



## Downtown Traffic Study

City of Brockton, Massachusetts  
May 2020



## Prepared for:

City of Brockton  
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## Executive Summary

For several decades, the City of Brockton has been seeking to reintroduce two-way traffic circulation by converting several major one-way corridors to two-way in the Downtown area. Previous studies have been conducted that outline proposed modifications to the existing transportation network. This Study serves as an updated analysis of the 1999 and 2007 Downtown Brockton Traffic Studies, aiming to recommend the implementation of an optimal two-way street network, while additionally proposing improved transit, bicycle, and pedestrian facilities. Contained in this report are an analysis of the existing conditions of the downtown network using present day traffic volume data, and an analysis of the recommended two-way street network, taking into consideration increased traffic volumes due to background growth and potential traffic-generating future developments.

The study area consists of approximately 0.12 square miles, located in downtown Brockton, roughly contained by Spring Street and Court Street to the north, Warren Avenue to the west, Belmont Street and Crescent Street to the south, and Commercial Street to the east. Many of the streets in the Downtown area currently serve one-way traffic, most notably the north/south pair of Main Street and Warren Avenue. Several east/west streets currently serve one-way operations as well.

An extensive data collection process was undertaken to gather existing traffic volumes, existing roadway conditions, and historical intersection crash records. BSC was also contracted in a separate study to perform an extensive survey of the Downtown area to determine available right-of-way for each street. This survey work has been completed, and layout plans have been prepared for the streets.

Several alternatives were considered for the two-way street network modifications, while alternatives were also considered for the design of individual Downtown roadways. The proposed two-way conversion alternative aligns with the recommendations provided in the 1999 and 2007 Downtown Traffic Studies, where Main Street and Warren Avenue will be converted to serve north/south traffic, while several one-way east/west streets will also be converted to serve two-way traffic, including West Elm Street, Belmont Street, Spring Street, and Petronelli Way. Three design alternatives were considered for Main Street and Legion Parkway, which took into consideration varying on-street parking configurations and pedestrian improvements. The proposed Main Street design improves pedestrian and bicycle infrastructure and removes the majority of on-street parking, while the proposed Legion Parkway design retains almost all existing parking and also improves infrastructure for pedestrians and bicyclists.

To perform a thorough traffic analysis, existing traffic volumes were projected to a 20-year planning horizon to account for future background growth. Furthermore, data provided in the Institute of Transportation Engineers (ITE) Trip Generation Manual was used to estimate anticipated trip generation resulting from proposed future downtown developments. Future traffic volumes were distributed across the proposed roadway network based on distribution methods used in the 2007 Traffic Study and trends in the 2018 existing volume data. A traffic model was developed for the proposed two-way system, which revealed that study area intersections will operate at acceptable levels of service during the morning and evening peak hour traffic periods.

The proposed Downtown improvements are recommended to be completed in three phases, beginning with the two-way conversion and roadway modifications of Main Street, West Elm Street, Belmont Street, Spring Street, and Legion Parkway. Improvements to intersections of Warren Avenue with West Elm Street, Belmont Street, Spring Street, and Legion Parkway should be included in Phase 1 as well. Further, Warren Avenue improvements are recommended to be completed in Phase 2, followed by the additional improvements in Phase 3. Project cost estimates have been broken down for each phase. The estimated total



cost of the project completion is 38 million dollars, including roadway reconstruction, utility upgrades, traffic signal improvements, and streetscape enhancements.

The proposed two-way conversion project will involve updated traffic signals with pedestrian timings and adaptive signal technology to improve traffic operations, emergency vehicle pre-emption, and BAT bus transit priority, as well as provisions for protected bike lanes, where possible. The major infrastructure upgrades, supported by the latest technology, will result in improved public safety for all users and will contribute towards the revitalization of the Downtown area for years to come. Based on the findings of this Study, it is recommended that the proposed two-way street system be implemented in Downtown Brockton.

# 1 Introduction

In 1974, the City of Brockton implemented a street network consisting of one-way streets in the Downtown area. The goal of the one-way network was to minimize congestion by getting vehicles through the area quickly and efficiently. While the one-way network achieved this goal, it also encouraged higher vehicle speeds, raising the potential for more crashes. Driver confusion navigating the one-way street network in some cases led to drivers avoiding Downtown altogether, adversely affecting retail operations in the area. Today, cities have begun to strive towards creating a network of “Complete Streets” in urban areas, that promote pedestrian and bicycle travel as much or more so than vehicular travel. Complete Streets improve safety for all users and supports retail expansion. While excessive congestion is not ideal, many urban planners view a slightly congested Downtown area as a sign of a healthy urban environment and increased interaction with Downtown businesses. Incorporating a two-way network with facilities for biking, walking, and public transit will ultimately have a positive effect on the ongoing revitalization efforts on the Downtown area.

## 1.1. Project Background

The City of Brockton has been seeking to modify the Downtown area street network to accommodate more two-way travel for several decades, and previous studies have been prepared to support proposed changes to the existing network. BSC has prepared this report as an updated analysis of the 1999 and 2007 Downtown Brockton Traffic Studies. These studies have identified an optimal two-way street network conversion. The goal of this Study is to provide recommendations for the implementation of this two-way street network, develop a new Downtown traffic model using updated traffic and other relevant data, and propose conceptual designs of Downtown roadways using Complete Streets principles to propose improved transit, bicycle, and pedestrian facilities.

Contained in this report are an analysis of the existing conditions of the Downtown network using present day traffic volume data, and an analysis of the recommended two-way street network, taking into consideration increased traffic volumes due to background growth and potential trips generated by future developments.

The current roadway network consists of a system of one-way and two-way roadways, creating many circuitous travel routes throughout Downtown Brockton. This study proposes to convert several of the one-way streets into two-way streets, creating more direct routes to distribute traffic through Downtown Brockton and to/from points within the Downtown. There are also minimal bicycle facilities within the Downtown area. In line with current MassDOT requirements, the Study recommends separated bike lanes where feasible, as well as an expansion of the bicycle network in Downtown Brockton. The bicycle lanes will consist of physically separated and protected lanes or marked lanes adjacent to vehicular travel, depending upon right-of-way and on-street parking constraints. Where bike lanes are not provided, shared lane markings, sharrows, will be proposed.

The Study also considers future development throughout Brockton. There are numerous planned developments in the City center including the addition of residential units, retail and office space, and structured parking that will accommodate the future needs of the area.

## 1.2. Study Process

### Review of Previous Downtown Traffic Studies

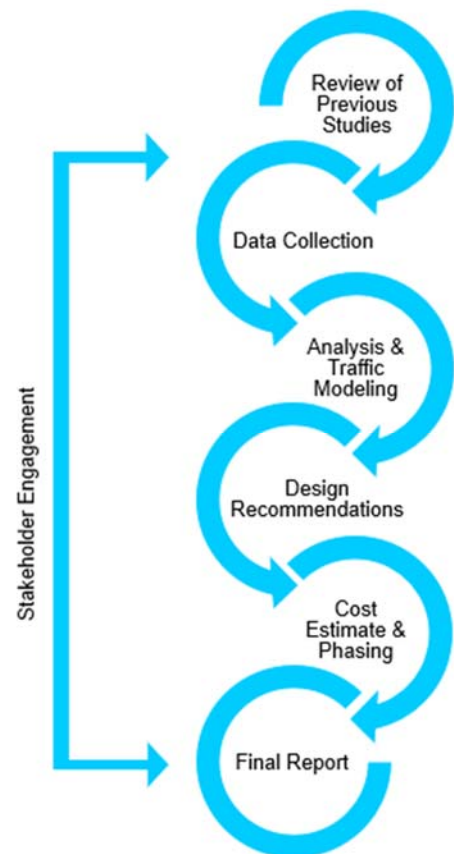
This Downtown Traffic Study began by reviewing previous iterations of Brockton Downtown Traffic Studies conducted in 1999<sup>1</sup> and 2007<sup>2</sup>. These studies explored the feasibility of reintroducing two-way operations to the Downtown. The original 1999 report concluded that returning to a two-way street network is desirable to provide better access to Downtown businesses while maintaining an acceptable level of service through the Downtown. The 2007 study provided an updated analysis and confirmed the findings of the previous report.

### Stakeholder Engagement

Several groups of stakeholders were consulted during the course of the Study, all of whom provided input and that was included in the final report and recommendations. Stakeholders were met with individually, as well as in group settings, in which BSC presented the project status and received important feedback and comments which were considered in the design of protected bike lanes, pedestrian space, on-street parking, bus stop locations, and more.

A project kick-off meeting with stakeholders was held in September 2018, followed by project update meetings in January, April, and May of 2019. A public meeting was conducted in September of 2019, in which residents were given the chance to express their thoughts about the project. Numerous meetings were also held with individual stakeholder groups included in the list presented below.

- City of Brockton (COB)
  - COB Planning Department (Lead Agency)
  - COB Engineers
  - COB Ward Councilors & Representatives
- Old Colony Planning Council (OCPC)
- Massachusetts Department of Transportation (MassDOT)
- Brockton Area Transit (BAT)
- Brockton Police Department
- Brockton Fire Department
- Brockton Parking Authority
- Metro South Chamber of Commerce
- ADA Community
- Local Business Owners and Brockton Residents



### Data Collection

In tandem with stakeholder engagement, a thorough data collection process was carried out, which included gathering the following:

<sup>1</sup> *Brockton Central Area Traffic Study*, Old Colony Planning Council & Rizzo Associates, Inc. July 1999.

<sup>2</sup> *Downtown Brockton Traffic Study Update*, Parsons Brinckerhoff. October 2007.



- Traffic volume data, including intersection vehicle turning movement counts and pedestrian and bicycle volumes
- Field measurements and observations of traffic operations
- Intersection crash history
- Survey work to establish roadway right-of-way\*

\*BSC was contracted by the City of Brockton in a parallel effort to establish the right-of-way of each roadway in the study area. The exact study area was determined based on previous studies and discussions with OCPC and the City.

### **Analysis & Traffic Modelling**

Upon the completion of the data collection process, a traffic model was constructed to analyze peak hour traffic patterns under several conditions, including present/future years and existing/proposed circulation. The results of the analysis and simulations were presented to stakeholders and revised to incorporate their feedback.

### **Design Recommendations**

Results from the traffic modelling process and input from the various groups of stakeholders informed the proposed Downtown traffic circulation and conceptual design. These recommendations are discussed at length in Section 3.4 of this report.

### **Cost Estimate & Phasing**

A sequence of phasing was established to implement the proposed two-way conversion, taking into account traffic impacts, safety, and cost. A cost estimate broken down by each phase has been provided.

## 2 Existing Conditions

### 2.1. Study Area Overview

The Downtown Brockton study area, shown in Figure 1, consists of approximately 0.12 square miles and nearly 5 linear miles of roadway, and is roughly bounded by Spring Street and Court Street to the north, Warren Avenue to the west, Belmont Street and Crescent Street to the south, and Commercial Street to the east.

Many of the streets in the study area currently serve one-way traffic. The most notable of these one-way streets are Warren Avenue in the southbound direction and Main Street in the northbound direction. There are several pairs of one-way streets serving eastbound/westbound traffic through the study area, including Belmont Street and Crescent Street (two lanes eastbound) and School Street and Frederick Douglass Avenue (two lanes westbound). West Elm Street serves one lane eastbound. Additionally, Petronelli Way and Green Street serve one lane of westbound traffic, and Franklin Street serves one lane of eastbound traffic.

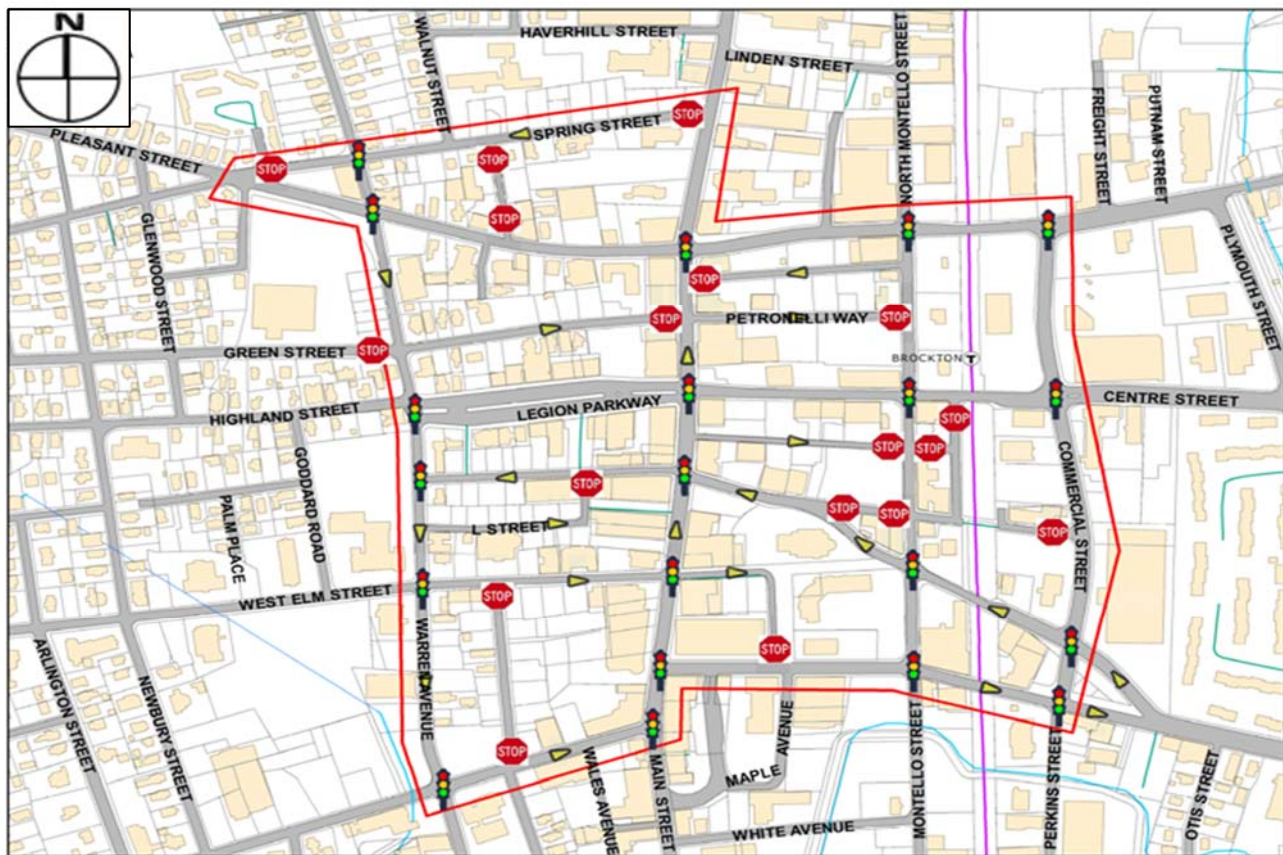


Figure 1: Downtown Study Area

Public transit in the Downtown area is provided by the Massachusetts Bay Transit Authority (MBTA) and the Brockton Area Transit (BAT) bus system. The MBTA commuter rail runs north/south through the study area, creating four railroad arch bridge underpasses on Court Street, Centre Street, School Street, and Crescent Street. The Crescent Street underpass is 15.5 feet at its highest point while the other three underpasses provide 14 feet or less in clearance, impinging on circulation and truck access. The undersides of these arch bridges bear marks from vehicle strikes due to the low clearance. The BAT bus system has

many stops within the Downtown area and is an important mode of transportation for many Brockton residents. Due to the existing one-way system, buses are routed through the Downtown in a circuitous manner.

## 2.2. Existing Roadway Conditions

Field measurements and observations were made to develop an understanding of the existing roadway configurations. Several key roads within the study area are discussed below. A complete inventory of the characteristics of the existing streets in the study area is presented in Table 1.

### Main Street

Main Street was analyzed between Belmont Street and Pleasant Street. This section of Main Street consists of two northbound travel lanes, a northbound bike lane, and on-street parking along both curbs. There are exclusive right-turn lanes at Main Street's intersections with Crescent Street, Centre Street, and Court Street. The curb-to-curb width of Main Street varies in the study area between 43 and 50 feet, with available right-of-way space ranging from 58 to 70 feet. Sidewalks of varying widths are available for pedestrians along both sides of the street. The sidewalks feature street lights, planted trees, and furniture such as benches. Main Street is the center of the Downtown area, as well as a primary emergency response corridor.



### Warren Avenue

Warren Avenue between Spring Street and Belmont Street consists of two southbound travel lanes. There are exclusive right-turn lanes at Warren Avenue's intersections with West Elm Street and Belmont Street. There are no existing bike facilities or on-street parking. The curb-to-curb width along Warren Avenue in the study area varies between 26 and 34 feet, while the right-of-way ranges between 41 and 50 feet. Sidewalks are present on both sides of the road, generally between 7 to 8 feet wide.





### **Belmont Street**

Belmont Street, designated as State Route 123, was analyzed between Warren Avenue and Main Street. The existing roadway consists of two eastbound lanes and on-street parking on the north side of the street. At its intersection with Main Street, Belmont Street has two left-turn lanes and a right-turn lane. Curb-to-curb width varies from 37 to 39 feet while the right-of-way is 50 feet. Both sides of the street consist of 6 to 7 foot wide sidewalks.

### **West Elm Street**

West Elm Street between Warren Avenue and Main Street consists of one eastbound lane and on-street parking on the south side of the street. There is a dedicated left-turn lane and a through lane at the intersection with Main Street. The curb-to-curb width along West Elm Street is 26 to 27 feet while the right-of-way is 42 feet. Sidewalks are available on both sides of the street, between 8 to 9 feet in width.



### **Legion Parkway**

Legion Parkway runs between Warren Avenue and Main Street. Eastbound and westbound lanes are separated by a central median, and 4 rows of angle parking are available along both outside curbs and both sides of the median. Travel lanes are approximately 20 feet wide and the overall right-of-way varies from 105 to 145 feet. Fifteen-foot wide sidewalks are available on both sides of the street.

### **Spring Street**

Spring Street operates as a westbound one-way street between Main Street and Pleasant Street. On-street parking is permitted on the south side of the street between Main Street and Warren Avenue. Curb-to-curb width varies from 26 to 28 feet. Seven-foot sidewalks exist on both sides of the street.



**Table 1: Downtown Brockton Streets Existing Conditions**

Street Name	Right-of-Way Width (feet)	Curb-to-Curb Width Range (feet)	No. of Lanes & Travel Direction	Bike Facilities?	On-Street Parking?
Warren Avenue	41.25 – 50	26 – 34	2 SB	None	None
Main Street	58 – 70	43 – 50	2 NB	NB 5' bike lane	Both sides
Montello Street	41.25 – 53	26 – 35	1 NB, 1 SB	None	None
Commercial Street	60	42 – 76	1 NB, 1 SB	None	East side
Spring Street	N/A	26 – 28	1 WB	None	South side
Pleasant Street	57	32 – 40	1 EB, 1 WB	None	None
Court Street	50 – 60	39 – 45	2 EB, 2 WB	None	None
Green Street	42	27 – 28	1 EB	None	South side
Petronelli Way	40	25 – 26	1 EB	None	South side
Legion Parkway	105 – 145	77 – 116	1 EB, 1 WB	None	Angle – Outside curbs and along median
Centre Street	50 – 70	33 – 45	1 EB, 1 WB	EB and WB 5' bike lanes	None
Frederick Douglass Avenue	40	24 – 25	2 WB	None	North side (1 block only)
School Street	41.25 – 60	33 – 36	2 WB	None	South side
Lincoln Street	41.25	26 – 27	1 EB, 1 WB	None	South side
West Elm Street	42	26 – 27	1 EB	None	South side
VFW Parkway	41.25 – 85	19 – 20	1 EB	None	None
Crescent Street	50 – 60	34 – 40 (West of Commercial) 62 – 65 (East of Commercial)	1 EB, 1 WB (West of Montello) 2 EB (East of Montello)	None	South side
Belmont Street	50	37 – 39	2 EB	None	North side



### 2.3. Study Area Intersections

The study area for the traffic impact analysis includes the following intersections throughout Downtown Brockton:

- Pleasant Street at Spring Street
- Warren Avenue at
  - Spring Street
  - Pleasant Street
  - Green Street
  - Highland Street & Legion Parkway
  - Frederick Douglass Avenue
  - West Elm Street
  - Belmont Street
- Main Street at
  - Spring Street
  - Pleasant Street & Court Street
  - Franklin Street
  - Green Street & Petronelli Way
  - Legion Parkway & Centre Street
  - Frederick Douglass Avenue & School Street
  - West Elm Street & VFW Parkway
  - Crescent Street
  - Belmont Street
- Montello Street at
  - Court Street
  - Franklin Street
  - Petronelli Way
  - Centre Street
  - Lincoln Street
  - School Street
  - Crescent Street
- Commercial Street
  - Court Street
  - Centre Street
  - School Street
  - Perkins Street & Crescent Street

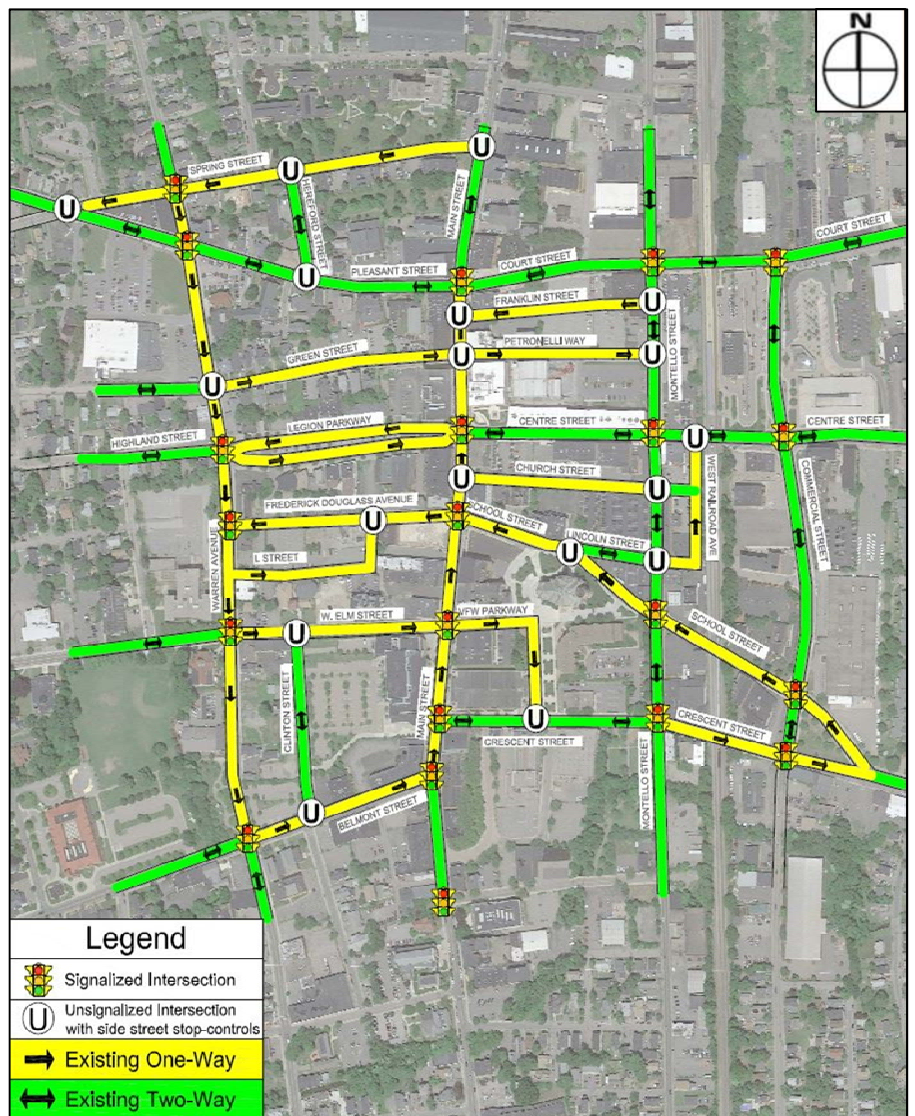


Figure 2: Existing Downtown Circulation and Intersection Controls

The existing traffic controls and lane usage throughout the study area are shown in Figure 2.

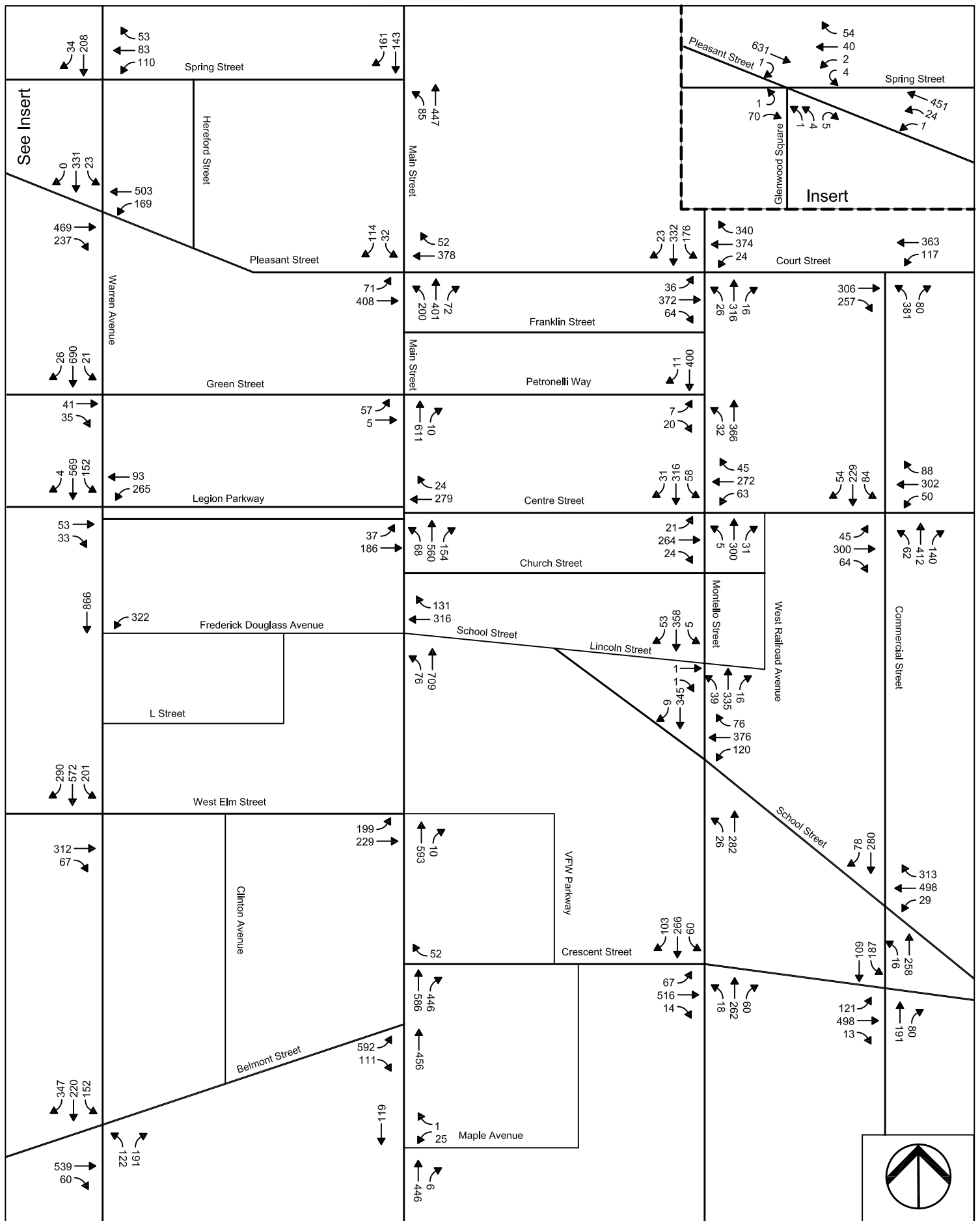


## 2.4. Existing Traffic Conditions

Existing traffic volume data were collected to establish a baseline condition for traffic conditions throughout the study area. The following summarizes the data collection efforts conducted as part of this Study.

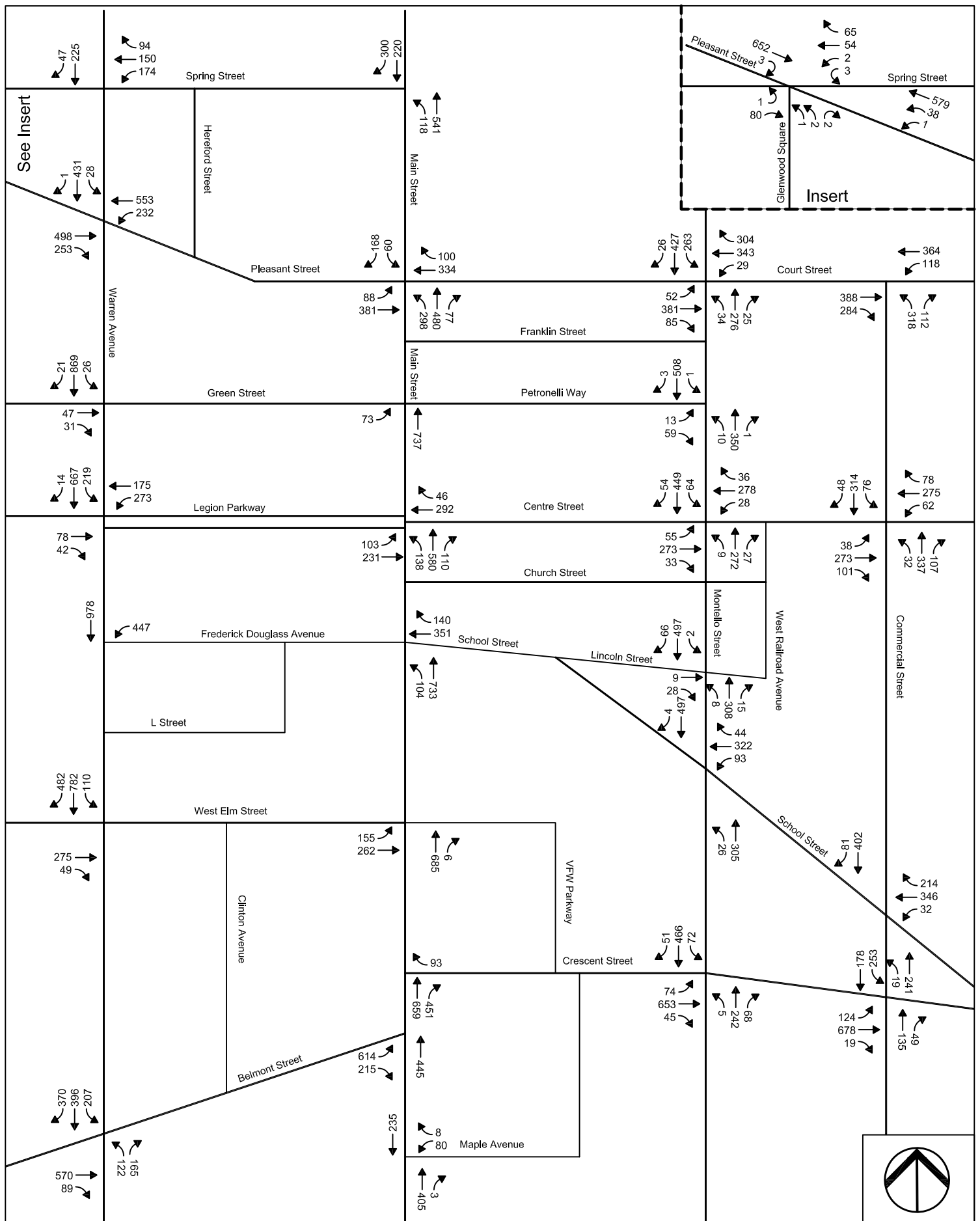
### 2.4.1. Manual Turning Movement Counts

Manual turning movement counts (TMCs) were conducted at 20 intersections within the study area, chosen in conjunction with OCPC and the City, in October 2018 and March 2019 during the weekday morning (7:00 – 9:00 AM) and weekday evening (4:00 – 6:00 PM) peak periods. Traffic counts that were conducted in 2017 by OCPC were used for remaining study area intersections. The 2017 TMC volumes were found to be higher in some cases than the 2018 volumes, so no adjustments were made to the 2017 volumes. The existing weekday morning and evening peak hour turning movement volumes are presented in Figure 3 and Figure 4. The detailed TMC data is provided in the Appendix.



2018 Weekday Morning Peak Hour Traffic Volumes - Existing Geometry  
Downtown Traffic Study  
Brockton, MA

Figure 3



2018 Weekday Evening Peak Hour Traffic Volumes - Existing Geometry  
Downtown Traffic Study  
Brockton, MA

Figure 4



### 2.4.2. Automatic Traffic Recorder Counts

In addition to the TMCs, automatic traffic recorders (ATRs) were placed at several locations within the study area. The ATRs collected data over a two-day period from Wednesday October 3 to Thursday October 4, 2018. The summary of the ATR data is presented in Table 2. The detailed traffic data is provided in the Appendix.

**Table 2: Automatic Traffic Recorder (ATR) Data Summary**

	Warren Ave, north of W. Elm St	Main St, between Green St & Legion Pkwy	Main St, south of Crescent St	Centre St, west of Montello St	Belmont St, west of Main St	Crescent St, west of Otis St
<b>Weekday Daily Volume<sup>1</sup></b>	12,701	8,152	11,427	7,564	7,945	19,012
<b>Weekday Morning Peak Hour</b>						
Volume <sup>2</sup>	861	555	795	541	518	1,488
K Factor <sup>3</sup>	0.07	0.07	0.07	0.07	0.07	0.08
<b>Weekday Evening Peak Hour</b>						
Volume	971	531	748	541	549	1,567
K Factor	0.08	0.07	0.07	0.07	0.07	0.08

1 vehicles per day  
 2 vehicles per hour  
 3 percentage of daily trips that occur during the peak hour

As seen in Table 2, the highest traffic volumes measured occurred on Crescent Street, Warren Avenue, and Main Street south of Crescent Street. Volumes decrease further north along Main Street (decreasing from 11,427 to 8,152 daily).

K factors provide an indication of how much traffic occurs during the peak hour periods along the roadways where data were collected. The data shows that between 7-8% of the daily volumes along these roadways were recorded during both the AM and PM peak hours.

### 2.5. Motor Vehicle Crash Data

Motor vehicle crash data were obtained for all study area intersections from the Brockton Police Department (BPD) and MassDOT crash records for the years 2014 - 2018. The current MassDOT average crash rate for unsignalized intersections in District 5 (the MassDOT district in which Brockton is located) is 0.57 and the average crash rate for signalized intersections is 0.75. Table 3 presents the motor vehicle crash data for the years 2014 - 2018. This data is also summarized in Figure 5. Collision diagrams have been developed based on the BPD crash reports to show the spatial distribution of crashes at each study area intersection. These diagrams are presented in the Appendix.

**Table 3: Motor Vehicle Crash Summary**

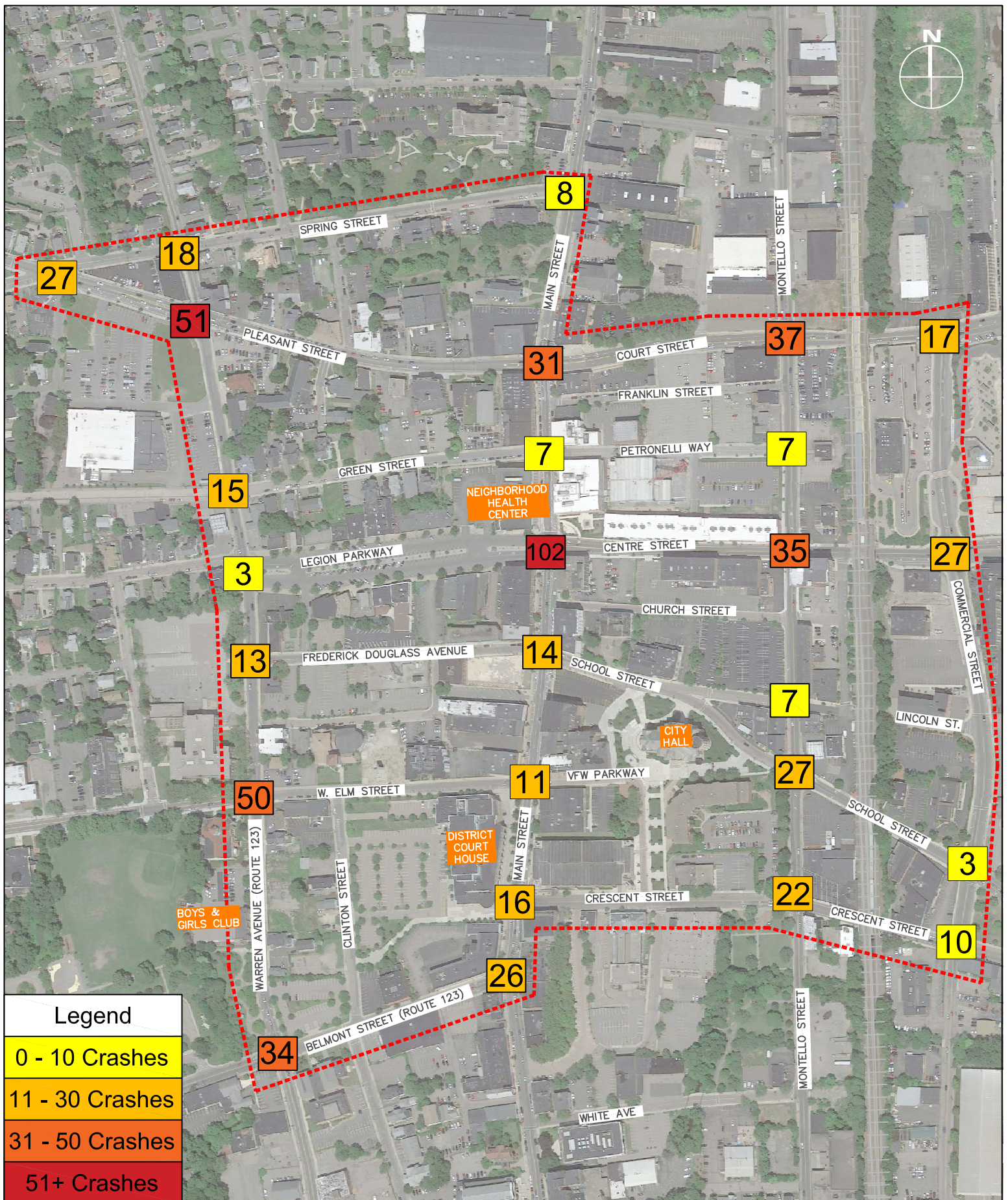
Intersection	Number of Crashes	Yearly Average	Signalized (S) or Unsignalized (U)	Crash Rate	Predominant Crash Type
Pleasant St @ Spring St	27	5.4	U	0.90	Angle: 10
Warren Ave @ Spring St	18	3.6	S	1.29	Angle: 9
Warren Ave @ Pleasant St*	51	10.2	S	1.26	Angle: 23
Warren Ave @ Green St	15	3.0	U	0.74	Angle: 8
Warren Ave @ Legion Pkwy	3	0.6	S	0.10	N/A
Warren Ave @ F Douglass Ave	13	2.6	S	0.45	Angle: 8
Warren Ave @ West Elm St*	50	10.0	S	1.45	Angle: 30
Warren Ave @ Belmont St	34	6.8	S	0.92	Rear-end: 15
Main St @ Spring St	8	1.6	U	0.33	Angle: 4
Main St @ Pleasant St / Court St*	31	6.2	S	0.77	Rear-end: 13
Main St @ Franklin St	3	0.6	U	N/A	N/A
Main St @ Green St / Petronelli Way	7	1.4	U	0.43	Rear-end: 3
Main St @ Legion Pkwy / Centre St*	102	20.4	S	3.42	Angle: 59
Main St @ F Douglass Ave / School St	14	2.8	S	0.52	Angle: 7
Main St @ West Elm St / VFW Pkwy	11	2.2	S	0.49	Angle: 3 Sideswipe: 3
Main St @ Crescent St	16	3.2	S	0.66	Rear-end: 8
Main St @ Belmont St	26	5.2	S	1.01	Rear-end: 14
Belmont St @ Clinton St	12	2.4	U	N/A	Angle: 8
Montello St @ Court St*	37	7.4	S	0.81	Angle: 22
Montello St @ Petronelli Way	7	1.4	U	0.37	Angle: 3
Montello St @ Centre St	35	7.0	S	1.16	Angle: 16
Montello St @ Lincoln St	7	1.4	U	0.37	Angle: 2
Montello St @ School St	27	5.4	S	1.03	Angle: 16
Montello St @ Crescent St	22	4.4	S	0.65	Rear-end: 10
Commercial St @ Court St	17	3.4	S	0.53	Rear-end: 9
Commercial St @ Centre St	27	5.4	S	0.76	Angle: 17
Commercial St @ School St	3	0.6	S	0.11	N/A
Commercial St @ Crescent St	10	2.0	S	0.34	Angle: 7
<b>Total</b>	<b>583</b>	<b>116.6</b>			

\*Top 200 Massachusetts crash intersection – based on available data from MassDOT between 2014-2016

Several observations can be made from the intersection crash history data in Table 3.

- The intersection of Main Street, Legion Parkway, and Centre Street experienced the most crashes over the five-year period, averaging approximately 20 per year.
  - Northbound motorists often misinterpreted the overhead traffic signals two blocks ahead at the intersection of Main Street and Pleasant Street for the traffic signals at this intersection, resulting in ignored red lights from poorly placed post-mounted traffic signals.
  - The crash rate at this intersection is 3.42 crashes per million vehicles entering the intersection, greatly exceeding the District 5 average of 0.75 for signalized intersections.
  - One fatal collision involving a pedestrian was reported in front of the Neighborhood Health Center.
- Angle collisions were the most predominant type of crashes.
- Nine signalized intersections exceeded the District 5 average crash rate of 0.75.
- Two unsignalized intersections, Pleasant Street at Spring Street and Warren Avenue at Green Street, exceed the District 5 average crash rate of 0.57.



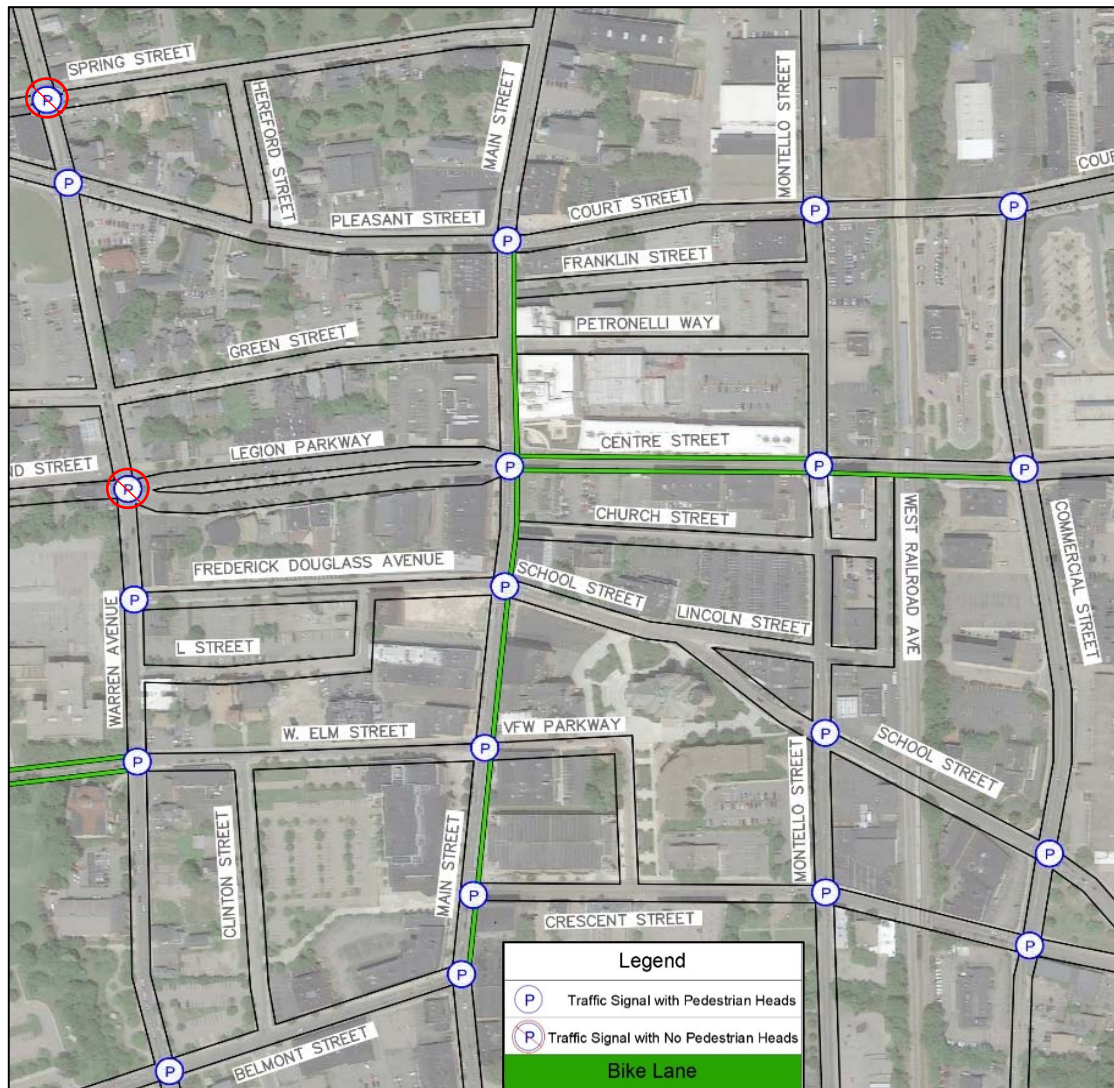


Downtown Vehicle Crashes 2014 - 2018  
Downtown Traffic Study  
Brockton, MA

Figure 5



## 2.6. Existing Pedestrian and Bicycle Facilities



**Figure 6: Existing Bicycle and Pedestrian Facilities**

Sidewalks are provided along all streets within the study area and are generally in fair to good condition. Several sections of sidewalk were identified as being subpar due to deterioration or insufficient width. Pedestrian crossings are available at all intersections in the Downtown area, along with pedestrian access ramps, although some do not meet current ADA standards. Pedestrian signals are provided although the majority do not include Accessible Pedestrian Signals (APS) with visual countdowns. Midblock crossings, such as the crosswalk on School Street in front of City Hall, would benefit from Rectangular Rapid Flash Beacons (RRFB's) to improve pedestrian safety. The intersection of Warren Avenue and Legion Parkway is one intersection where pedestrian signals are not provided, leaving pedestrians to cross long distances without a designated phase.

There is a limited number of existing bike lanes in the Downtown area. A northbound bike lane on Main Street is provided from Belmont Street to Pleasant Street. East and westbound bike lanes are provided on Centre Street between Main Street and Montello Street. Existing bike lanes are also present on West Elm Street to the west of Warren Avenue, extending out of the study area. The existing pedestrian and bicycle facilities are shown in Figure 6.

## 2.7. Existing Transit Facilities



Figure 7: Existing BAT Bus Routes

Downtown Brockton is served by the Brockton Area Transit Authority (BAT) and the Massachusetts Bay Transportation Authority (MBTA). The BAT operates several bus routes that travel through Downtown Brockton, with stops throughout the area. The BAT Centre serves as the Downtown terminus of the Brockton-based bus routes and is located along Commercial Street between Centre Street and Court Street.

The Middleborough/Lakeville line of the MBTA's Commuter Rail system has a stop in Downtown Brockton along Commercial Street between Centre Street and Court Street. The Commuter Rail line provides inbound access to South Station in Boston to the north and outbound access to Middleborough to the south. In the summer, the Cape Flyer train travels from Boston to Hyannis, and makes a stop in Brockton. The existing public transportation facilities in Downtown Brockton are shown on Figure 7.

### 3 Future Conditions

Traffic volumes in the study area were projected to the year 2038, which reflects a 20-year traffic planning horizon. The methodology for estimating future traffic growth considers two components: general background traffic growth that may be affected by changes in demographics or population trends and specific traffic growth that accounts for planned or proposed developments that can affect the traffic patterns throughout Downtown Brockton. The planning horizon considers all potential traffic growth to ensure that roadway and intersection modifications and upgrades are consistent with the future needs of the transportation infrastructure.

#### 3.1. Background Traffic Growth

To account for potential traffic growth throughout Downtown Brockton, a one percent per year annual traffic growth rate was applied to the existing conditions traffic volumes to develop the 2038 future conditions, based on discussions with Old Colony Planning Council. The one percent per year annual growth rate reflects a conservatively high projection for analytical purposes.

#### 3.2. Site Specific Growth

In addition to the general background growth, the future conditions consider traffic volumes expected to be generated by proposed or planned projects throughout Downtown Brockton. Specific information related to proposed projects was obtained from the Brockton Urban Revitalization Plan (URP) Report<sup>3</sup> and from discussions with City of Brockton officials. Expected traffic volumes from planned and proposed projects throughout Downtown Brockton were estimated using data provided in the Institute of Transportation Engineers (ITE) Trip Generation Manual. Table 4 shows the proposed projects that were considered in establishing the future traffic volumes. A map of the project locations is shown in Figure 8. Table 5 shows the total number of trips expected to be generated by the proposed projects in Downtown Brockton. The City is also considering the relocation of the fire and police departments to Warren Avenue opposite Legion Parkway. Associated trips are already in the network.



Figure 8: Study Area Future Developments

<sup>3</sup> Downtown Brockton Urban Revitalization Plan, A.G. Jennings, LLC and Stantec. May 2016.



Table 4: Proposed Developments in Downtown Brockton

Map Location <sup>1</sup>	Project	Location	Size and Land Use
B	Furniture building rehabilitation	93 Centre Street	60 residential units/3,821 sf retail
C	Kresge building acquisition and rehabilitation	121 Main Street	50 residential units
D	First Parish building renovation	19 Main Street	20 residential units
F	Petronelli Gym rehabilitation	28 Petronelli Way	20 residential units
G	Convenience store acquisition and redevelopment	95 Montello Street	2,000 sf retail/24,000 sf office
H	Office building acquisition	47 West Elm Street	45 residential units
I	Petronelli Way mixed-use development	Northwest corner of Petronelli Way and Montello Street	203 residential units/3,000 sf retail
J	Restaurant incubator	11-15 Frederick Douglass Avenue	3,125 sf retail
K	Enterprise Block Phase 2	Between Petronelli Way and Centre Street	102 residential units
L	Municipal Parking Garage	East side of Enterprise Phase 2	400 parking spaces
M	Pharmacy	Corner of Montello Street and Court Street	1,400 sf retail
N	Hotel Grayson renovation	28 Frederick Douglass Avenue	20 residential units
O	Montello Street mixed-use development	Between Centre Street and Court Street	230 residential units/9,000 sf retail
P	Warren Ave./Pleasant St. vacant parcels	Warren Avenue and Pleasant Street intersection	20 residential units
Q	Shawmut Bank renovation	90 Main Street	6,500 sf retail/48,000 sf office
R	Police Station relocation	7 Commercial Street	155 residential units/9,000 sf retail
S	Fire Station relocation	42-52 Pleasant Street	20 residential units
V	Vacant infill lot	121-137 Main Street	11,000 sf retail
X	Redevelopment of fire destroyed building	63 Legion Parkway	4,600 sf retail
Y	Legion Parkway parcel redevelopment	111 Legion Parkway	40 residential units/7,500 sf retail
Z	School Street parcel redevelopment	26 School Street	40 residential units
AB	Main Street parcel redevelopment	137-157 Main Street	170 residential units
AC	F. Douglass Avenue/ Warren Avenue block development	Entire block	100 residential units New 400 space garage

<sup>1</sup> Location on Figure 8

**Table 5: Trip Generation – Downtown Brockton Projects**

	Daily Trips	Weekday Morning Peak Hour			Weekday Evening Peak Hour		
		Enter	Exit	Total	Enter	Exit	Total
1,300 residential units <sup>1</sup>	7,083	122	346	468	349	223	572
70,000 sf retail <sup>2</sup>	4,717	41	25	66	201	216	417
80,000 sf office <sup>3</sup>	855	88	14	102	15	77	92
Total	12,655	251	385	636	565	516	1,081

<sup>1</sup> Based on ITE Land Use Code 221 – Multifamily Housing (Mid-Rise)

<sup>2</sup> Based on ITE Land Use Code 820 – Shopping Center

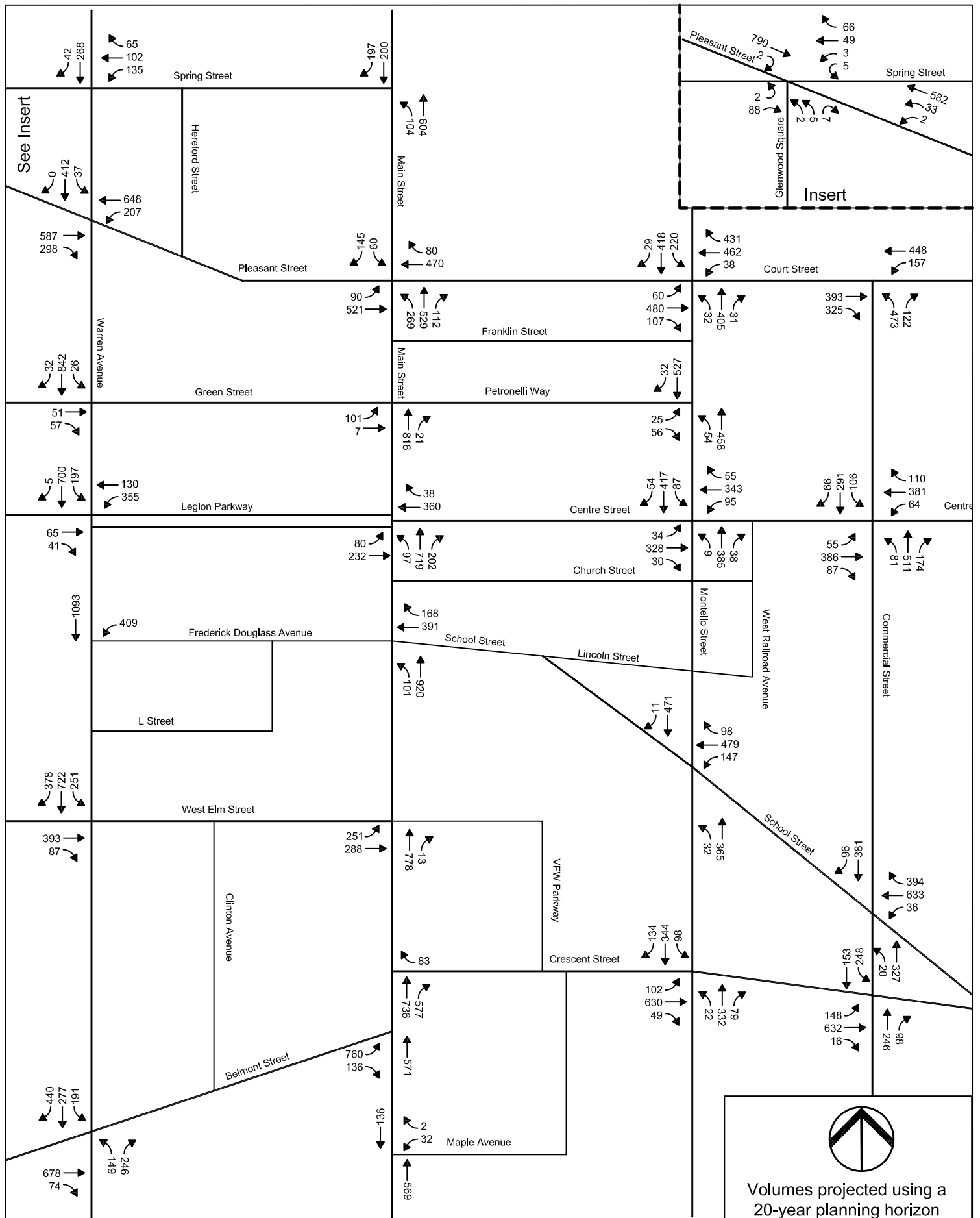
<sup>3</sup> Based on ITE Land Use Code 710 – General Office Building

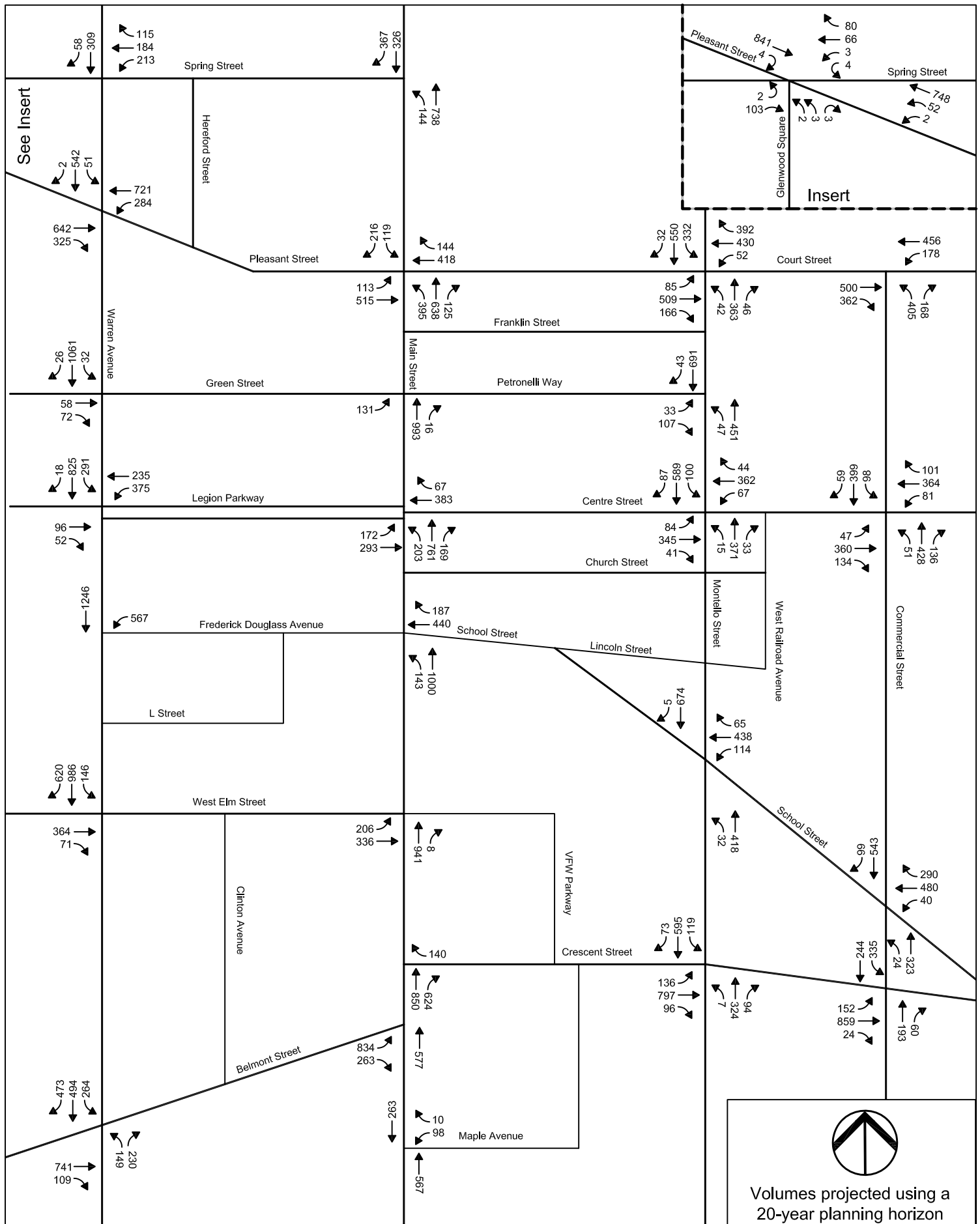
As seen in Table 5, the proposed developments are projected to generate 636 new trips during the weekday AM peak hour and 1,081 trips during the weekday PM peak hour. The trip generation estimates shown in Table 5 were distributed across the existing one-way and proposed two-way street networks based on existing traffic patterns and the locations of the proposed projects in the Downtown Brockton area. The locations of existing and proposed parking garages and lots were also taken into consideration for developing trip distribution patterns. It must be noted that the trip estimates are conservative, as no shared or multi-purpose trips are accounted for.

### 3.3. Future Traffic Volumes – Existing Roadway Network

The one-percent per year annual growth rate and the estimated traffic volumes from the projects listed in Table 4 were added to the 2018 existing condition traffic volumes to develop the 2038 future volumes, which are presented in Figures 9 and 10 for the weekday morning and evening peak hours, respectively. The traffic volumes shown in these figures represent a future condition without any modifications or changes to the existing roadway network and vehicular circulation throughout Downtown Brockton.

A discussion of the proposed roadway reconfiguration and circulation changes and the impacts to traffic patterns is provided in the next section.







### 3.4. Proposed Design

The objective of the project is to convert several streets in Downtown Brockton from one-way to two-way operations and provide a bicycle and pedestrian network throughout the area. The project will incorporate Complete Streets principles throughout the Downtown Brockton area by providing an increase in bicycle lanes and enhanced pedestrian facilities while improving vehicular circulation and access to adjacent properties. The proposed design underwent several iterations, as feedback from the City and stakeholders led to fine-tuning and modifications. The proposed plan is described in the following sections.

#### 3.4.1. Alternatives Considered

##### Downtown Circulation Alternatives

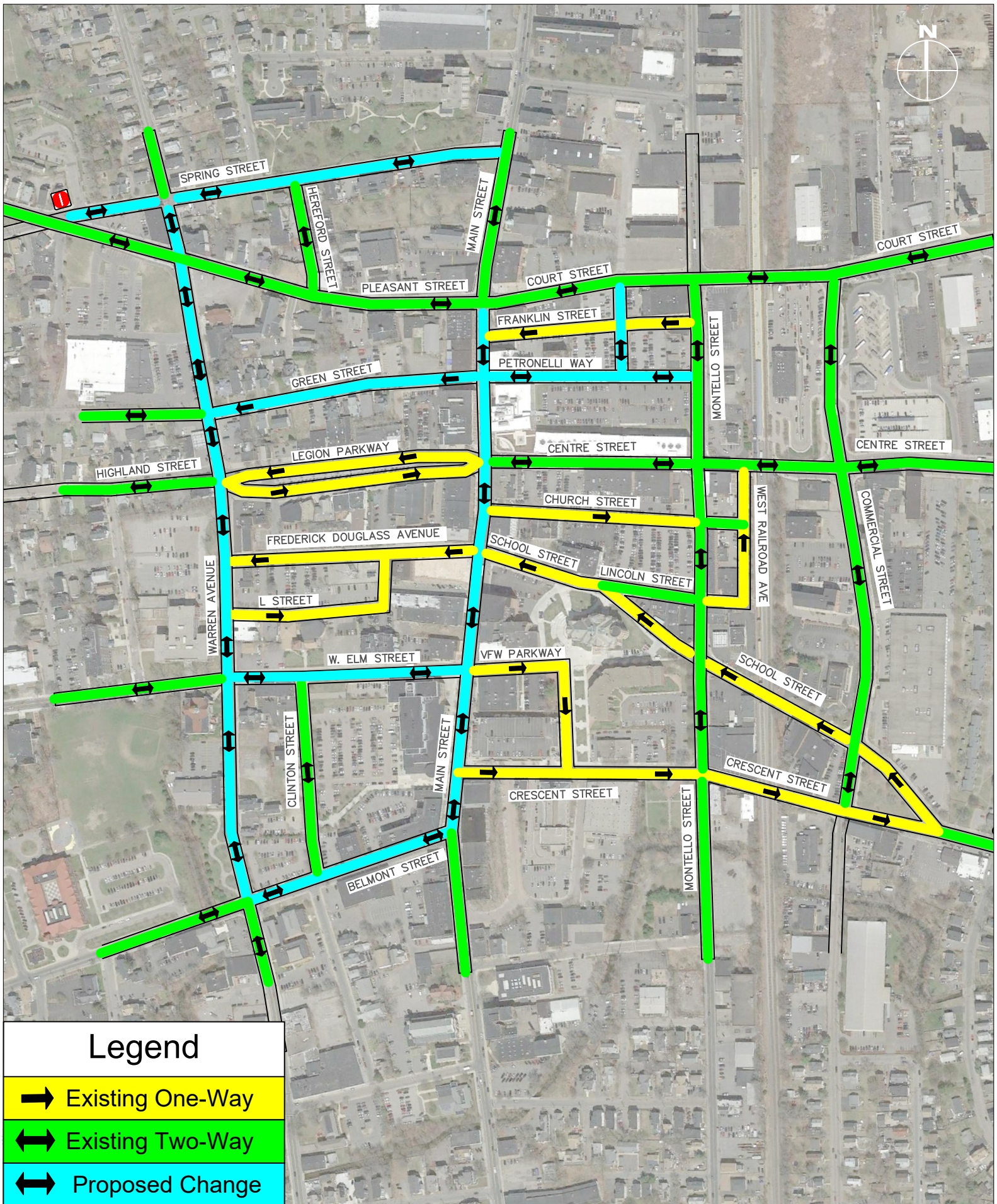
Previous Downtown Traffic Studies conducted in 1999 and 2007 identified and recommended a preferred circulation alternative. These studies analyzed traffic conditions for the following alternatives:

- No-Build: Maintain existing traffic circulation.
- One-Way Alternative: Convert Main Street to two-way traffic and convert Montello Street to one-way northbound. This alternative was not considered in this Study, as it was eliminated from consideration in the previous 2007 Downtown Traffic Study.
- Two-Way preferred alternative: Convert Main Street and Warren Avenue to two-way traffic, along with several other streets described below.

The preferred future street network alternative, shown in Figure 11, includes the following changes to vehicular circulation patterns:

- Main Street: two-way between Belmont Street and Pleasant Street
- Warren Avenue: two-way between Belmont Street and Spring Street
- Belmont Street: two-way between Warren Avenue and Main Street
- West Elm Street: two-way between Warren Avenue and Main Street
- Spring Street: two-way between Warren Avenue and Main Street
- Petronelli Way: two-way between Main Street and Montello Street
- Green Street: One-way westbound between Warren Avenue and Main Street
- As part of a separate project, a new north/south street will be constructed between Petronelli Way and Court Street





Proposed Downtown Circulation  
Downtown Traffic Study  
Brockton, MA

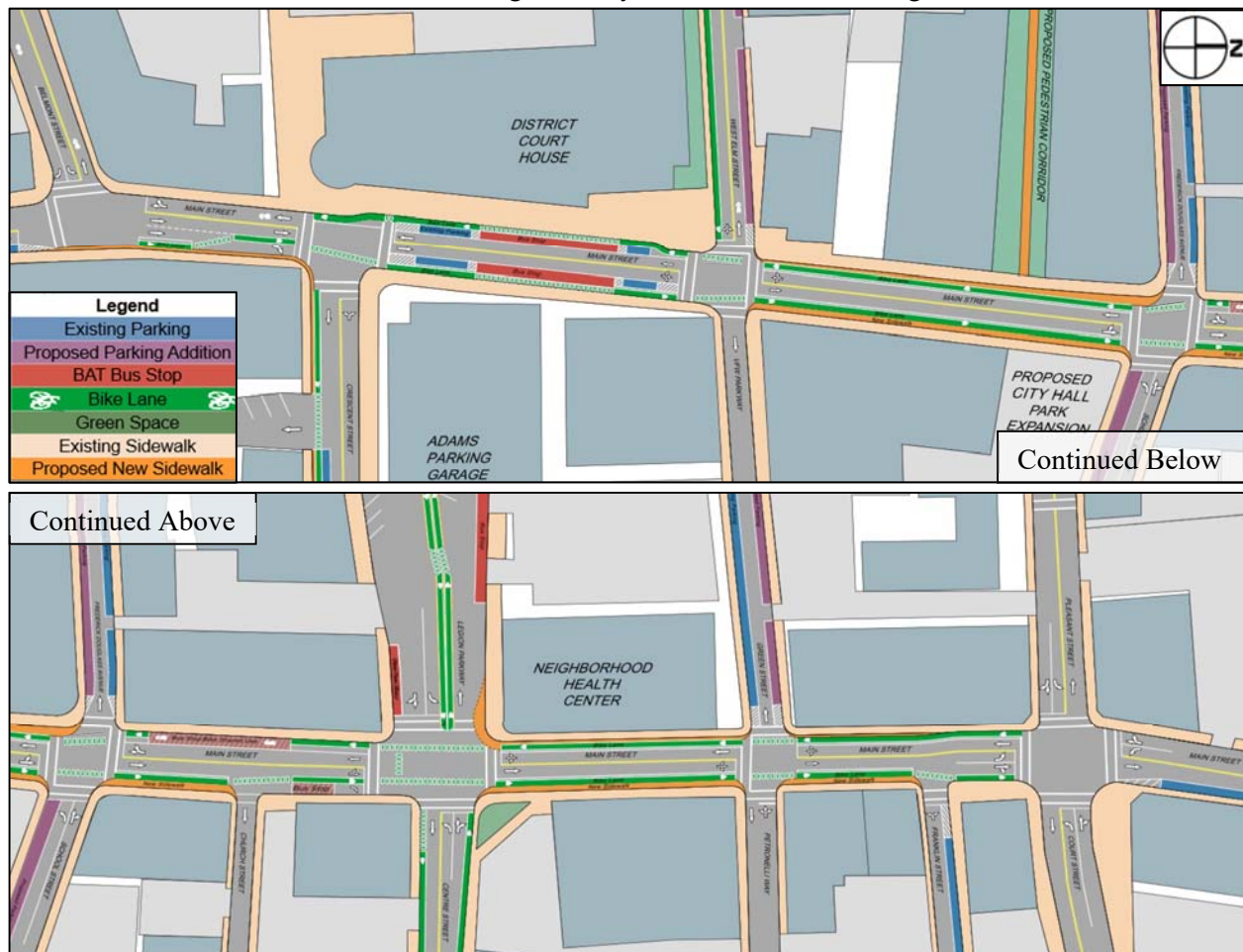
Figure 11



### Main Street Design Considerations

Three alternatives, described below, were considered for the conceptual design of Main Street between Belmont Street and Pleasant Street. These alternatives balance varying levels of on-street parking availability with provisions for pedestrians and bicyclists. Other design considerations such as existing traffic patterns and future traffic analysis were factored into the development of the preferred alternative.

- Alternative 1: Maintain on-street parking where possible, except for bus stops and turning lanes.
- Alternative 2: Chicane parking design, where parking is available on one side of the street, alternating mid-block. Widened sidewalks are provided along certain blocks.
- Alternative 3: (Preferred) On-street parking is removed and sidewalks are widened along most blocks. Pedestrian amenities are significantly enhanced. Shown in Figure 12 below.



**Figure 12: Proposed Main Street Concept Plan**

Shown in Figure 12, the preferred two-way design of Main Street provides raised northbound and southbound protected bike lane from Belmont Street to Pleasant Street and Court Street. The bike lanes are protected from the travel lanes with a raised 2-foot minimum buffer. Significant increases to sidewalk space are proposed along nearly every block of Main Street. A bump-out area is proposed in front of the Neighborhood Health Center. The majority of the existing street parking is removed, with several spots remaining near the District Court House. The losses to on-street parking will be offset by additions to on-street parking near Main Street, and existing and proposed off-street parking facilities, discussed later in this report. Figures for the conceptual design of Alternatives 1 and 2 are contained in the Appendix.



**Figure 13: Proposed Main Street Concept Plan – West Elm Street / VFW Parkway to F. Douglass Avenue / School Street**

Figure 13 displays a close-up view and cross section of a block along Main Street. The existing parking spaces along this block are proposed to be removed, and sidewalk space is increased on each side of the street by 3 to 8 feet. Buffered 5-foot wide bike lanes are provided in each direction. The proposed 11-foot travel lanes are consistent along the Main Street corridor and provide sufficient room for BAT buses and emergency vehicles. As seen in Figure 13, an expansion to City Hall Park and a midblock pedestrian corridor are also proposed, which will further improve the pedestrian experience, and attract more foot-traffic to Main Street. While on-street parking directly on Main Street will be removed, increased parking in the Downtown and enhanced pedestrian infrastructure will encourage shoppers to visit local businesses.



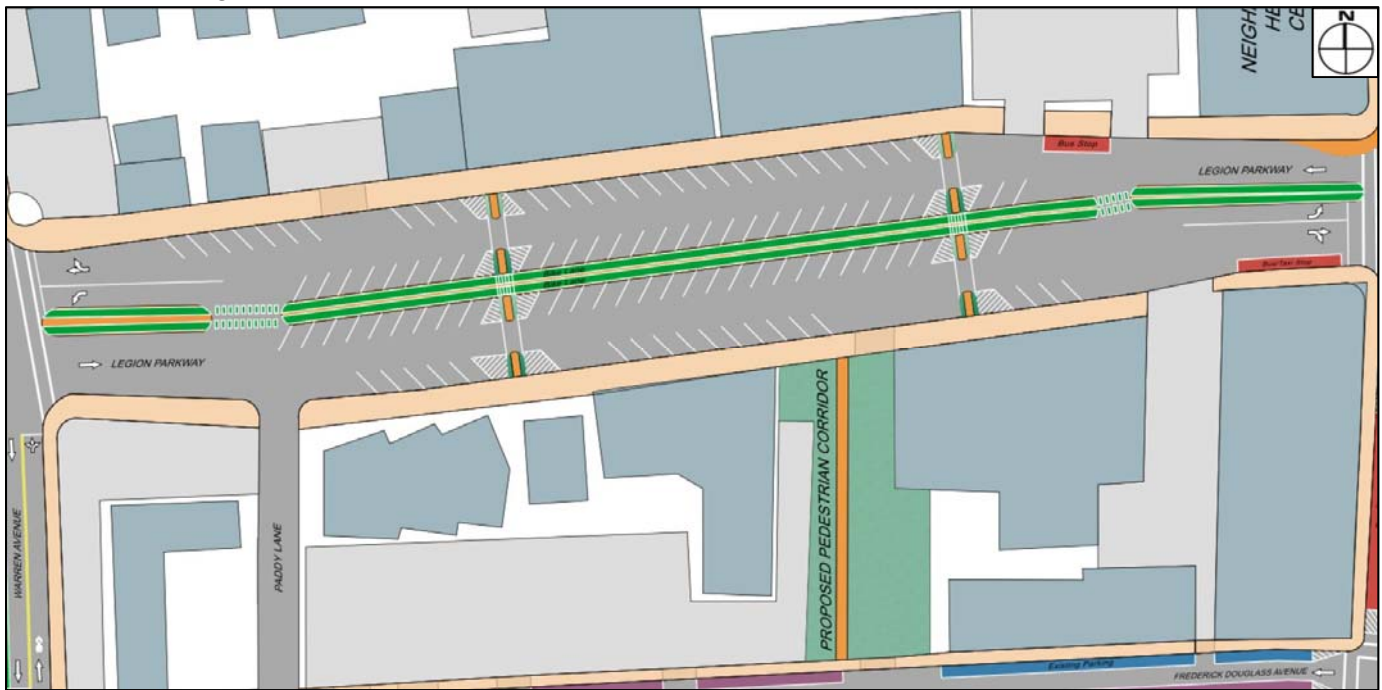
**Main Street Concept: Looking North from School Street**



### Legion Parkway Design Alternatives

Three alternatives were considered for the design of Legion Parkway, described below:

- Alternative 1: Maintain all existing parking and install bike lanes along center median.
- Alternative 2 (Preferred): Install two mid-block curb bump-outs and pedestrian crossings, and install bike lanes along center median. Shown in Figure 14.
- Alternative 3: Remove angled parking along center median, widen sidewalks, and install bike lanes along the outside curbs.



**Figure 14: Proposed Legion Parkway Concept Plan**

The preferred design of Legion Parkway maintains nearly all the existing parking spots, while making bicycle and pedestrian infrastructure improvements. The proposed midblock crossings would improve the visibility of pedestrians as they wait to cross Legion Parkway, while protected bicycle facilities along the center median allow bicyclists to travel without the concern of cars backing up into them out of parking spots.

The preferred Legion Parkway design also modifies the central median layout by narrowing the median opening at the eastern end of Legion Parkway to prevent left-turning vehicles from cutting across Legion Parkway out of the parking lot next to the Neighborhood Health Center. Additionally,



**Legion Parkway Concept: Looking East from Warren Avenue**

the median closest to Main Street also is proposed to be shifted north to provide better intersection alignment with Centre Street. The preferred alternative takes into account the wishes of stakeholders and the public to maintain as many parking spaces as possible, while also enhancing pedestrian and bicycle infrastructure.

### 3.4.2. Bicycle Facilities

The City of Brockton has adopted Complete Streets policies to improve pedestrian and bicycle infrastructure. As part of the conceptual Downtown design, an expansion of bicycle facilities throughout Downtown Brockton is proposed. As previously presented in the Existing Conditions sections of this report, the existing bicycle facilities throughout Downtown Brockton are primarily provided along Main Street and Centre Street, with little connectivity to other blocks within the Downtown and to other areas of the City. The proposed bicycle network, shown in Figure 15, aim to improve connectivity and safety for bicyclists in the Downtown area.

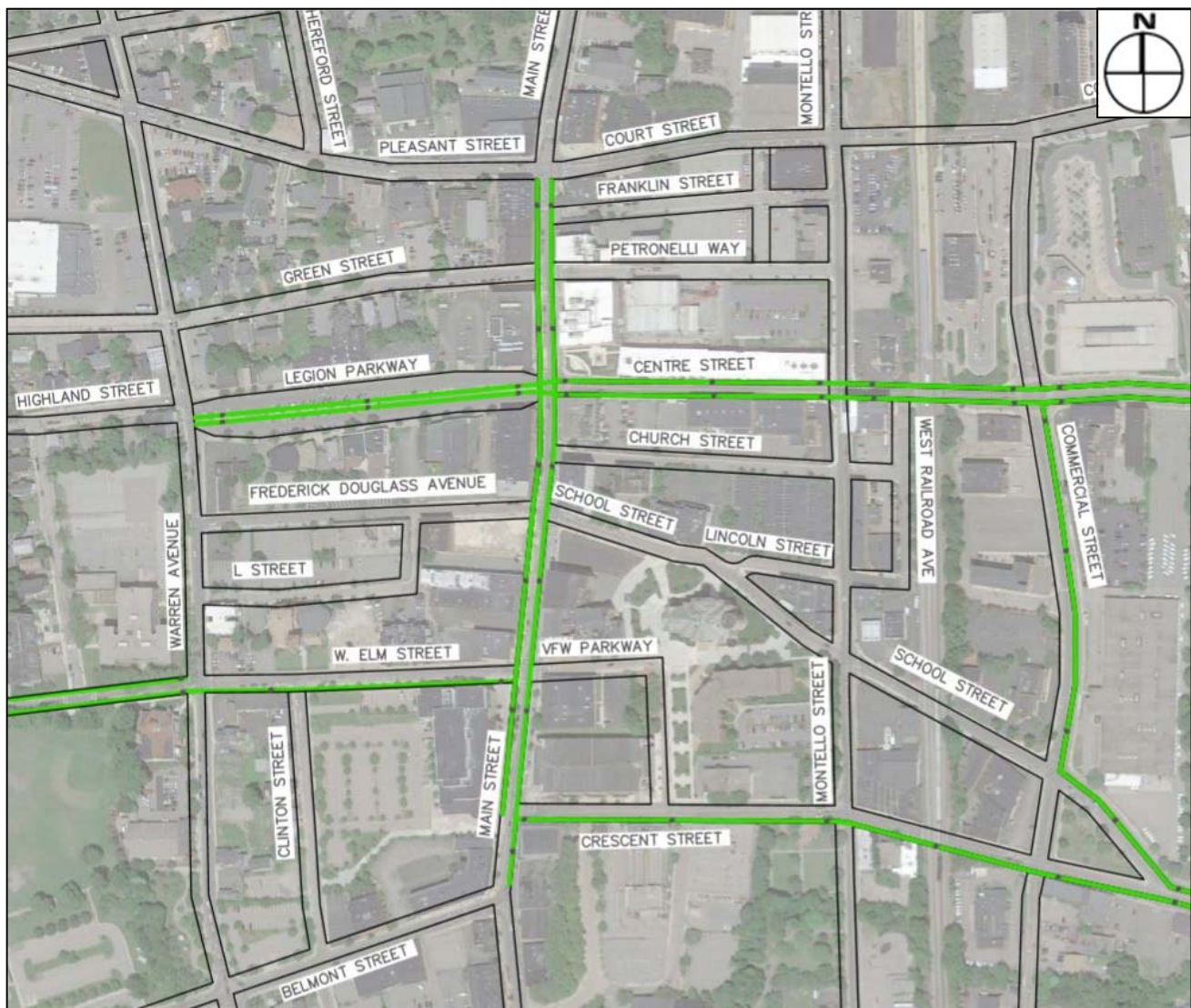


Figure 15: Proposed Bike Lane Network

To the extent possible, bicycle lanes will be raised and separated from vehicular traffic. Two-foot minimum buffers are proposed between parking lanes and bike lanes. The following is a list of the proposed bicycle facilities:

- Main Street northbound between Belmont Street and Pleasant Street
- Main Street southbound between Pleasant Street and Crescent Street
- West Elm Street eastbound between Warren Avenue and Main Street
- Legion Parkway (both directions) between Warren Avenue and Main Street
- Crescent Street eastbound between Main Street and Plymouth Street
- Commercial Street (both directions) between Centre Street and Crescent Street
- Centre Street (both directions) between Main Street and Hunt Street

#### **3.4.3. Traffic Signal Improvements**

The proposed design will include several traffic signal technology improvements including the implementation of signal pre-emption for emergency vehicles and transit signal priority for BAT buses. This will allow emergency response vehicles and buses to navigate through the Downtown area in an efficient and prioritized manner.

Adaptive traffic signal technology is also recommended to be implemented at all signalized intersections in the Downtown area. Adaptive traffic signals adjust signal timings and cycle lengths automatically based on traffic demand. Remote traffic monitoring and operation by the City will also be included. New traffic signal equipment including mast arms and properly placed overhead signals will be implemented at nearly all signalized intersections.

New phasing and traffic signal timings will be required for intersections where circulation patterns are changed and where additional lanes are proposed. The traffic signals will be coordinated throughout Downtown, as coordination of the signals along Main Street and Warren Avenue is critical to allow for efficient traffic flow in both directions, especially during the peak commuter periods.

Improvements to pedestrian signals are also proposed as part of this project. All pedestrian traffic signal equipment and curb ramps will be upgraded where necessary to conform with ADA requirements and include pedestrian signal countdowns. Leading pedestrian signal phases will be implemented where feasible.

#### **3.4.4. Proposed Roadway Modifications**

Several roadway and intersection modifications throughout Downtown Brockton are proposed and are listed below. All new turning movements created by the conversion of the one-way streets to two-way were evaluated to ensure that WB-50 trailer trucks (50-foot long trucks) can maneuver throughout the area. Turning movements were also evaluated for a BAT bus and a City of Brockton fire emergency vehicle.



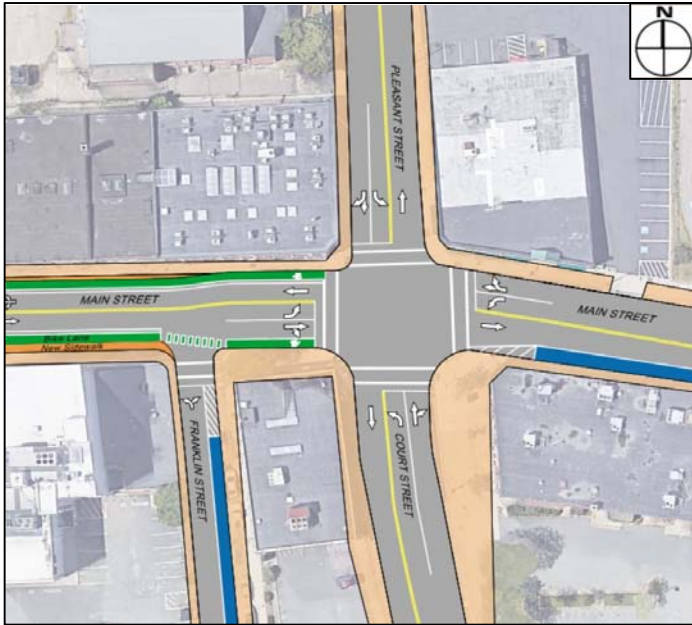


Figure 16: Main Street at Pleasant/Court Street Concept Plan

- **Pleasant Street at Spring Street & Glenwood Square:** While Spring Street will be converted to a two-way street, a movement from Pleasant Street onto Spring Street eastbound will still be prohibited. A curb bump-out will be installed to prevent vehicles from attempting this maneuver.
- **Main Street at Pleasant Street & Court Street:** The exclusive right-turn lanes on the northbound, southbound, and westbound approaches will be eliminated and exclusive left-turn lanes will be provided. This intersection is shown in Figure 16.
- **Main Street at Green Street & Petronelli Way:** Green Street will be reversed to serve westbound traffic and the eastbound approach will be eliminated.

- **Main Street at Legion Parkway & Centre Street:** The right-turn lanes will be eliminated along the northbound and westbound approaches. A left-turn lane will be installed along the westbound approach. A curb bump-out will be installed on the northwest corner of the intersection to provide for safer pedestrian crossings and a larger sidewalk area to serve the Neighborhood Health Center. The median along the Legion Parkway eastbound approach will be moved to the north to provide for better intersection alignment. Overhead mast arms and signals will be provided to improve signal visibility at this intersection.
- **Main Street at Frederick Douglass Avenue & School Street:** The right-turn lane will be eliminated from the westbound approach and a left-turn lane will be installed. The left-most paved area along the School Street westbound approach will be converted to on-street parking.
- **Main Street at West Elm Street & VFW Parkway:** The eastbound approach will be reduced to a single lane due to the two-way conversion of West Elm Street.
- **Main Street at Crescent Street:** The westbound approach will be moved north and the existing taxi stand lane along the north side of Crescent Street will be removed. Main Street southbound left-turns onto Crescent Street will be prohibited.
- **Main Street at Belmont Street:** The eastbound approach will consist of exclusive left-turn and right-turn lanes. Main Street northbound left-turns onto Belmont Street will be prohibited.

The proposed plan for Warren Avenue from Belmont Street to Spring Street is presented in Figure 17. The design proposes to maintain the southbound right-turn lanes at West Elm Street and Belmont Street. Vehicles often disrupt the flow of traffic by stopping to pick-up and drop-off children in the travel lane in front of the Boys & Girls Club. The City is in communication with the Boys & Girls Club to find a more suitable pick-up and drop-off location in the form of a potential driveway along West Elm Street. Specific intersections along Warren Avenue are further described below.



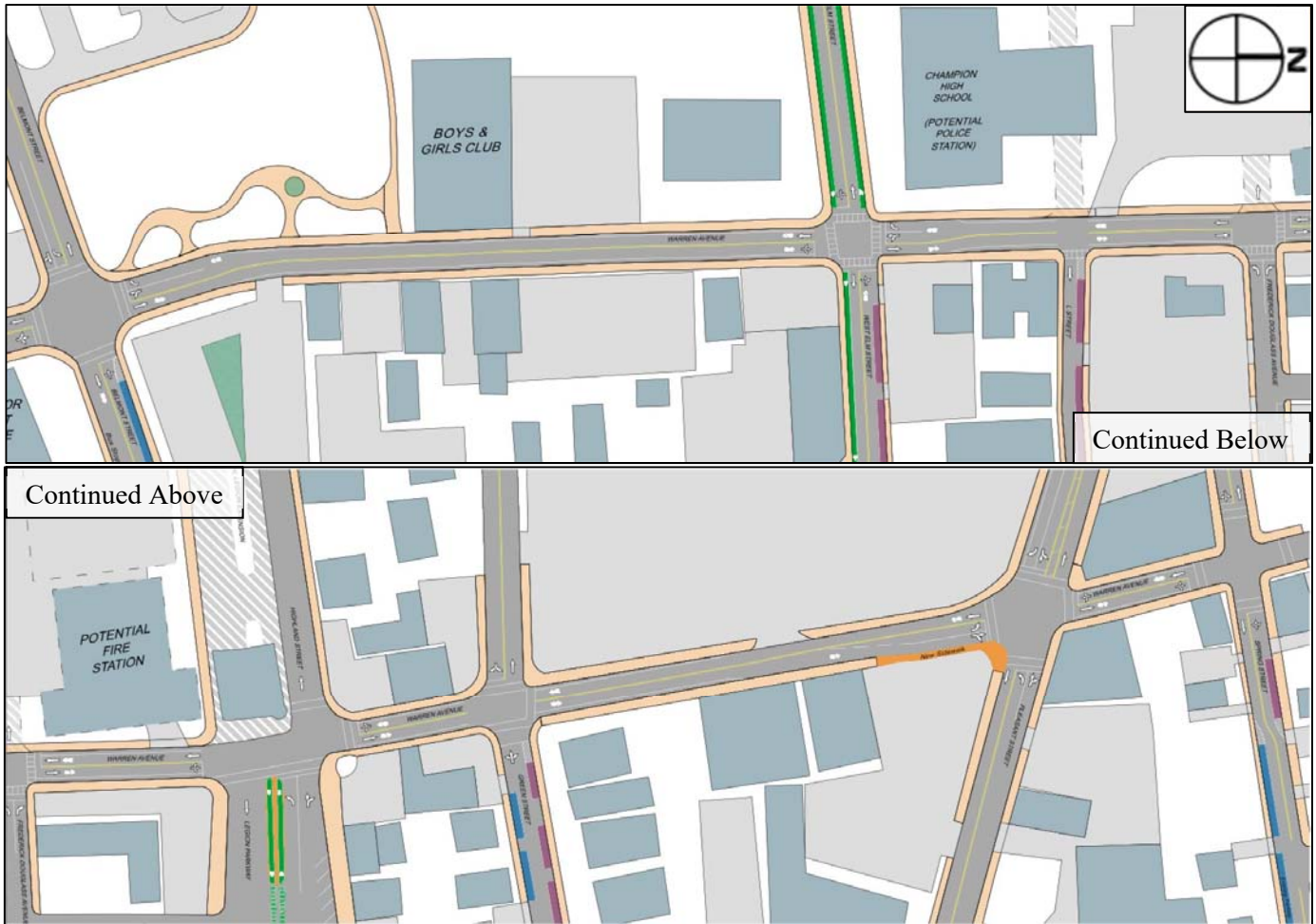


Figure 17: Warren Avenue Concept Plan

- **Warren Avenue at Spring Street:** Spring Street will be converted to two-way operations and all movements will be allowed at the intersection.
- **Warren Avenue at Pleasant Street:** A left-turn lane will be installed along Warren Avenue northbound. The roadway width will be expanded six feet on the east side to accommodate this lane, which requires a right-of-way land taking. This intersection is shown in Figure 18.
- **Warren Avenue at Green Street:** Green Street traffic will be reversed to serve the westbound direction and will add a single lane approach to this intersection.
- **Warren Avenue at Highland Street & Legion Parkway:** The island along Legion Parkway will be modified to provide better alignment at the



Figure 18: Warren Ave at Pleasant St Concept

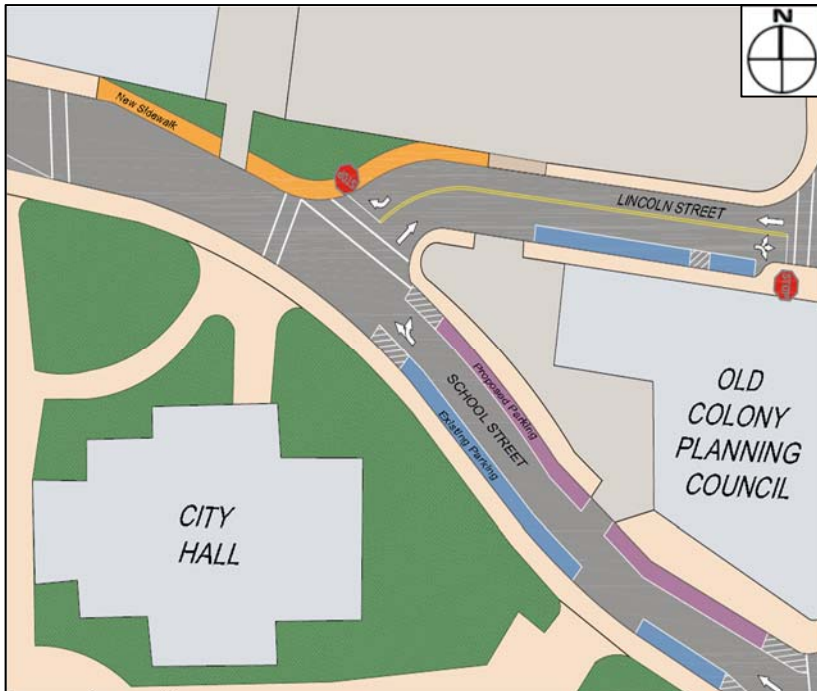


Figure 19: School Street at Lincoln Street Concept Plan

- School Street at Lincoln Street:** This intersection will be reconstructed to create a T-style intersection, which will improve sight lines, and enhance pedestrian safety. Proposed improvements at this intersection are shown on Figure 19.
- Montello Street at Court Street:** The westbound approach will consist of a through/left-turn lane and a right-turn lane. The sidewalk on the south side of Court Street is proposed to be widened from approximately 6 feet to 10 feet between Court Avenue and Montello Street to enhance pedestrian movements. As a result, the Court Street westbound approach will provide a right-turn and through/left lane and only one westbound receiving lane will be provided. This intersection is shown on Figure 20.
- Montello Street at Crescent Street:** The right-turn lane at the southbound approach will be removed and a left-turn only lane will be installed.

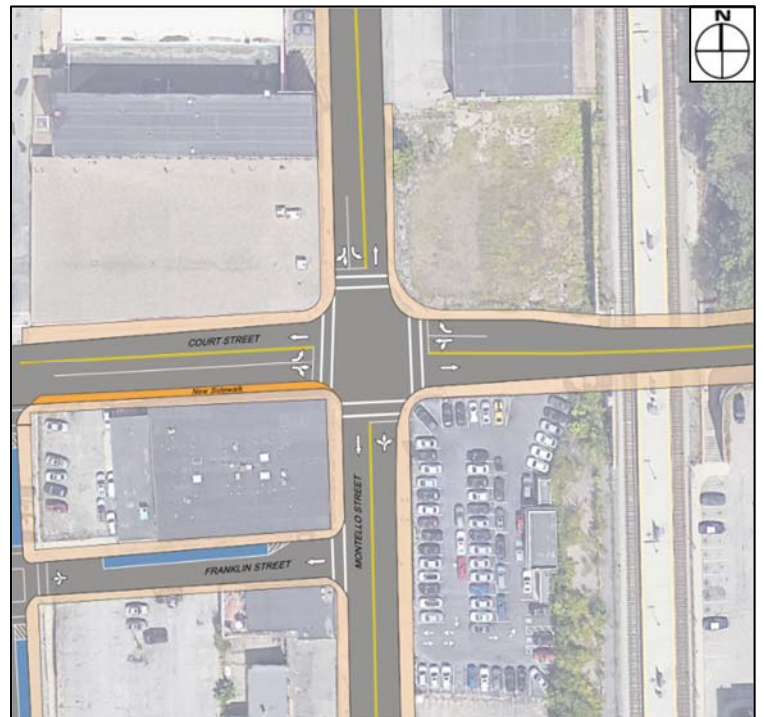


Figure 20: Montello Street at Court Street Concept Plan

Proposed conceptual designs for all Downtown roadway modifications can be found in the Appendix.

### 3.4.5. Public Transportation

Bus stop locations were also taken into consideration in the proposed roadway network design. BAT has proposed new bus stop locations along Main Street southbound and Warren Avenue northbound for the proposed two-way operations. Bus stops will be designed to facilitate safety, accessibility, and operations and will be incorporated in the detailed roadway design project.

### 3.4.6. Parking Impacts

The proposed design will result in the loss of on-street parking in some areas and will add on-street parking spaces in other areas. The proposed on-street parking changes are summarized in Table 6. Losses to on-street parking will offset by existing and proposed additions to off-street parking facilities. A new parking garage along Petronelli Way is nearing completion at the time of this report, and a potential off-street parking facility along Frederick Douglass Avenue is under consideration.

A 2017 Downtown Parking Study<sup>4</sup> conducted by Nelson Nygaard provides a detailed inventory of the existing on- and off-street parking supply in the Downtown area. This study found that the total parking network as a whole is underutilized, although some areas experience high peak hour utilization, such as along Main Street and Legion Parkway. The proposed changes to the on-street parking supply under the preferred alternative are presented in Figure 21.

**Table 6: Proposed On-Street Parking Changes**

Street Name	Existing Parking	Proposed Parking	Net Change (# of spots)
<b>Main Street</b>	Both sides between Belmont St and Pleasant St	Removal of most on-street parking spaces to expand bicycle and pedestrian infrastructure, with the exception of several near the District Court House.	-83
<b>Commercial Street</b>	East side, between Centre St and School St	Several spaces are proposed to be added on the west side of the street between Court St and Centre St	+8
<b>Spring Street</b>	South side, between Warren Ave and Main St	Alternating “chicane” design	+/- 0
<b>Green Street</b>	South side, between Warren Ave and Main St	Parking will be added to the north side of the street	+32
<b>Legion Parkway</b>	Four rows of angle parking, along outside curbs and central median	Several spots removed to accommodate proposed pedestrian crossings	-13
<b>Frederick Douglass Avenue</b>	North side, between Main St and parking lot	Existing parking will be extended on north side of the street and added on south side	+35
<b>L Street</b>	Several spots on the south side of the street	South side parking will be removed, replaced with increased spots on the north side	+13
<b>West Elm Street</b>	South side, between Warren Ave and Main St	South side parking will be removed, replaced with north side parking	+4
<b>Belmont Street</b>	North side, between Warren Ave and Main St	Some on-street parking is proposed between Cottage St and Main St	+10
<b>Petronelli Way</b>	South side, between Main St and Montello St	On-street parking will be removed	-24
<b>Church Street</b>	None	Several spots will be added on the south side of the street between Main St and Montello St	+7
<b>School Street</b>	South side, between Montello St and Lincoln St	Parking will be added on the north side of the street between Lincoln St and Montello St, and on the south side near Main Street.	+20
<b>VFW Parkway</b>	None	Several spots will be added to the north side of the street	+10
<b>Crescent Street</b>	South side, between Main St and Montello St	Several will be removed close to Main St. Taxi stand will be removed from the north side	-3

<sup>4</sup> Brockton Downtown Parking Study, Nelson Nygaard. January 2017.





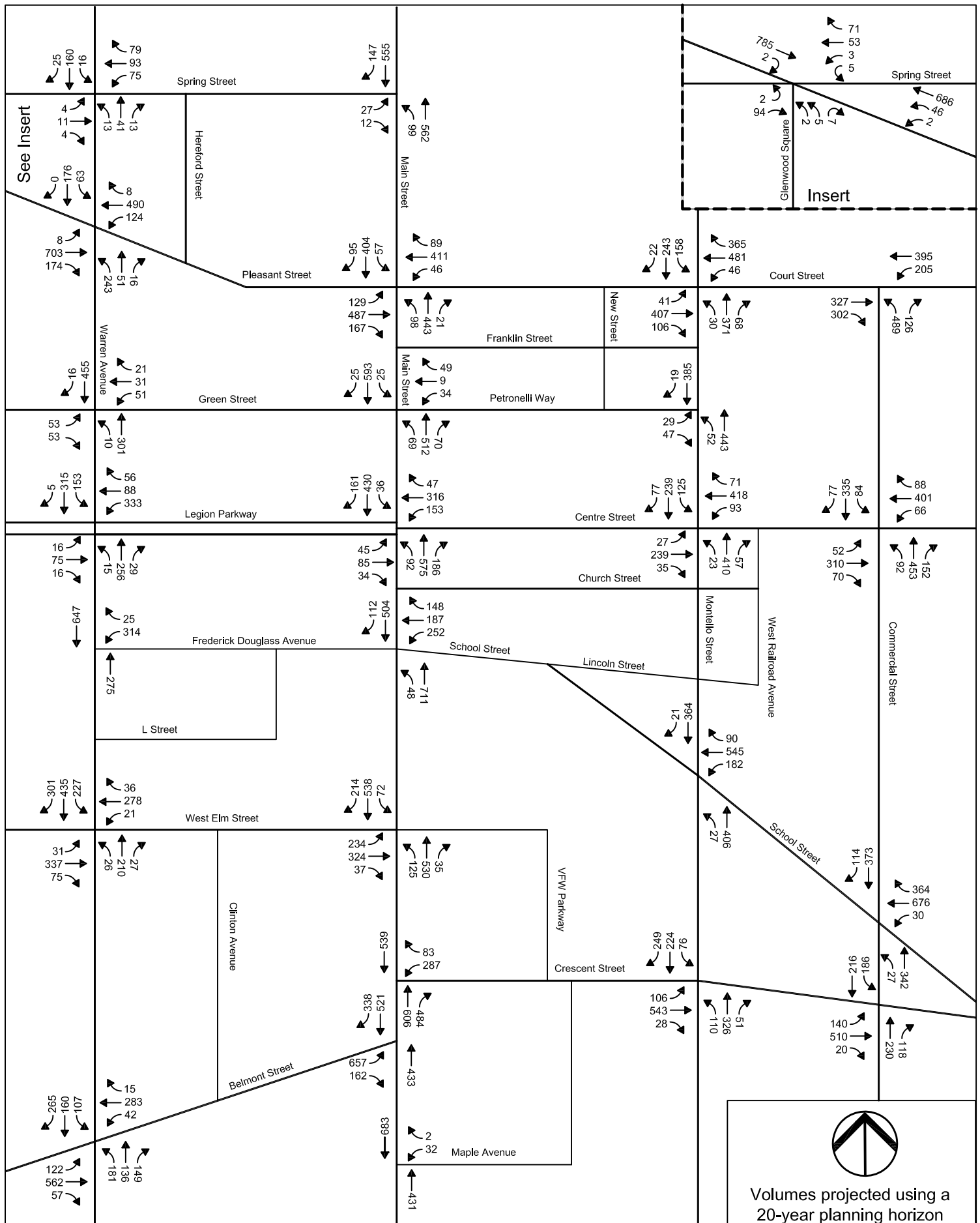


### 3.5. Future Traffic Volumes – Proposed Roadway Network

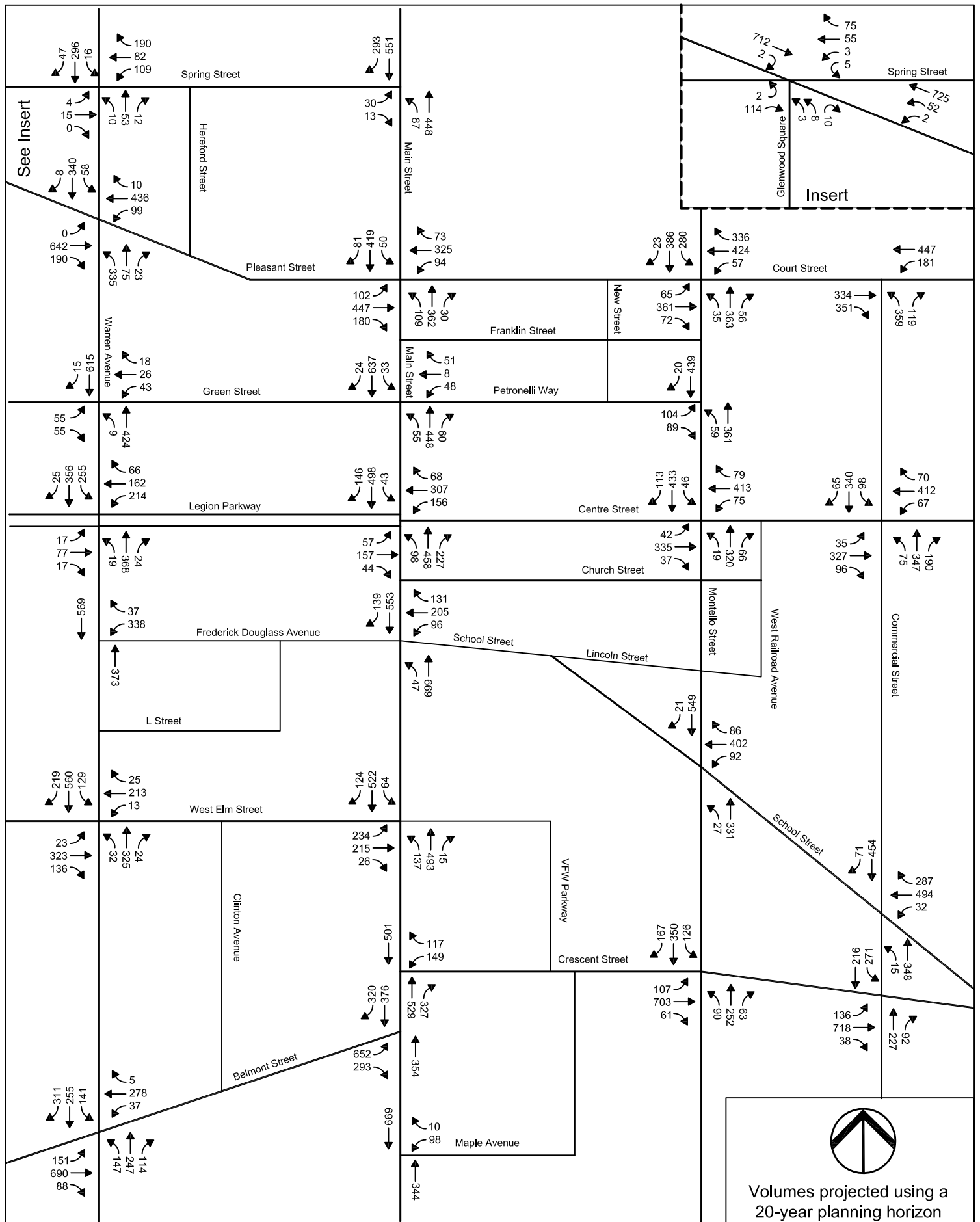
The proposed roadway layout and two-way traffic operations throughout Downtown will enable additional travel routes that do not currently exist. Traffic volumes were assigned to each of the new routes based on a review of the prior 1999 and 2007 studies and were further refined to reflect balanced future traffic operations throughout the Downtown.

The addition of northbound movements along Warren Avenue, southbound movements along Main Street, and westbound movements along Belmont Street and West Elm Street are the four major circulation changes to Downtown Brockton after full implementation of the two-way conversions. Additional north-south and east-west travel routes will be opened with the conversion of the streets. These conversions will reduce the number of circuitous travel routes throughout Downtown Brockton and will provide more direct connections for through traffic and for origins and destinations within the Downtown area.

The 2007 PB report presented future traffic volume networks with some of the proposed converted streets. Existing 2018 traffic volumes were used in conjunction with the anticipated trip generation from Downtown developments and the traffic distributions from the 2007 PB report to develop the 2038 future traffic volume conditions. Adjustments were made to properly balance the north-south traffic volumes to reflect a balanced network. The 2038 future traffic volumes with the proposed roadway network are presented in Figures 22 and 23, respectively, for the weekday morning and evening peak hours.



2038 Weekday Morning Peak Hour Traffic Volumes - Proposed Geometry  
Downtown Traffic Study  
Brockton, MA



2038 Weekday Evening Peak Hour Traffic Volumes - Proposed Geometry  
Downtown Traffic Study  
Brockton, MA

Figure 23

## 4 Traffic Operations Analysis

To assess the quality of traffic flow, capacity analyses were conducted at the study area intersections for the weekday morning and weekday evening peak hours. Analyses were conducted using the Synchro 10 traffic analysis software, which is based on methods defined in the Highway Capacity Manual 2010<sup>6</sup>. The Synchro analysis was supplemented with a microsimulation analysis using PTV Vissim traffic modeling software. This software was used to validate assumptions and generate video models for stakeholder presentations to visualize traffic flow throughout the proposed network.

A primary result of capacity analyses is the assignment of a Level of Service (LOS) to traffic facilities under various traffic flow conditions. Six Levels of Services are defined for each type of facility. They are given letter designations from A to F, with LOS A representing operating conditions with little delay and LOS F representing conditions with the most delay.

The average delay per vehicle approaching an intersection is used to quantify the LOS at a particular intersection. The LOS designations are defined below in Table 7. Average delay measures the mean stopped delay experienced by vehicles entering an intersection during the analysis period. Average delay is measured for each individual turning movement that must yield the right of way and for the intersection as a whole, if signalized.

**Table 7: Level of Service Designations**

Level of Service	Average Delay (seconds/vehicle)	
	Unsignalized	Signalized
A	0.0 - 10.0	0.0 - 10.0
B	>10.0 – 15.0	>10.0 – 20.0
C	>15.0 – 25.0	>20.0 – 35.0
D	>25.0 – 35.0	>35.0 – 55.0
E	>35.0 – 50.0	>55.0 – 80.0
F	>50.0	>80.0

Source: Transportation Research Board, *Highway Capacity Manual*, National Research Council, 2010.

Tables 8 and 9 show the level of service of the study area intersections during the weekday morning and weekday evening peak hours for the following scenarios:

- 2018 Existing Conditions
- 2038 Future Conditions without Improvements
- 2038 Future Conditions with Improvements

<sup>6</sup> *Highway Capacity Manual* 2010; Transportation Research Board; Washington, DC; 2010.



**Table 8: Intersection Level of Service – Weekday Morning Peak Hour**

	2018 Existing Geometry		2038 Existing Geometry		2018 Proposed Geometry		2038 Proposed Geometry	
	Delay <sup>1</sup>	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Warren Ave at Spring St	13.5	B	14.3	B	18.8	B	18.2	B
Warren Ave at Pleasant St	8.3	A	10.4	B	34.8	C	60.8	E
Warren Ave at Legion Pkwy & Highland St	15.8	B	18.6	B	30.4	C	46.0	D
Warren Ave at Frederick Douglass Ave	7.3	A	9.9	A	18.1	B	17.6	B
Warren Ave at West Elm St	18.7	B	26.6	C	19.7	B	35.4	D
Warren Ave at Belmont St	48.6	D	91.1	F	19.5	B	41.8	D
Main St at Pleasant St & Court St	17.8	B	25.7	C	32.0	C	41.9	D
Main St at Legion Pkwy & Centre St	12.3	B	16.2	B	15.3	B	42.8	D
Main St at Frederick Douglass Ave & School St	8.4	A	10.9	B	23.0	C	70.3	E
Main St at West Elm St & VFW Pkwy	8.8	A	11.3	B	48.6	D	124.6	F
Main St at Crescent St	3.5	A	3.8	A	17.8	B	21.6	C
Main St at Belmont St	5.1	A	9.7	A	19.7	B	41.8	D
Montello St at Court St	22.2	C	77.4	E	28.3	C	33.6	C
Montello St at Centre St	20.2	C	30.9	C	23.6	C	35.2	C
Montello St at School St	17.5	B	21.6	C	21.7	C	23.3	C
Montello St at Crescent St	13.0	B	19.7	B	25.4	C	28.6	C
Commercial St at Court St	22.7	C	48.6	D	25.9	C	42.4	D
Commercial St at Centre St	14.7	B	26.6	C	23.2	C	23.2	C
Commercial St at School St	9.3	A	11.6	B	14.0	B	14.3	B
Commercial St at Crescent St & Perkins St	18.4	B	25.0	C	15.8	B	16.5	B

1 Delay measured in seconds per vehicle

Table 9: Intersection Level of Service – Weekday Evening Peak Hour

	2018 Existing Geometry		2038 Existing Geometry		2018 Proposed Geometry		2038 Proposed Geometry	
	Delay <sup>1</sup>	LOS	Delay	LOS	Delay	LOS	Delay	LOS
Warren Ave at Spring St	12.3	B	13.1	B	22.8	C	26.4	C
Warren Ave at Pleasant St	9.5	A	15.9	B	51.4	D	103.5	F
Warren Ave at Legion Pkwy & Highland St	20.1	C	49.6	D	19.2	B	27.4	C
Warren Ave at Frederick Douglass Ave	9.5	A	14.7	B	15.0	B	21.7	C
Warren Ave at West Elm St	18.3	B	47.2	D	18.5	B	32.3	C
Warren Ave at Belmont St	77.8	E	162.7	F	24.7	C	89.5	F
Main St at Pleasant St & Court St	27.9	C	59.8	E	26.1	C	39.9	D
Main St at Legion Pkwy & Centre St	14.2	B	17.6	B	17.8	B	27.7	C
Main St at Frederick Douglass Ave & School St	8.6	A	10.9	B	14.7	B	40.1	D
Main St at West Elm St & VFW Pkwy	10.1	B	13.0	B	18.0	B	67.7	E
Main St at Crescent St	3.7	A	4.6	A	8.9	A	8.9	A
Main St at Belmont St	5.2	A	9.6	A	14.1	B	14.2	B
Montello St at Court St	24.7	C	143.4	F	21.8	C	33.9	C
Montello St at Centre St	19.1	B	86.0	F	21.0	C	28.6	C
Montello St at School St	15.9	B	24.9	C	8.3	A	10.9	B
Montello St at Crescent St	20.2	C	87.9	F	23.6	C	27.7	C
Commercial St at Court St	22.9	C	44.8	D	18.5	B	24.1	C
Commercial St at Centre St	11.2	B	17.0	B	16.2	B	18.5	B
Commercial St at School St	3.6	A	12.8	B	12.9	B	15.2	B
Commercial St at Crescent St & Perkins St	19.1	B	44.5	D	11.5	B	31.3	C

1 Delay measured in seconds per vehicle

Several observations can be made from the Synchro analysis results presented in Tables 8 and 9 above.

- The majority of study area intersections are expected to operate at LOS D or better under the 2038 Future Build conditions during both the AM and PM peak hour periods.
- During the AM peak hour period, the intersection of Main Street at West Elm & VFW Parkway is expected to operate at LOS F under the 2038 Future Build conditions.
- During the PM peak hour period, the intersections of Warren Avenue at Pleasant Street and Warren Avenue at Belmont Street are expected to operate at LOS F under the 2038 Future Build conditions. Under the 2038 Future No-Build conditions, one intersection is expected to operate at LOS F during the AM peak hour period, and four during the PM peak hour period.

Detailed operations analysis tables that present queues, v/c ratios, and delays are provided in the Appendix.

## 5 Project Phasing

The proposed design of the Downtown Brockton area will require a construction schedule that consists of several phases. The recommended phasing sequence is described below and presented in Figure 24. Several factors influenced the proposed phasing, including discussions with stakeholders and the project team, construction cost, and construction impacts to the Downtown. A Synchro analysis was performed to determine the operational impacts of the phased two-way conversion. A summary of this analysis is contained in the Appendix. BSC recommends completing the two-way conversion and other proposed improvements along Main Street under Phase 1 alongside the improvements to Legion Parkway, West Elm Street and Belmont Street, Spring Street, and Court Street. The two-way conversion of Warren Avenue could be completed in Phase 2, while additional roadway and intersection improvements grouped under Phase 3 may be completed at any point during the project.

### **Phase 1:**

- Main Street
  - Two-way conversion
  - Northbound and southbound cycle track installation
  - Sidewalk and curb replacement
  - Roadway reconstruction
  - Traffic signal reconstruction at each signalized intersection
- West Elm Street
  - Two-way conversion
  - Roadway curb-to-curb realignment, sidewalk and curb replacement
  - Roadway reconstruction
  - Traffic signal reconstruction at intersection with Warren Avenue
- Belmont Street
  - Two-way conversion
  - Sidewalk and curb replacement
  - Roadway reconstruction
  - Traffic signal reconstruction at intersection with Warren Avenue
- Legion Parkway
  - Install curb bump-out in front of Neighborhood Health Center
  - Realign center median near Main Street
  - Install midblock crossings and curb bump-outs
  - Install two-way cycle track on central median
  - Roadway reconstruction
  - Traffic signal reconstruction at intersection with Warren Avenue
- Spring Street
  - Two-way conversion (chicane style lanes and parking arrangement)
  - Roadway reconstruction
  - Curb bump-out and Do Not Enter signage at intersection with Pleasant Street
  - Traffic signal reconstruction at intersection with Warren Avenue
- Green Street
  - Reverse direction of one-way traffic to westbound
  - Allow parking on both sides of street



- Court Street
  - Widen sidewalk at south side of Court Street between Court Avenue and Montello Street
  - Install proposed lane configuration

### **Phase 2:**

- Warren Avenue
  - Two-way conversion
  - Roadway curb realignment, sidewalk and curb replacement
  - Roadway reconstruction
  - Traffic signal reconstructions at intersections with Frederick Douglass Avenue and Pleasant Street

### **Phase 3: (to be completed at any point during the project)**

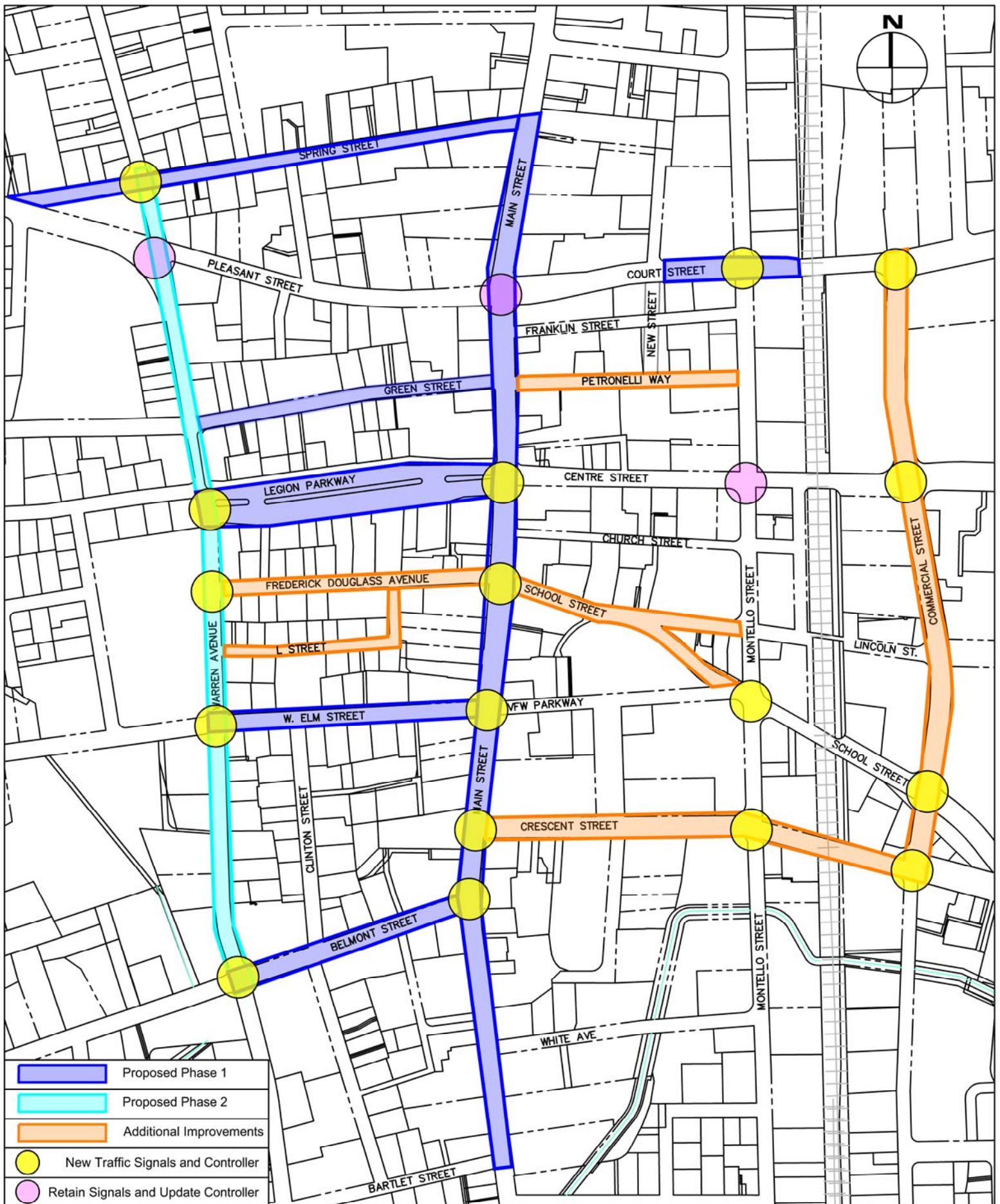
- Frederick Douglass Avenue
  - Sidewalk and curb replacement
  - Roadway reconstruction
- School Street and Lincoln Street realignment
  - Roadway reconstruction
  - Implement north side School Street parking between Lincoln Street and Montello Street
- Crescent Street
  - Install eastbound cycle track
  - Roadway realignment, sidewalk and curb replacement
  - Roadway mill & overlay
- Montello Street
  - Signal reconstruction at each signalized intersection
  - Mill and overlay
- Commercial Street
  - Northbound and southbound cycle tracks between Centre Street and Crescent Street
  - Sidewalk and curb replacement
  - Signal reconstruction at each signalized intersection
  - Mill and overlay

### **Utility and Streetscape Upgrades**

In addition to the improvements described above, the City plans to make upgrades to the existing aged utilities in the Downtown area. For example, the current sewer system along Main Street is over 100 years old and needs to be replaced. Water utilities will also be reconstructed, as well as private utilities such as gas and electric.

To support existing and future municipal communications technology, the City plans to install a fiber optic network in the Downtown area. As part of this project, the City proposes to install underground conduit during the reconstruction to facilitate the deployment of the fiber optic equipment.

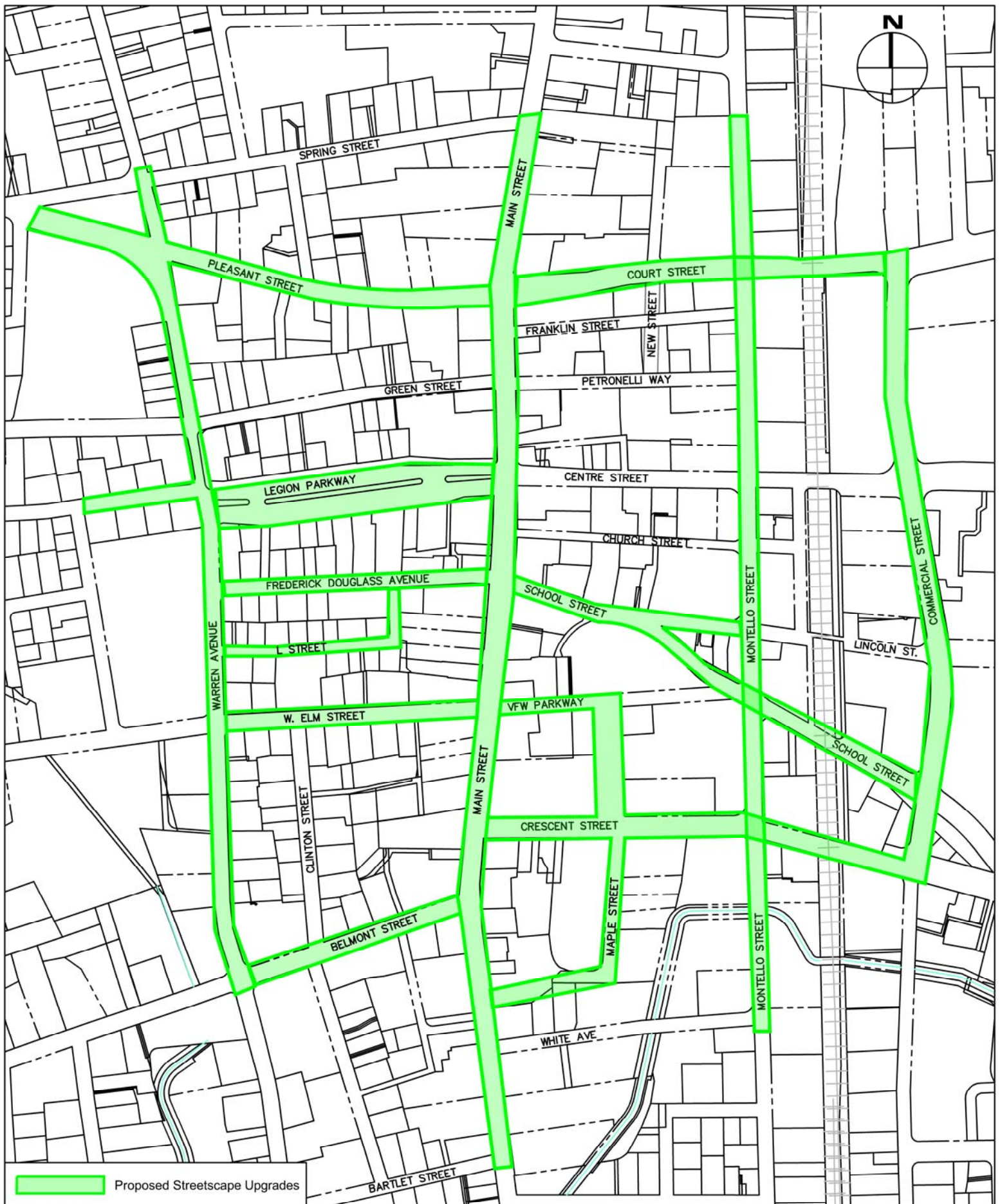
Proposed streetscape upgrades include street furniture, lighting, and green space additions such as trees and other plantings. The utility and streetscape improvements are included in the project cost estimate, displayed in the next section. Figure 25 displays the Downtown streets where streetscape improvements are proposed.



Proposed Project Phasing  
 Downtown Traffic Study  
 Brockton, MA

Figure 24





Proposed Streetscape Upgrades  
Downtown Traffic Study  
Brockton, MA

Figure 25



## 6 Opinion of Probable Construction Costs

A preliminary opinion of probable cost estimate has been developed and broken down by the proposed phases. Major components of the estimate include the following:

- Field topographical surveys for roadway design
- Traffic and pedestrian signal upgrades and/or reconstruction at 21 signalized intersections
- Full depth roadway reconstruction of Main Street, Warren Avenue, West Elm Street, Belmont Street, etc.
- Reconstruction of curbs, sidewalks, and ADA curb ramps
- Pavement marking and signage
- Reconstruction water and sewer utility lines along Main Street and Warren Avenue
- Installation of a fiber-optic cable network
- Streetscape and landscaping upgrades

The project cost estimate is summarized in Table 10. Costs are separated by construction, survey, and utility work. Estimates are also included for engineering, contingency, and traffic control costs. Complete cost estimate details are contained in the Appendix.

**Table 10: Project Cost Estimate**

	Phase 1	Phase 2	Phase 3	Total
Construction	\$ 8,413,000.00	\$ 3,845,000.00	\$ 5,984,000.00	\$ 18,242,000.00
Construction Contingency (20%)	\$ 1,683,000.00	\$ 769,000.00	\$ 1,197,000.00	\$ 3,649,000.00
Survey	\$ 400,000.00	\$ 0.00	\$ 0.00	\$ 400,000.00
Design Engineering (15%)	\$ 2,737,000.00	\$ 0.00	\$ 0.00	\$ 2,737,000.00
Construction Engineering (10%)	\$ 842,000.00	\$ 385,000.00	\$ 599,000.00	\$ 1,826,000.00
Traffic Control (5%)	\$ 421,000.00	\$ 193,000.00	\$ 300,000.00	\$ 914,000.00
<b>Roadway Subtotal</b>	<b>\$ 14,496,000.00</b>	<b>\$ 5,192,000.00</b>	<b>\$ 8,080,000.00</b>	<b>\$ 27,768,000.00</b>
Main Street Water Utilities	\$ 970,000.00	\$ 0.00	\$ 0.00	\$ 970,000.00
Main Street Sewer Utilities	\$ 837,000.00	\$ 0.00	\$ 0.00	\$ 836,500.00
Warren Avenue Water Utilities	\$ 0.00	\$ 702,000.00	\$ 0.00	\$ 702,000.00
Warren Avenue Sewer Utilities	\$ 0.00	\$ 612,000.00	\$ 0.00	\$ 612,000.00
Fiber-Optic Conduit Installation	\$ 1,016,000.00	\$ 349,000.00	\$ 976,000.00	\$ 2,341,000.00
Streetscape / Landscape Allowance	\$ 1,578,000.00	\$ 470,000.00	\$ 2,517,000.00	\$ 4,565,000.00
<b>Overall Subtotal</b>	<b>\$ 18,897,000.00</b>	<b>\$ 7,325,000.00</b>	<b>\$ 11,573,000.00</b>	<b>\$ 38,000,000.00</b>

The complete project, including utility work, is estimated to cost approximately 38 million dollars to reach full completion. The first phase, which includes all of the Main Street, Legion Parkway, West Elm Street, Belmont Street, Spring Street, and Court Street improvements, is estimated to cost nearly 19 million dollars. The second phase includes all of the Warren Avenue upgrades and is expected to cost just over 7 million dollars, while the third phase is expected to cost 11.5 million dollars. The cost estimates are preliminary and are subject to change during the design of this project.

## 7 Conclusions and Recommendations

BSC has completed this Downtown Brockton Traffic Study as an update to and expansion upon previous studies with the purpose of determining the feasibility and optimal design of a two-way Downtown street network. BSC recommends numerous improvements to traffic circulation, traffic signal technology, and pedestrian and bicycle infrastructure, with a total estimated project cost of approximately 38 million dollars. These upgrades will contribute towards improving the revitalization of the Downtown area.

The proposed design includes introducing adaptive traffic signal to the Downtown area to improve travel time reliability and an upgraded central control system to monitor the signal network and efficiently facilitate emergency responses. Additionally, infrastructure improvements such as accessible pedestrian signals, increases to sidewalks and green spaces, and separated bike lanes will enhance pedestrian and bicycle network connectivity.

Analysis has shown that Downtown traffic operations will be acceptable under the proposed two-way circulation. Under the 2038 future build conditions, with a few exceptions, the signalized study area intersections are expected to operate at LOS D or better during the AM and PM peak hours.

It is recommended that this project should be constructed in phases, beginning with the proposed upgrades to Main Street, Legion Parkway, West Elm Street, Belmont Street, Spring Street, and Court Street, followed by the two-way conversion and improvements to Warren Avenue. The remaining proposed upgrades to the Downtown area are to be completed in any sequence at the discretion of the City of Brockton.

The next steps for this project will include:

- Review of this Study by the City of Brockton and MassDOT District 5
- Submission of a Project Need Form (PNF) and Project Initiation Form (PIF) by the City
- Full survey of the Downtown streets and development of detailed construction plans

**List of Appendices:**

Appendix A: Supplemental Report Figures

Appendix B: Crash Data / Collision Diagrams

Appendix C: Cost Estimate Summary

Appendix D: Traffic Volumes

Appendix E: Capacity Analysis Synchro Reports

## **Appendix A: Supplemental Report Figures**



## **Appendix B: Crash Data/Collision Diagrams**

## **Appendix C: Cost Estimate Summary**

## Appendix D: Traffic Volumes

## **Appendix E: Capacity Analysis Synchro Reports**