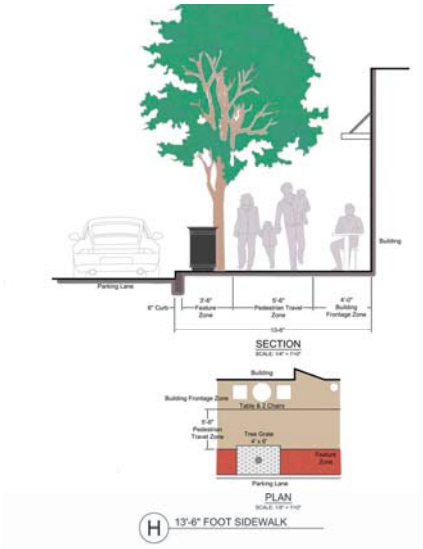

SECTION
PLAN
H 13'-6" FOOT SIDEWALK

Figure 13


Perspective A-1


Perspective A-2


Perspective A-3

Figure 4-14A


Perspective B-1


Perspective B-2


Perspective B-3


Perspective B-4

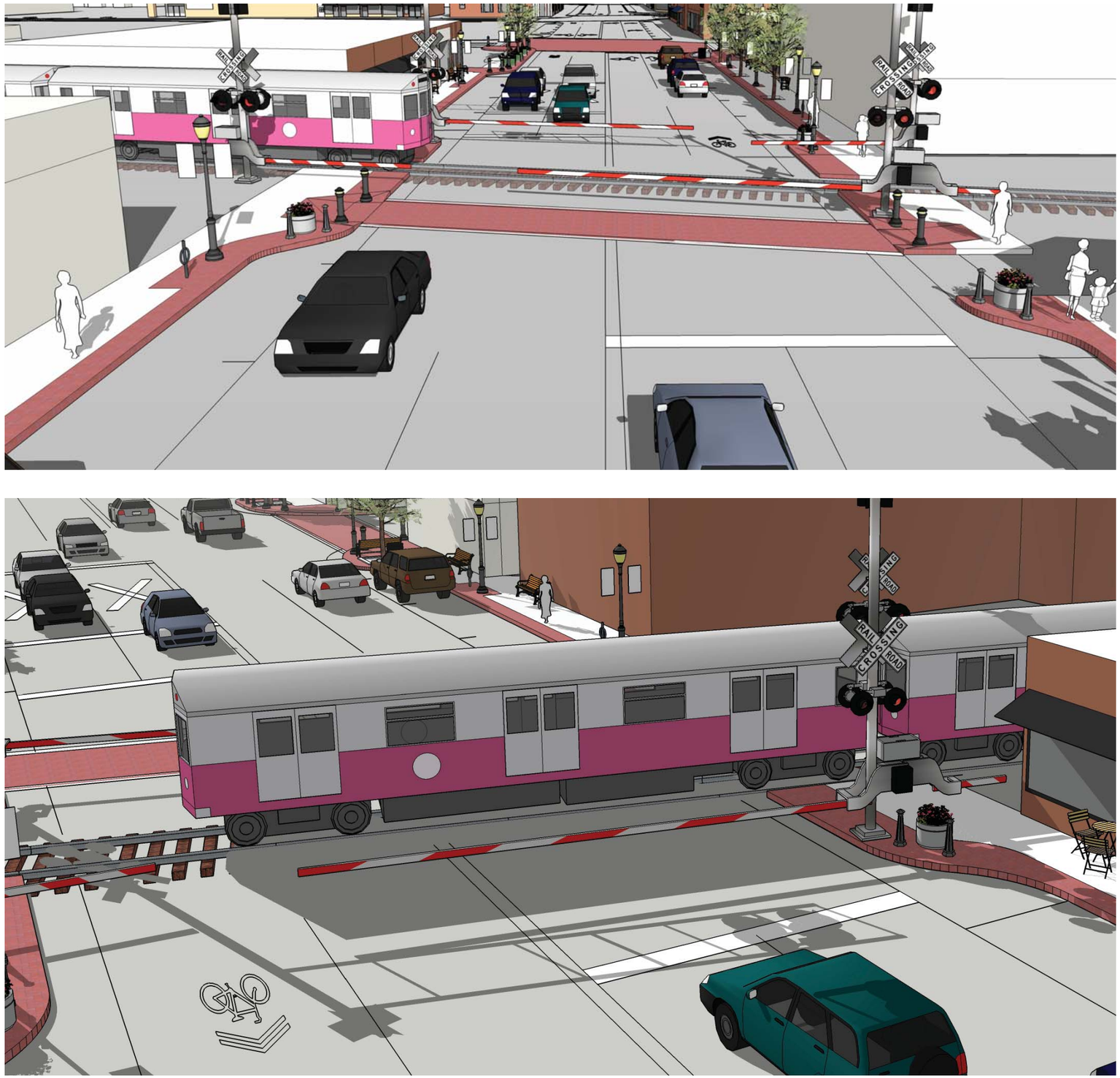


Figure 4-16

4.4.4 *Gateways*

Gateways fall into three different categories; First is a metal arch pedestrian connection to interior parking, Second is a brick column/metal arch entry to the Town Common at the Great Plain Avenue. The third is a brick column with accents a planter and seat walls to announce entry to Needham's commercial center on Great Plain Avenue and Chestnut Street. The concept for the gateways is to have a hierarchy of unified structures that vary in scale and complexity. The simplest is the pedestrian gateway and the more complex is Needham commercial center gateway.

4.4.4.1 Pedestrian Gateway Connection - Metal Arch

The new metal archways will match the existing one leading to the commuter rail parking lot. There is room for subtle design variations to mark their distinct locations. There are two proposed pedestrian gateways, one on Dedham Avenue by the First Parish Church and one on Great Plain Avenue near Pickering Street at the connection to the parking lot behind Santander Bank. There are two potential locations, one on Highland Avenue, next to the Santander Bank, and the other leading to Eaton Square just west of the railroad crossing. Both depend on the implementation of designs currently in planning.

4.4.4.2 Town Common Gateway - Brick Column with Metal Arch

The Town Common gateway has brick columns that draw from the brick in the Town Hall. The columns are topped with a metal archway similar to the design of the pedestrian gateway.

4.4.4.3 Needham Center Gateway - Brick Column with Planter Seat wall (Optional Metal Arch)

Needham Center gateways are located at either end of Great Plain Avenue, one at the corner of Pickering Street at Greene's Field and the other at Maple Street (See Figures 4-17, 4-18, and 4-19). The gateways are located at three intersections. The gateways are designed with columns on both sides of the road and planter seat walls attached to the column. Separate planters are across the side streets at the intersection to extend the visual appearance of "gateway". Crosswalks with concrete pavers further reinforce the gateway concept. The columns have the signage panels that can be electronic or cases that hold posters. The circle medallion with the Needham seal is built into the design. An optional archway can be extended across the road (See Figure 4-18) and lighting installed on the structure. The third gateway is on the east side of Chestnut Street on the corner of School Street. This is also the corner of the Public Safety Complex. The gateway is on the right side of the road as one enters the central business district. It also has a planter attached to a brick column but differs with a higher wall at the back of the planter. Letters spelling out "Needham Center" can be applied to the wall.


Town of Needham
Incorporated, 1711
dancing
with the NEEDHAM
stars
SATURDAY
JUNE
15TH
2013
Own Your Peace
CIRCLE OF HOPE

Figure 4-17

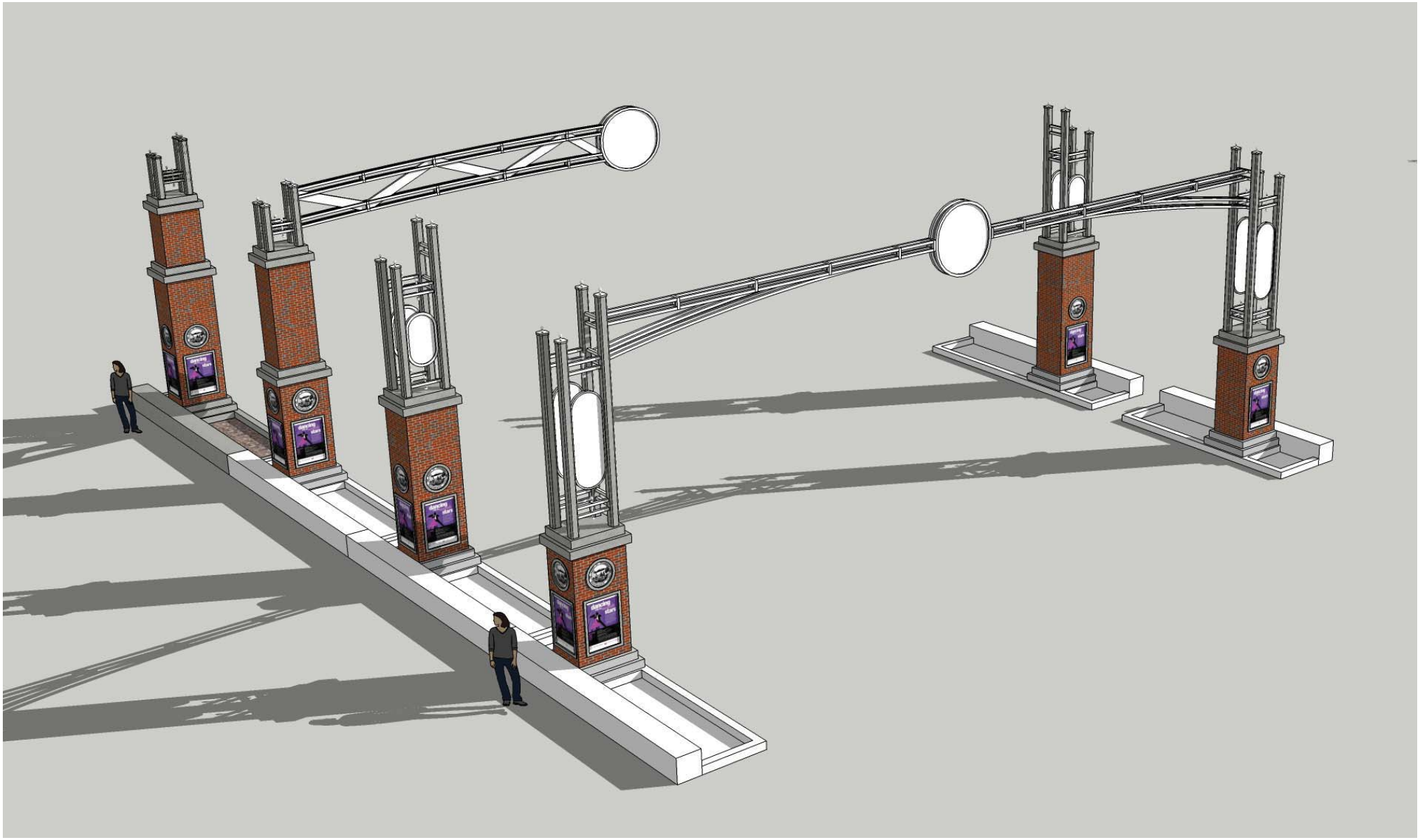


Figure 4-19

4.5 Conceptual Plans /Preliminary Design Recommendations

The purpose of the streetscape improvements is to promote economic growth by providing a safe, accessible, aesthetically pleasing and pedestrian friendly environment. The design intent is to create a sense of place that conveys Downtown Needham's unique identity. Recommendations for achieving this goal are visualized in the Conceptual Plans and renderings. They are discussed in the summary below. Further recommendations to be address in the Preliminary Design are also provided.

The Conceptual Plans are the result of the decisions and process described in sections: *4.2 Existing Elements to Use in Streetscape Design, 4.3. Unifying Elements and Inspirational Images, 4.4 Improvement Alternatives.* Plans encompassing Needham's central business district are divided into three sections according to the street name (Figures 4-20, Key Plan):

- Great Plain Avenue – From Washburn Avenue to Warren Street (Figure 4-21).
- Highland Avenue and Chapel Street –From South of May Street to Great Plain Avenue (Figure 4-25).
- Chestnut Street –From Oak Street to Great Plain Avenue (Figure 4-28).

4.5.1 *Great Plain Avenue*

Focal points are at the two gateways and at the Town Common. The sidewalk streetscape links the focal points together.

4.5.1.1 Downtown Needham Gateway - Gateways at Maple and Pickering Street intersections announce entry while calming traffic into Downtown Needham (Figures 4-22 and 4-24). Gateways introduce unifying design elements of brick and artistic metalwork in the design of columns. The brick columns will tie in with the Town Hall addition and the metalwork will tie in with the existing metal archway leading to the commuter rail parking lot off Great Plain Avenue (Figure 4-19). The Needham seal and an interchangeable community based sign are placed on the columns (Figure 4-17). Columns will have accent lighting. Adding fixtures on the columns to supplement street lighting will be looked into during the preliminary design. Granite curbed planters and seat walls are at the base of the columns and located at other corners of the intersection. Seat walls will have hand rails or a mechanism to prevent skate boarding. Possible materials such as wood bench seats on the granite wall will be looked into during the preliminary design. Plants in the planters will be low groundcovers/perennials or annuals. Planters without columns will also have upright flowering trees. Gateways will have concrete pavers with granite accents. Refer to section 4.4.4 for more gateway information.

4.5.1.2 Town Common –The sidewalk in front of the Town Common will be widened to a minimum of fourteen feet to improve circulation and provide space for community events such as the Memorial Day Parade. The curb along the parking spaces will have no reveal to allow for handicap accessibility along its entirety. The farthest space to the west will be designated as handicap parking. Bollards will be placed in pairs between the spaces where there are no light posts to provide an edge to the flush curb. Parking spaces will be paved with concrete pavers in a grey color to differ from the crosswalks. An arc shaped seating/gathering area will be centered on the sidewalk opening to both the Common and the street sides. The memorial will be updated and relocated with

the flagpole in the center of the space. Seat walls and planters will extend from both sides. Materials for the memorial (with bronze plaques) are brick and granite. The seat wall material will match the planter seat walls at the gateways. Optional tables (possibly chess) and chairs can be in the seating area. Low brick walls with an arched gateway will define the sidewalk corners and form a gateway to the common. The gateway will have a brick base with a metal arch to be designed in concert with the other gateways. The predominant pavement will be concrete pavers with granite highlights at the archways and seating area. The edging behind the curb will be either a grey paver or exposed aggregate concrete for contrast. A community Kiosk can be placed at one corner and a sculpture at the other. The sidewalk on the opposite side of Great Plain Avenue will receive the same treatment to unify the central block. The south side will also have street trees. The Town Common side is kept open to visually connect to the Town Hall.

4.5.1.3 Sidewalk Streetscape (Figures 4-22 to 4-24):

Paving-All sidewalks on Great Plain Avenue will be exposed aggregate with a concrete paver strip behind the curb that denotes the Feature Zone. Aggregate in the concrete will be a warm grey with beige tones from local sources and only lightly exposed. Concrete paver patterns and variations in color will be designed in the next phase of preliminary design. Widths of the pavers will vary according to the sidewalk width. Other sidewalk areas designed with concrete pavers are at gateways, intersection bump outs and municipal parking connections. Grading and drainage for sidewalks will be addressed in the preliminary design.

Lighting- Lighting will be even along the streetscape and more intense at the intersections and crosswalks. New acorn globe luminaires on ornamental posts, matching the existing lighting, will be installed forty four feet on center between every other parking space. Globes will have metal banding that can vary in finish. Traffic lights will also have globe fixtures on the post top. Multiple fixtures on light or traffic signal posts may be considered at intersections/crosswalks if necessary. Banner arms will be placed on alternate posts. Light source type will be addressed in the preliminary design.

Seating Areas- There are four types of seating on Great Plain Avenue (Section 4.4.3). A location for potential parklet has been added to the plan just west of Pickering Street. A parklet is a seasonal seating area placed in one or two parking spaces to allow supplemental outdoor space in the summer vacation months when not as much parking is required. The parklet can be designed to match seating area A below.

A. Umbrellas, tables and chairs with a planter/fence edge. The larger seating area is placed in the feature zone (Section 4.4.2).

B. Smaller café tables, some with a fenced edge and some with umbrellas. The smaller seating areas are placed in the feature zone or in the building zone.

C. Planters with bench seats. This configuration is placed at the gateways and intersection bump-outs.

D. Benches. Benches are placed mostly in the building zone.

Artwork/Pedestrian Gateways- Arched gateways are placed at pedestrian connections to the municipal parking areas. They will be designed to be similar to the existing gateway leading to the commuter rail line. Refer to section 4.4.4.1. Places for possible sidewalk sculpture are identified on the plan.

Crosswalks- Intersection will support safety in the crosswalk design. Bollards with lights will be placed on either side of pedestrian crossing ramps to accompany the street lights (higher intensity). The ramps will be elongated and dished with truncated dome detectable warning plates. Bump outs reduce the length of travel. Crosswalk material will be concrete pavers in a red color with white stop lines that contrast the asphalt pavement. Concrete pavers will be held in place with flush granite curbing at the outer edge. Crosswalks at the two Town Common Intersections will be in a box configuration.

Bicycle Accommodations- Dismounting/mounting areas are added on the bump outs at the two gateways where the dedicated bike lane becomes a sharrow. If the rider chooses not to use the sharrow, the rider can dismount and walk on the sidewalk. Bike racks accommodating two bikes each are located at the dismount areas and throughout each block of the streetscape.

Trees – Tree species will be addressed in the preliminary design. Trees will be upright in form and care will be taken not to obstruct business signs. The designer will coordinate with the town arborist in tree selection. The base (tree pit) treatment will vary according to the widths of the sidewalks. Structural soil will be installed as a base in critical areas to ensure the survivability of the tree.

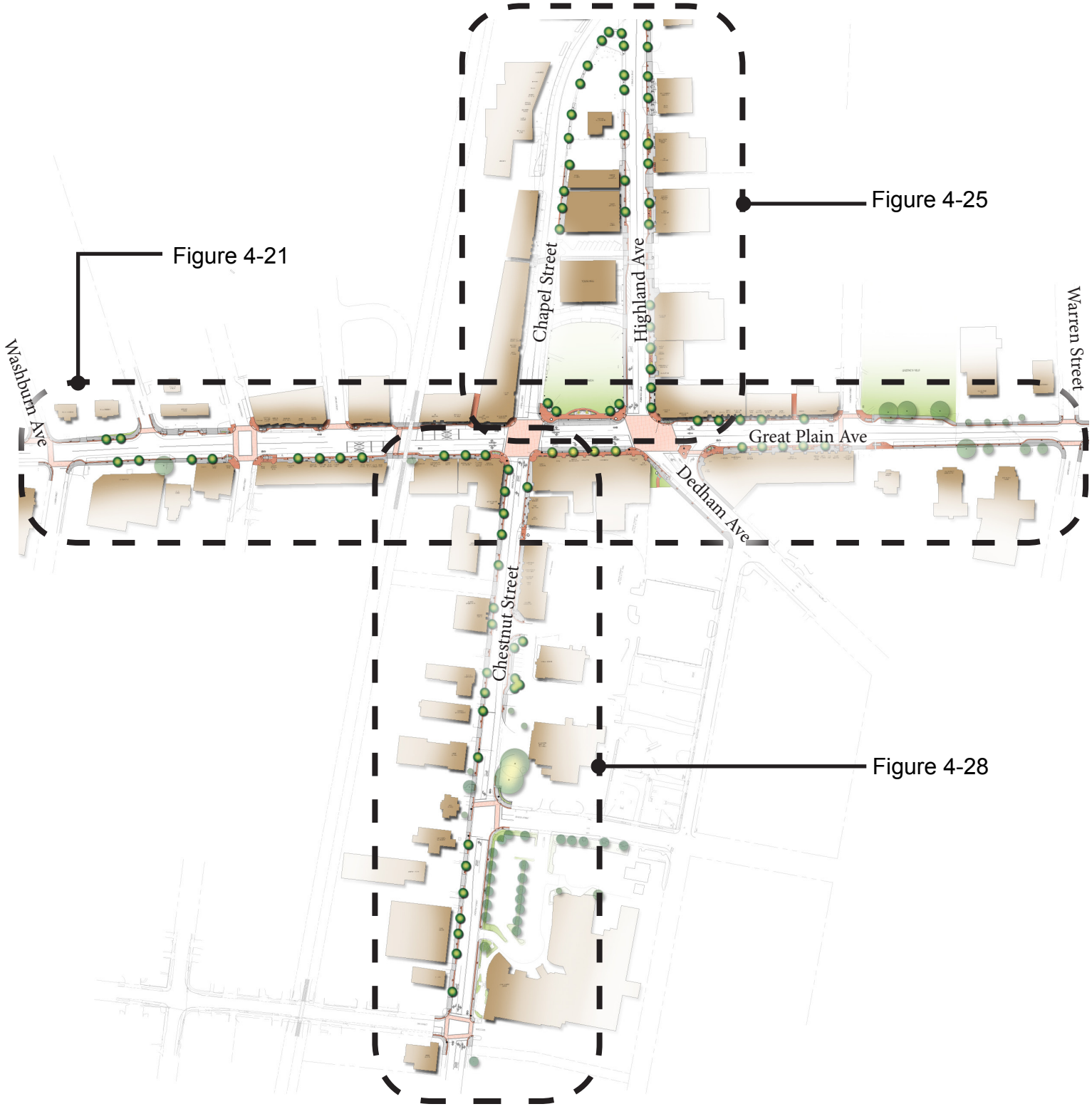
4.5.2 *Highland Avenue and Chapel Street*

Sidewalk Improvements (Figures 4-26 and 4-27) on Highland Avenue will be similar to Great Plain Avenue. Three smaller seating areas with planters and fencing are spaced along the feature zone on the east side of the street as sidewalk widths permit. Benches are placed in the building zone. Curbed planters with benches are placed where the sidewalk widens across from the service center. Curbed planters with trees are placed at the edge of the Walgreen parking lot to reinforce the street edge and add relief to the pavement. The granite walkway is continued across Highland Ave to be coordinated with the parking lot improvements at Walgreens and extend to Green's Field. Concrete finish is broom swept to match Chapel Street. The northeast corner of Highland Avenue and Great Plain Avenue will need to be coordinated in the future with a potential pedestrian way if vehicular access is removed from behind Santander Bank. This would allow the parking to shift away from the busy intersection and allow for a larger bump-out area.

Improvements on Chapel Street will begin north of the Town Hall parking lot. Sidewalk design will be the same as Chestnut Street. The area at the service center does not have sidewalks; however the current treatment at the nose of Chapel St. and Highland Ave. will be continued down to meet the sidewalk. The current treatment is a three foot plus/minus town maintained planting strip at the back of the curb. Street trees and ornamental lights will be added along this strip. The current granite crosswalk will be reset. Brick columns will be installed, according to previous plans, in front of the Chapel Street parking lot.

4.5.3 *Chestnut Street*

Chestnut Street illustrations are shown on Figures 4-29 and 4-30. A gateway focal point is at the northwest corner of School Street. This point is significant because of future plans to improve the public safety complex and parking within the block of Chestnut Street, School Street, and Lincoln Street. The exact location and design will need to be coordinated with future public safety complex plans and a proposed police and fire monument. The gateway concept is similar to the two on Great Plain Ave. except that it will not extend across the intersection because of space limitations. The sidewalk streetscape will follow the same design as on Great Plain Avenue (Section 4.5.1.3). The grass strip will be removed and sidewalks widened to eight feet where possible. Pavers will line the curb at the feature zone however; concrete paving will be broom finish to match new sidewalks south of Marsh Road. Sidewalk paving will extend across driveways for continuity. Light spacing will be further apart where there is no on street parking.



Key Plan

Needham, Massachusetts

Figure 4-20

Scale: N.T.S.

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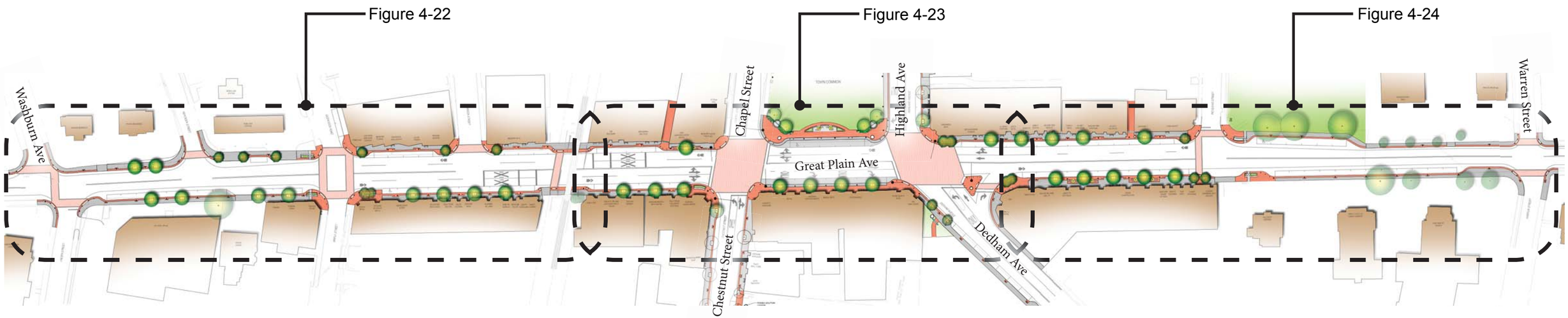

Great Plain Ave

Needham, Massachusetts

Figure 4-21

Scale: N.T.S.

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Great Plain Ave

Needham, Massachusetts

Figure 4-22

Scale: 1” = 40’-0”

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Great Plain Ave

Needham, Massachusetts

Figure 4-23

Scale: 1” = 40’-0”

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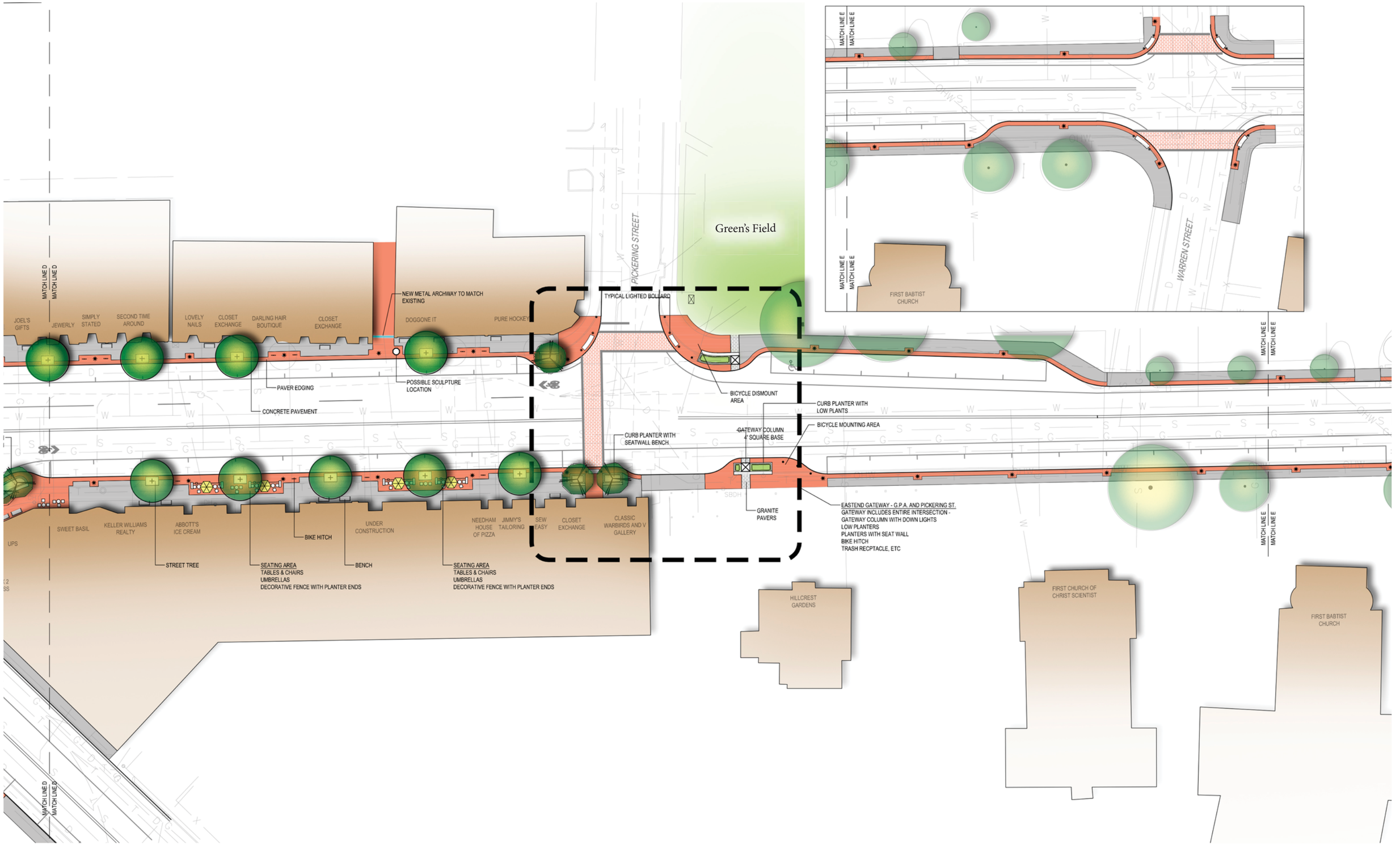

Great Plain Ave

Needham, Massachusetts

Figure 4-24

Scale: 1" = 40'-0"

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Highland Ave

Needham, Massachusetts

Figure 4-25

Scale: N.T.S.

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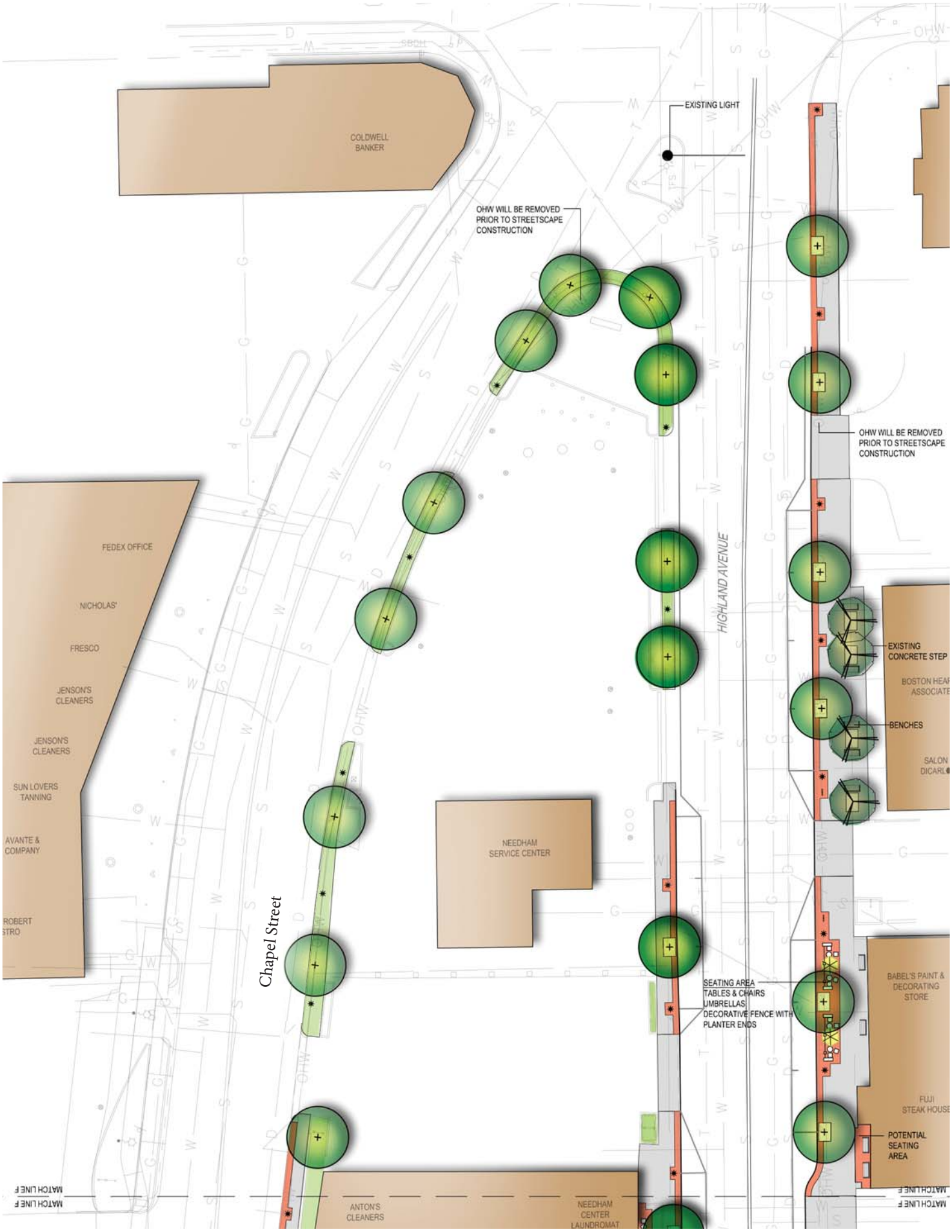

Highland Ave

Needham, Massachusetts

Figure 4-26

Scale: 1" = 40'-0"

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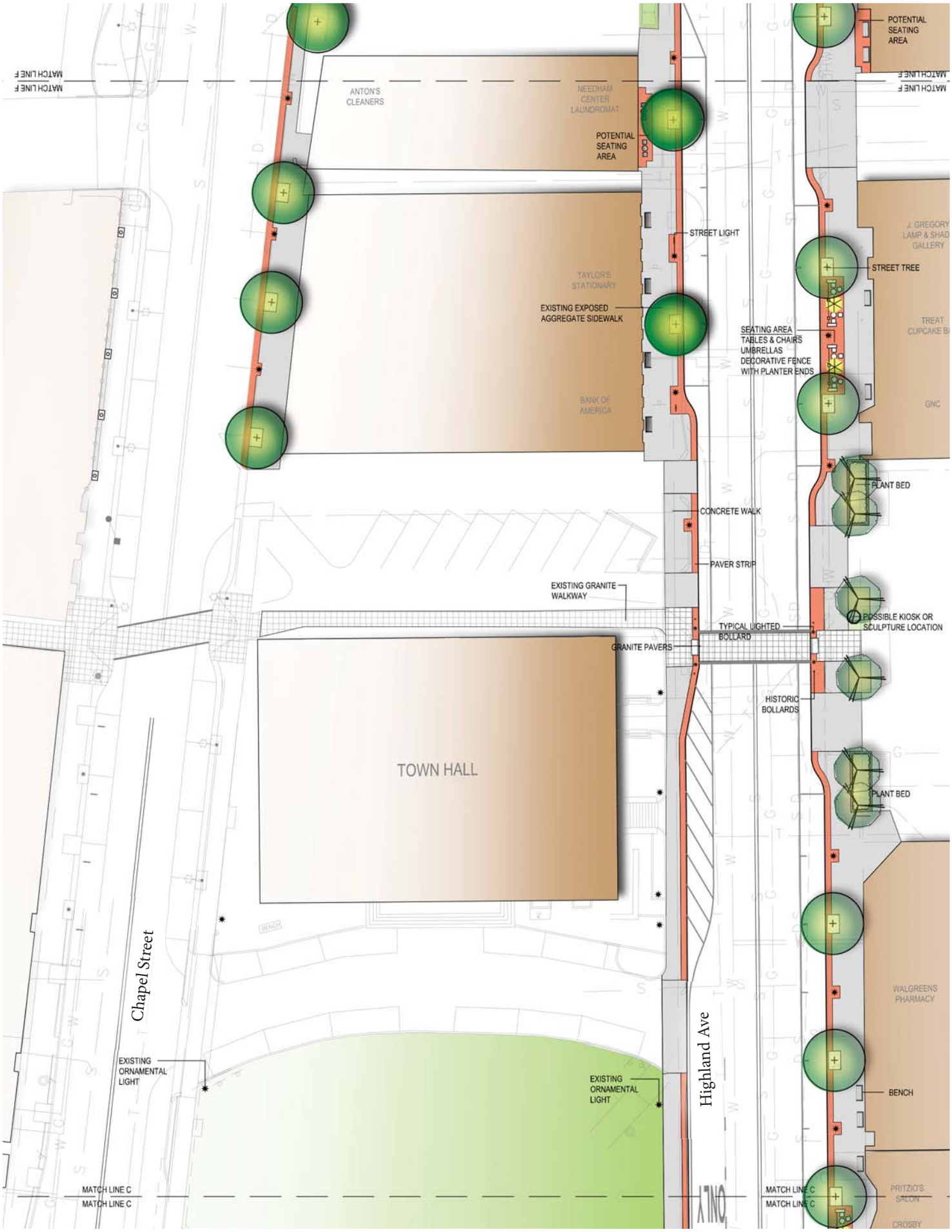

Highland Ave

Needham, Massachusetts

Figure 4-27

Scale: 1” = 40’-0”

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Figure 4-29

Figure 4-30

Chestnut Street

Needham, Massachusetts

Figure 4-28

Scale: N.T.S.

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Great Plain Ave

Needham, Massachusetts

Figure 4-29

Scale: 1” = 40’-0”

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Great Plain Ave

Needham, Massachusetts

Figure 4-30

Scale: 1” = 40’-0”

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APPENDIX A

Traffic Volume Data

APPENDIX B

Intersection Crash Data

APPENDIX C

Existing Streetscape Elements Inventory

APPENDIX D

Existing Elements Study

APPENDIX E

Town Common Options

APPENDIX F

Downtown Streetscape Committee Meeting Minutes

APPENDIX G

Traffic Analysis Output