

# ROAD SAFETY AUDIT

Route 123 (Belmont St.)/West St./West Side Plaza Dr.,  
Route 123/Forest Ave./West Side Plaza Dr.  
Route 123/West St.

City of Brockton

May 5, 2016

Prepared For:  
MassDOT



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## Background

A Road Safety Audit (RSA) was conducted along a one-third mile long corridor of Route 123 (Belmont Street) in Brockton (see Figure 1). The corridor is defined as beginning at a point approximately 100 feet east of Angus Beaton Drive and ending approximately 200 feet east of West Street. The three signalized intersections located within the corridor were the focus of the RSA. From west to east, these include Belmont Street at West Street/West Side Plaza Driveway, Forest Avenue/West Side Plaza Driveway and West Street.

The corridor is under design by MassDOT (Project #608088). The Road Safety Audit process is a way of evaluating the safety of an intersection using a multidisciplinary team of engineers, administrators and safety personnel to identify issues that may be corrected to improve safety. The Team may identify short-term, medium-term, and long-term improvements which can be implemented in the near-term through maintenance or in the medium or long-term through the design process.

The MassDOT Highway Division obtains crash data from the Massachusetts Registry of Motor Vehicles (RMV) database and uses the data for many purposes. One of the primary purposes is to identify high crash locations at intersections throughout the Commonwealth. The crashes are grouped into clusters based on a crash cluster analysis method developed by their consultant, Geonetics. The information is presented in a GIS format which merges the crashes into clusters based on their location relative to each other. The software then calculates an Equivalent Property Damage Only (EPDO) rating for all the clusters and ranks them. Based on this analysis methodology the signalized intersections within the study area of Belmont Street/Forest Avenue/West Side Plaza Driveway and Belmont Street/West Street have been identified as high crash locations and within the top 5 percent of High Crash Locations within the Old Colony Planning Commission (OCPC).

Below is a summary of the EPDO and the number of crashes which have occurred at each intersection.

1. Belmont Street/West Street/West Side Plaza Driveway
  - 12 crashes (2012-2014)
  - EPDO rating of 20 (2012 – 2014)
2. Belmont Street/Forest Avenue/West Side Plaza Driveway
  - 21 crashes (2012-2014)
  - EPDO rating of 69 (2012-2014)
3. Belmont Street/West Street
  - 32 crashes (2012 – 2014)
  - EPDO rating of 80 (2012-2014)

## Project Data

The audit was conducted on Wednesday, April 13, 2016. The RSA agenda appears in Appendix A. Table 1 lists the audit team participants and their affiliation. The contact information for the audit team members is contained in Appendix B.

**Table 1: Participating Audit Team Members**

<b>Audit Team Member</b>	<b>Agency/Affiliation</b>
John Mastera	MassDOT Highway Safety Management
Leah Nesbitt	MassDOT Highway Safety Intern
Barbara LaChance	MassDOT District 5 Traffic
Bianca Marshall	MassDOT District 5 Traffic
Shaun D. Handy	MassDOT District 5 Projects
Jason Walters	MassDOT District 5 Projects
Kevin Galligan	Brockton Fire Department/Traffic Signals
Robert DiBari	Brockton Police Department/Traffic
Donald Mills	Brockton Police Department/School Division
Tobias T. Cowans	Brockton Public Schools/Director of Readiness and Emergency Management
Ray Guarino	Old Colony Planning Council (OCPC)
Bill McNulty	Old Colony Planning Council (OCPC)
Shane O'Brien	City of Brockton Planning
Paul Chenard	Old Colony Planning Council (OCPC)/Transportation Planner
Jim Antonizick	Tetra Tech
Nancy Doherty	Tetra Tech
Ethan Cecelya	Tetra Tech

Data provided to audit team members and reviewed at the RSA included area maps, peak hour traffic volumes, speed limit regulations and detailed crash information and is contained in Appendix C. The crash data and collision diagrams are based on crashes that were reported by the Brockton Police Department from 2012 to 2014.

## Project Location and Description

In Brockton, Belmont Street (Route 123) is an Urban Principal Arterial providing an east-west link between Route 24 to downtown. From the westerly limit of the corridor at Angus Beaton Drive to West Street, Belmont Street is under the jurisdiction of the MassDOT. Continuing through the intersection at West Street, Belmont Street is under local jurisdiction.

Belmont Street generally has a 70-foot-wide right-of-way which includes two travel lanes and a sidewalk with curbing in each direction. It has a posted speed limit of 35 mph. East of West Street, Belmont Street narrows as it approaches Torrey Avenue to one lane in each direction within a 55-foot right-of-way. The

side streets approaching the intersections do not have posted speed limits and are *defacto* 30 mph. No bicycle accommodations are provided along Belmont Street.

In the area of the audit, Belmont Street provides access to Brockton High School, Brockton Fire Station No. 6, the Brockton Registry of Motor Vehicles, two large athletic facilities, the Brockton Fairgrounds and many retail/commercial establishments. Brockton High School is located just south of the study area on Angus Beaton Drive. The school, which operates from 7:20 a.m. to 1:59 p.m., has a significant impact on traffic operations along the corridor for approximately 40 minutes before school opens and for approximately 20 minutes after school ends. Brockton Fire Station No. 6 is located at the westerly West Street intersection, south of Belmont Street.

#### Route 123 (Belmont Street)/West Street/West Side Plaza Driveway

This is a four-legged signalized intersection located in the westerly end of the corridor. The Belmont Street eastbound approach consists of a 120-foot long left turn lane, two through lanes and an unmarked right turn lane. The Belmont Street westbound approach consists of two through lanes. Both the West Street and West Side Plaza Driveway approaches each provide one shared left/through/right turn lane. Crosswalks are provided on the minor approaches. Bituminous sidewalks are located on both sides of Belmont Street and West Street, and are in fair condition. Along the south side of Belmont Street, east of West Street, the back of the sidewalk has no separation from adjacent parking lots. There is no sidewalk provided along the West Side Plaza Driveway. All four intersection corners have pedestrian ramps, but the ramps do not comply with Americans with Disabilities Act and Architectural Access Board (ADA/AAB) standards.

A 7-Eleven convenience store, located at the southeast quadrant of the intersection, has multiple large driveway openings on both Route 123 and West Street. A driveway to the Brockton Fire Station is located on West Street approximately 80 feet south of Belmont Street.

A fully actuated traffic signal operates with an eastbound lead protected left turn phase followed by a concurrent Belmont Street eastbound/westbound phase and a concurrent West Street/West Side Plaza Driveway phase. The traffic signal system does not include pedestrian accommodations. A cable connects the traffic signal controller to the Brockton Fire Station. Therefore, the fire department can pre-empt the traffic signal system to call a green indication to the northbound West Street approach when fire trucks are departing the station and entering the intersection. The traffic signal at this intersection is coordinated with the traffic signal controlling the Route 123/Angus Beaton Drive intersection to the west and the Route 123/Forest Avenue/West Side Plaza Driveway intersection to the east. The coordination is in effect from 10:00 a.m. to 7:00 p.m. on weekdays.

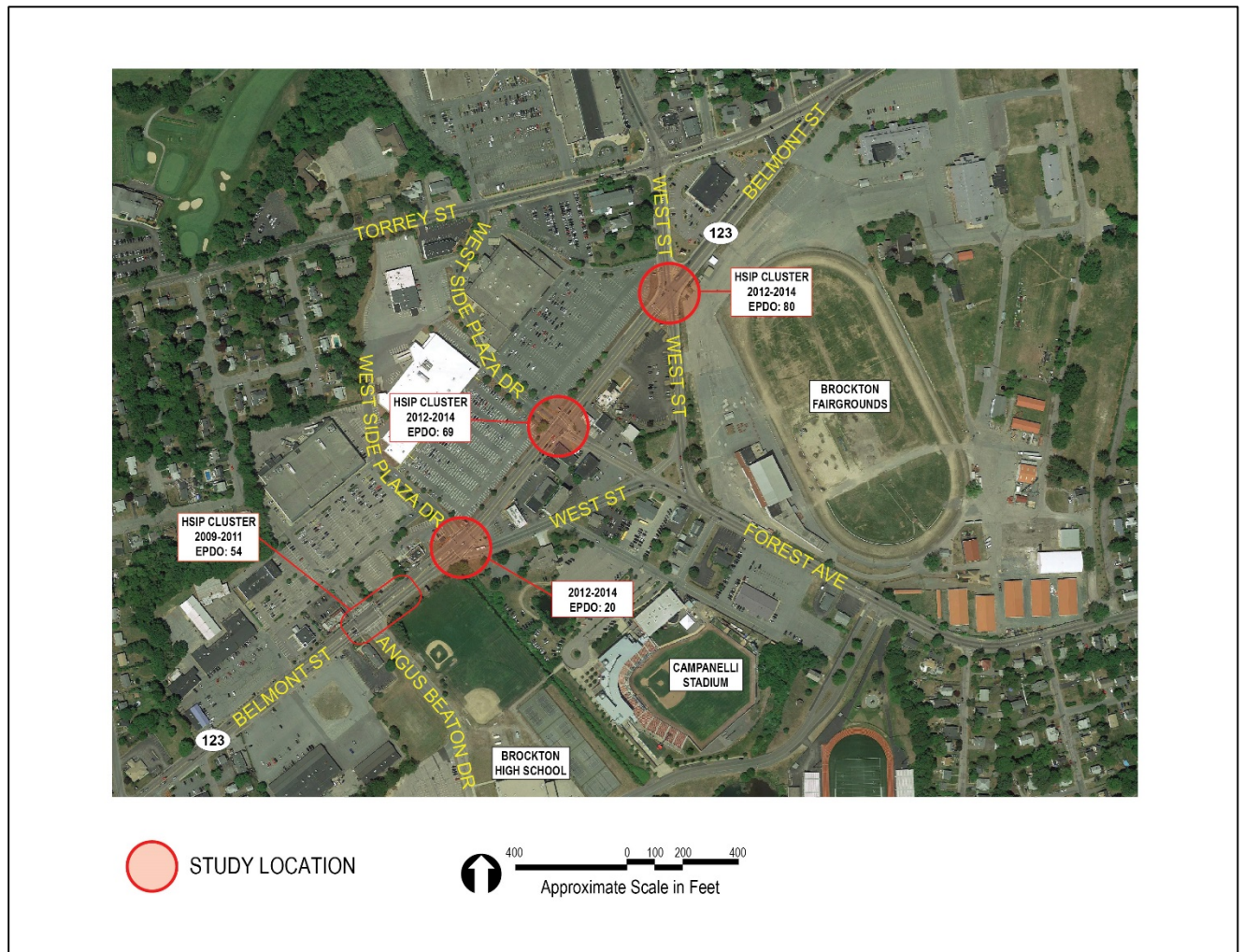


Figure 1: Locus Map

Route 123 (Belmont Street)/Forest Avenue/West Side Plaza Driveway

Located approximately 530 feet east of West Street, in the center of the corridor, is the four-way signalized intersection of Belmont Street, Forest Avenue, and West Side Plaza Driveway. Both the Belmont Street eastbound and westbound approaches consist of shared left/through and through/right lanes. The Forest Avenue and West Side Plaza Driveway approaches each provide one shared left/through/right lane. However, on the West Side Plaza Driveway traffic often queues in two lanes.

The Shell Gas Station and Rent A Center store, both located at the southerly corners of the intersection, have multiple driveway openings on Belmont Street and Forest Avenue.

Bituminous sidewalks are located along Belmont Street and are in fair condition. Sidewalks are not provided on Forest Avenue or the West Side Plaza Driveway. Crosswalks are provided on the east leg of

Belmont Street, Forest Avenue and the driveway. All four intersection corners have pedestrian ramps, but the ramps do not comply with ADA/AAB standards.

The traffic signal operates with a Belmont Street eastbound/westbound concurrent phase followed by an eastbound lagging protected left turn phase and a Forest Avenue/West Side Plaza Driveway concurrent phase. The traffic signal system includes an exclusive pedestrian phase. The traffic signal at this intersection is coordinated with the traffic signal controlling the Route 123/West Street/West Side Plaza Driveway intersection. It was noted during the morning peak period, the duration of the Belmont Street green phase was less than the duration of the green phase for the minor approaches.

#### Route 123 (Belmont Street)/West Street

Approximately 650 feet east of Forest Avenue, Belmont Street forms a skewed intersection with West Street. This intersection is under City of Brockton control. At this intersection, the Belmont Street eastbound and westbound approaches provide a left turn/through lane and a through/right turn lane. In the westbound direction, the right turn is channelized. There is no control provided at the merge point where vehicles turning right from westbound Belmont Street either enter northbound West Street or cross West Street and enter the West Side Plaza Driveway. The West Street northbound approach to Belmont Street provides one shared left/through/right lane. The West Street southbound approach includes a through lane and an exclusive right turn lane. A left turn is prohibited from West Street southbound onto Belmont Street eastbound. Concrete sidewalks are located on both sides of Belmont Street and West Street. The sidewalks are in fair condition. Crosswalks exist at all the approaches, including the channelized right turn lane. All four intersection corners have pedestrian ramps, but the ramps do not comply with ADA/AAB standards.

The traffic signal operates with three phases accommodating permissive east/west and north/south phases as well as an exclusive pedestrian phase. The traffic signal at this intersection is not coordinated with the traffic signals at West Street/West Side Plaza Driveway or Forest Avenue.

# Audit Observations and Potential Safety Enhancements

The RSA was conducted at the West Branch of the Brockton Public Library. In attendance were representatives from MassDOT, the City of Brockton, Old Colony Planning Council and Tetra Tech.

The following sections describes each of the safety issues in detail and discusses the potential enhancements and safety improvements developed by the RSA team. Following this section is a summary table outlining the issue, the potential solution, timeframe and responsible agency.

## **Route 123 (Belmont Street) Corridor**

### **Safety Issue #1 Congestion at School Opening and Ending**

#### **Observations:**

1. Between 6:40 a.m. and 7:20 a.m. and 2:00 p.m. and 2:20 p.m., when students are either arriving at or departing from Brockton High School, long queues form in the westbound left turn lane on Route 123 at Angus Beaton Drive which extend through the entire study corridor and beyond the easterly West Street intersection. This results from the high number of students which cross Belmont

Street at Angus Beaton Avenue during these time periods. Students are dropped off/picked up in the shopping center parking lot on the north side of the street. Crossing guards activate the exclusive pedestrian phase and then augment the red signal indications with hand held STOP signs. The pedestrian phase is called almost every cycle which results in the long delays and queues on Belmont Street. The long queues result in gridlock on Belmont Street with drivers becoming frustrated and exhibiting aggressive driving behavior as seen in Image 1.



**Image 1: Belmont Street WB during school arrival**

2. At the Belmont Street/Forest Avenue intersection 5 of the 21 reported crashes occurred during periods of Brockton High School traffic congestion.

#### **Potential Safety Enhancements:**

1. Encourage crossing guards to group students to the extent possible prior to activating the pedestrian phase.
2. Adjust the timing plan for the Route 123/Angus Beaton Drive intersection to provide a longer left turn phase indication westbound.



3. Provide a police button on the Route 123/Angus Beaton Drive intersection control cabinet to allow Brockton police to extend the left turn phase.

## Safety Issue #2 Pedestrian Facilities

### Observations:

1. There are a number of locations along the corridor where poor placement of signal equipment reduces the sidewalk width to less than two feet.
2. The transition from sidewalks to crosswalks does not meet current design standards for pedestrian accommodations and ADA/AAB accessibility standards.
3. Sloped granite edging on the north side of Belmont Street does not provide adequate protection for pedestrians.
4. RSA members indicated that pedestrians cross Belmont Street outside of crosswalks and were observed using cell phones or texting while walking across Belmont Street. This is prevalent in front of the 7 Eleven where there are no crosswalks on Belmont Street.



**Image 2: Sidewalk obstructed by signal equipment**

### Potential Safety Enhancements:

1. Relocate signal equipment to provide a minimum five foot wide clear sidewalk.
2. Replace granite sloped edging with vertical granite curbing and add ADA/AAB compliant accessible ramps at crosswalks.
3. Work with Brockton Public Schools to educate students on pedestrian safety.

## Safety Issue #3 Bicycle Accommodations

### Observations:

1. There are no bicycle accommodations provided along the corridor. The shoulders along Belmont Street are generally less than one or two feet wide and too narrow to accommodate bicycles. Although bicycle traffic is light within the corridor, there was a bicycle crash at the West Street/West Side Plaza driveway intersection. The cyclist traveling on West Street hit a vehicle that was stopped waiting to turn onto Belmont Street.

### Potential Safety Enhancements:

1. Provide bicycle accommodation per MassDOT's new Healthy Transportation Initiative Policy. Enhancements may include shared or dedicated bike lanes as well as bicycle detection and bike route signs & pavement markings (shared lane markings, for example) to alert drivers of the presence of the bikeway.
2. Consider a cycle track along the north side of Belmont Street.

## Safety Issue #4 Access Management

### Observations:

1. Curb cuts throughout the corridor do not meet current MassDOT standards. The numerous curb cuts at 7-Eleven, Sunny's Auto Center and the Shell Gas Station, all located along the south side of Belmont Street, were mentioned at the RSA. The numerous and wide curb cuts make it difficult for motorists to determine where a vehicle may be turning to enter the roadway or turning to enter a driveway.
2. Numerous access points to shopping centers are provided along the north side of Belmont Street and on West Street. This encourages traffic to cut through the shopping centers to avoid Belmont Street. RSA team members asked if the driveways could be consolidated.



**Image 3: Poor access management along Belmont Street**

### Potential Safety Enhancements:

1. Consolidate driveway openings to the extent possible.
2. Work with property owners to narrow curb cuts.
3. Consider closing the West Side Plaza Driveway on West Street to discourage cut-through traffic.

## Safety Issue #5 Traffic Signal Control

### Observations:

1. Signal pre-emption is not available for emergency vehicles.
2. A bus priority system is not available for Brockton Area Transit Authority buses.
3. The traffic signals at Angus Beaton Drive, West Street/West Side Plaza Drive and Forest Avenue are coordinated. It was observed that the coordination was not always functioning properly.
4. These signals which are under MassDOT control are not coordinated with the signals at Belmont Street/West Street and Belmont Street/Torrey Street which are under City of Brockton control. A coordinated system may reduce rear-end type collisions along the corridor.
5. The 100 percent design plans for the MassDOT's Project #606036 *Traffic and Safety Improvements of Belmont Street (Route 123) in the City of Brockton* includes updated traffic signal equipment at the Belmont Street/Angus Beaton Drive intersection. However, it is not noted on the plans that the intersection is to be coordinated with the Belmont Street/West Street/West Side Plaza Driveway.

### Potential Safety Enhancements:

1. Check existing coordination equipment and repair as needed.
2. Provide pre-emption for emergency vehicles.

3. As requested by the City of Brockton, provide a bus priority system for Brockton Area Transit Authority buses.
4. Work with the City of Brockton and MassDOT to provide a coordinated traffic signal system on Belmont Street from Angus Beaton Drive to Torrey Street.

## **Safety Issue #6 Lighting**

### **Observations:**

1. Existing lighting is provided by cobra-head fixtures mounted on utility poles. RSA team members indicated that lighting levels are inadequate and that the cobra-heads are sporadically located through the corridor.

### **Potential Safety Enhancements:**

1. Taking into account ambient lighting from parking areas, provide consistent lighting levels through the corridor with LED fixtures.

## **Safety Issue #7 Drainage**

### **Observations:**

1. Ponding occurs at the West Street/Forest Avenue/West Side Plaza intersection during periods of heavy rain.
2. On-street debris may be clogging catch basins.

### **Potential Safety Enhancements:**

1. Provide more frequent street sweeping.
2. Provide adequate drainage through the corridor as part of any future design.

## **Route 123 (Belmont Street)/West Street/West Side Plaza Driveway**



**Image 4: Belmont Street at West Street and West Side Plaza Driveway**

### **Safety Issue #1 Geometry**

#### **Observations:**

1. Audit team members noted that when motorists turn left from West Street onto Belmont Street (to proceed west) they often incorrectly enter the eastbound left turn lane before merging into the inner westbound departure lane. It was also noted that left turning vehicles from West Street often block southbound through vehicles. These issues are related to the poor alignment of the West Street approach to the intersection.
2. Three of the angle collisions involved vehicles approaching the intersection from West Street. One crash involved a vehicle proceeding north into the West Side Plaza colliding with a vehicle traveling east on Belmont Street and two crashes involved vehicles turning left from West Street colliding with vehicles exiting from the West Side Plaza Driveway.
3. During periods of substantial school-related traffic, maximizing the left turn lane on the Belmont Street westbound approach to Angus Beaton Drive may reduce the queue which extends through the corridor. This would require either removing or reducing the length of the Belmont Street eastbound left turn lane at West Street.
4. The large southwest corner radius encourages motorists to speed while turning and not to stop when turning right from Belmont Street eastbound onto West Street southbound. A "Right On Red After Full Stop" sign faces the Belmont Street eastbound approach. This concerns audit team

members because a significant volume of pedestrians cross in the West Street crosswalk. Additionally, the high turn speed, along with the proximity to the Brockton Fire Station driveway to Belmont Street, make it difficult for fire equipment to safely exit from the fire station.

**Potential Safety Enhancements:**

1. Consider installing lane extension lines to guide vehicles turning left from West Street onto Belmont Street.
2. Consider prohibiting a left turn from Belmont Street eastbound into West Side Plaza. This would have the benefit of removing the left turn lane which would allow the left turn lane at Angus Beaton Drive to be extended and would eliminate westbound vehicles from entering the turn lane when turning from West Street.

It would result in shifting approximately 22, 36 and 61 vehicles during the weekday morning, weekday afternoon and Saturday midday peak hour, respectively to the shopping center driveways at either Angus Beaton Drive or Forest Avenue. The need for a left turn lane on Belmont Street eastbound at Forest Avenue would need to be evaluated if this recommendation is implemented.

3. Consider reducing the southwest corner radius. Provide mountable curbing to accommodate emergency vehicles and large trucks.
4. Consider realigning the West Street approach to Belmont Street to reduce the southwest corner radius and provide an approach that is perpendicular to Belmont Street. This would effectively reduce the crossing distance for pedestrians. The City of Brockton owns the land in the southwest quadrant and may be amenable to the impact to City property.

**Safety Issue #2 Traffic Signal Control, Signing and Pavement Markings**

**Observations:**

1. There are no lane use pavement markings or signs provided for the Belmont Street right turn lane.
2. A pedestrian crosswalk sign is located on the southeast corner of the intersection facing Belmont Street eastbound. However, there is not a crosswalk on the west leg of Belmont Street.
3. A right turn on red is allowed on all approaches to the intersection. However, motorists were observed not stopping before turning.
4. The signal detectors on Belmont Street appear to be malfunctioning. For instance it was observed that a green indication is given to Belmont Street although a vehicle was waiting on a minor approach with little or no traffic on Belmont Street.
5. The SCHOOL pavement marking west of the intersection is not in accordance with the Massachusetts Amendments to the 2009 MUTCD. The amendments stipulates that a School Zone can be established if the school involved includes one or more grades between Grade 1 and Grade 8. Brockton High School includes only students from Grade 9 and up.

**Potential Safety Enhancements:**

1. Provide adequate pavement markings and signing for the Belmont Street eastbound right turn lane.
2. Consider a “No Turn on Red” restriction for the Belmont Street eastbound right turn lane.
3. Remove the existing crosswalk sign.
4. Test and repair, as necessary, loop detectors on Belmont Street.
5. Remove the SCHOOL pavement marking west of the intersection.

### **Safety Issue #3 Pedestrian Accommodations**

#### **Observations:**

1. There are no crosswalks on the Belmont Street approaches to the intersection.
2. There is no pedestrian signal equipment.

#### **Potential Safety Enhancements:**

1. Consider crosswalks on both Belmont Street approaches.
2. Consider installing pedestrian signals with countdown heads and accessible pedestrian pushbuttons.
3. Consider concurrent pedestrian signal phasing if a Belmont Street eastbound left turn is restricted.

### **Safety Issue #4 Catch Basin Maintenance**

#### **Observations:**

1. The catch basin located in the eastbound right turn lane approximately 10 feet before the STOP line is severely depressed and not at grade. This encourages drivers to pull away from the curb line when turning right from Belmont Street onto West Street.

#### **Potential Safety Enhancements:**

1. Repair the catch basin and bring the grate up to the existing grade.

### **Safety Issue #5 Bus Stop**

#### **Observations:**

1. A Brockton Area Transit Authority bus stop is located on the eastbound side of Belmont Street, west of West Street. This stop is heavily used by Brockton High School students. The buses stop in the outer through lane to pick-up and drop-off passengers causing delays to through traffic.

#### **Potential Safety Enhancements:**

1. Install a bus turnout on the eastbound side of Belmont Street. The 100 percent design plans for the MassDOT’s Project #606036 *Traffic and Safety Improvements of Belmont Street (Route 123)* in the City of Brockton includes a bus turnout which will allow the buses to move out of the Belmont Street travel way to pick-up and drop-off passengers.

## **Route 123 (Belmont Street)/Forest Avenue/West Side Plaza Driveway**



**Image 5: Belmont Street at Forest Avenue/West Side Plaza Driveway**

### **Safety Issue #1 Traffic Signal Operations/Equipment**

#### **Observations:**

1. The amount of time a green indication is provided to Belmont Street is shorter than the green time provided to the minor street approaches. The Belmont Street phase ends before the demand on Belmont Street is completely met and without a vehicle on the minor approaches. The audit team noted that six crashes involving vehicles turning left from Belmont Street, all of which resulted in injuries. The short amount of green time given to Belmont Street may be causing motorists to drive aggressively through the intersection, resulting in injury crashes. The short green time provided to Belmont Street may be the result of detectors that are not working properly or an inadequate signal timing plan.
2. Based on the signal permit, a lagging phase is provided to Belmont Street eastbound. Although not observed during the audit, members indicated the phase is occasionally called.
3. A five-section signal head faces the eastbound approach, however, there is no exclusive left turn lane on the eastbound approach.

#### **Potential Safety Enhancements:**

1. The signal detectors on Belmont Street need to be evaluated and possibly repaired.

2. The signal timing settings need to be evaluated and possibly adjusted to provide adequate capacity on Belmont Street.
3. Consider upgrading the existing five-section signal head to “flashing yellow” signal head per the MUTCD.
4. Consider exclusive left turn lanes with protected left turn phasing for Belmont Street. Left turn accommodations may be critical if the aforementioned left turn restriction from Belmont Street into the West Side Plaza Driveway at West Street is implemented.
5. Consider restriping the West Side Plaza Driveway to a left turn lane and shared through/right turn lane.
6. For the West Side Plaza Driveway approach, consider a lead left turn phase followed by concurrent northbound/southbound phase.

## **Safety Issue #2 Pedestrian Accommodations**

### **Observations:**

1. The existing pedestrian signal heads and push buttons at the Forest Avenue and West Street (east) intersections do not meet current MUTCD or MassDOT standards.
2. The pedestrian flashing Do Not Walk phase appears too short to safely allow slower pedestrians to cross Belmont Street.
3. There is no crosswalk on the west leg of Belmont Street.

### **Potential Safety Enhancements:**

1. Update pedestrian signal equipment to the latest Accessible Pedestrian Signal (APS) standards, including countdown pedestrian signal heads and pushbuttons.
2. Evaluate the need and feasibility of a crosswalk on the west leg of Belmont Street.



## **Route 123 (Belmont Street)/West Street**



**Image 6: Belmont Street at West Street**

### **Safety Issue #1 Traffic Signal Control, Signing and Pavement Markings**

#### **Observations:**

1. There is no control provided at the merge point where vehicles turning right from the channelized westbound Belmont Street right turn enter West Street. Three crashes involved vehicles turning right from Belmont Street westbound onto West Street.
2. There are no advance warning signs to the crosswalk located at the westbound Belmont Street channelized right turn at West Street.
3. The Object Marker sign on the triangular island is not appropriate for that location as it faces both Belmont Street eastbound and West Street northbound traffic.
4. The lane drop on eastbound Belmont Street, which occurs approximately 400 feet east of the intersection, is not adequately marked.
5. Traffic signs at the intersection appear old and are not reflective.



**Image 7 Warning signs missing at crosswalk**

#### **Potential Safety Enhancements:**

1. Install a YIELD sign and markings at Belmont Street channelized right turn.
2. Replace the Object Marker sign on the triangular island with a Keep Left sign.
3. Provide crosswalk signs at the crosswalk at the westbound Belmont Street channelized right turn at West Street.
4. Consider installing lane-reduction transition markings at the lane drop on Belmont Street, east of the intersection.
5. Inventory and replace, as necessary, all traffic signs which do not have adequate reflective coating.

## **Safety Issue #2 Geometry**

### **Observations:**

1. The triangular island is poorly delineated and may not be set back enough from West Street. An audit member indicated that while proceeding north on West Street across Belmont Street after dark, he hit the edge of the poorly lit island.

### **Potential Safety Enhancements:**

1. Provide reflectorized edge lines on all sides of the island.
2. Redesign the island with standard setbacks from the travel way.
3. Consider prohibiting a right turn from Belmont Street westbound onto West Street. The right turn volume is minor with 15 or less right turning vehicles during the weekday and Saturday peak hours. This would result in the removal of the triangular channelizing island.

## **Safety Issue #3 West Side Plaza Driveway at West Street**

### **Observations:**

1. Seven of the 32 crashes which occurred at the Belmont Street/West Street intersection occurred at or close to the West Side Plaza Driveway on West Street. The driveway is located approximately 70 feet north of Belmont Street. These crashes involved vehicles exiting from the driveway onto West Street. Vehicles exiting from the driveway must cross two lanes of southbound traffic in order to turn left onto West Street northbound. It was observed during the audit that sight lines to the north are poor due to vegetation at the Our Lady of Lourdes church.

### **Potential Safety Improvements**

1. Improve existing sight lines at the West Side Plaza Driveway on West Street by working with the Our Lady of Lourdes church to trim vegetation to a height of less than 2 feet.
2. Consider restricting the West Side Plaza Driveway on West Street to a right turn in and a right turn out.

## Safety Issue #4 Pedestrian Accommodations

### Observations:

1. Two pedestrian crashes occurred at this intersection. Both occurred outside of crosswalk locations.
2. The existing pedestrian signal heads and push buttons do not meet current MUTCD or MassDOT standards.
3. The pedestrian flashing Do Not Walk phases appear too short to safely allow slower pedestrians to cross Belmont Street.

### Potential Safety Enhancements:

1. Evaluate the existing pedestrian crossing times and adjust as necessary.
2. Update pedestrian signal equipment to the latest Accessible Pedestrian Signal (APS) standards, including countdown pedestrian signal heads and pushbuttons.

## Safety Issue #5 Lighting

### Observations:

1. 28 percent of crashes occurred after dark.
2. Audit team members suggested that the triangular island is not sufficiently lighted.

### Potential Safety Enhancements:

1. Evaluate and enhance intersection lighting as appropriate.

## Summary of Road Safety Audit

Table 2 below summarizes the issues identified in the previous section and includes the potential safety payoff, approximate cost, a time frame for completion and the responsible agency.

Safety payoff estimates are subjective and are based on the relative percent of crashes that may be reduced by the enhancement based on known and documented crash reduction factors, if available, or estimated crash reduction based on a stated source [for example, low (<30%), medium (31% to 70%), and high (>71%)]. The time frame is categorized as short-term (<1 year), mid-term (1 to 3 years), or long-term (>3 years). The costs are categorized as low (<\$10,000), medium (\$10,001 to \$50,000), or high (>\$50,001).

Table 2: Potential Safety Enhancement Summary

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Responsible Agency
<b>Corridor Wide</b>					
Congestion During School Opening and Ending	Encourage crossing guards to group students to the extent possible prior to activating the pedestrian phase.	Medium	Short-Term	Low	City of Brockton
	Adjust the timing plan for the Route 123/Angus Beaton Drive intersection to provide a longer left turn phase westbound.	Medium	Short-Term	Low	MassDOT
	Provide a police button on the Route 123/Angus Beaton Drive intersection control cabinet to allow Brockton police to extend the left turn phase.	Medium	Short-Term	Low	MassDOT
Pedestrian Facilities	Relocate signal equipment to provide a minimum 5 foot wide clear sidewalk.	High	Long-Term	High	MassDOT/ City of Brockton
	Replace granite sloped edging with vertical granite curbing and add ADA /AAB compliant accessible ramps at crosswalks	Medium	Long-Term	High	MassDOT
	Work with Brockton Public Schools to educate students on pedestrian safety.	High	Short-Term	Low	City of Brockton
Bicycle Accommodations	Provide bicycle accommodations. Enhancements may include shared or dedicated bike lanes as well as bicycle detection and bike route signs & pavement markings (shared lane markings, for example) to alert drivers to the presence of the bikeway.	High	Long-Term	High	MassDOT/ City of Brockton
	Consider a cycle track along the north side of Belmont Street	High	Long-Term	High	MassDOT City of Brockton
Access Management	Consolidate driveways to the extent possible.	Medium	Medium-Term	Medium	MassDOT/ City of Brockton

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Responsible Agency
	Work with property owners to narrow curb-cuts.	Medium	Medium-Term	Medium	MassDOT/ City of Brockton
	Consider closing the West Side Plaza Driveway on West Street to discourage cut-through traffic.	Low	Medium-Term	Low	City of Brockton
Traffic Signal Control	Check existing coordination equipment and repair as needed.	Medium	Short-Term	Low	MassDOT
	Provide traffic signal pre-emption for emergency vehicles.	High	Long-Term	High	MassDOT/ City of Brockton
	Provide a bus priority system for Brockton Area Transit Authority buses.	Low	Long-Term	High	MassDOT/City of Brockton
	Work with the City of Brockton and MassDOT to provide a coordinated traffic signal system on Belmont Street from Angus Beaton Drive to Torrey Street.	Medium	Long-Term	High	MassDOT/ City of Brockton
Lighting	Provide consistent lighting levels through the corridor with LED fixtures.	Medium	Long-Term	High	MassDOT/ City of Brockton
Drainage	Provide more frequent street sweeping.	Low	Short-Term	Low	MassDOT/ City of Brockton
	Provide adequate drainage through the corridor as part of any future design.	Low	Long-Term	High	MassDOT
<b>Belmont St./ West St./West Side Plaza Dr.</b>					
Geometry	Consider installing lane extension lines to guide vehicles turning left from West Street onto Belmont Street.	Medium	Short-Term	Low	MassDOT

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Responsible Agency
	Consider prohibiting a left turn from Belmont Street eastbound into West Side Plaza. The need for a left turn lane on Belmont Street eastbound at Forest Avenue would need to be evaluated if this recommendation is implemented.	Medium	Long-Term	Medium	MassDOT
	Consider reducing the southwest corner radius. Provide mountable curbing to accommodate emergency vehicles and large trucks.	Low	Medium-Term	High	MassDOT
	Consider realigning the West Street approach to Belmont Street to reduce the southwest corner radius and provide an approach that is perpendicular to Belmont Street.	Low	Long-Term	High	MassDOT
Traffic Signal Control, Signing and Pavement Markings	Provide adequate pavement markings and signing for the Belmont Street eastbound right turn lane.	Low	Short-Term	Low	MassDOT
	Consider a "No Turn on Red" restriction for the Belmont Street eastbound right turn lane.	Medium	Short-Term	Low	MassDOT
	Remove the existing crosswalk sign	Low	Short-Term	Low	MassDOT
	Test and repair as necessary loop detectors on Belmont Street	Medium	Short-Term	Medium	MassDOT
	Remove the existing SCHOOL pavement marking west of the intersection.	Low	Short-Term	Low	MassDOT
Pedestrian Accommodations	Consider crosswalks on both legs of Belmont Street.	Low	Long-Term	Medium	MassDOT
	Consider installing pedestrian signals with countdown heads and accessible pedestrian pushbuttons on the north, south and possibly west legs of the intersection.	High	Long-Term	High	MassDOT

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Responsible Agency
	Consider concurrent pedestrian signal phasing if the eastbound left turn is restricted.	Low	Long-Term	High	MassDOT
Catch Basin Maintenance	Repair the catch basin on the south side of Belmont Street (west of West Street). Bring the grate up to the existing grade.	Low	Short-Term	Low	MassDOT
Bus Stop	Install a bus turnout at the Belmont Street eastbound bus stop located west of West Street.	Medium	Long-Term	High	MassDOT/ City of Brockton
<b>Belmont St./ Forest Avenue/West Side Plaza Dr.</b>					
Traffic Signal Operations and Equipment	The signal detectors on Belmont Street need to be evaluated and possibly repaired.	Medium	Short-Term	Low	MassDOT
	The signal timing settings need to be evaluated and possibly adjusted to provide adequate capacity on Belmont Street.	Medium	Short-Term	Low	MassDOT
	Consider upgrading the existing five-section signal head to a "flashing yellow" signal head per the MUTCD.	Medium	Long-Term	Medium	MassDOT
	Exclusive left turn lanes with protected left turn phasing should be considered for Belmont Street.	High	Long-Term	High	MassDOT
	Consider restriping the West Side Plaza Driveway to a left turn lane and shared through/right turn lane.	Low	Short-Term	Low	MassDOT/ City of Brockton
	For the West Side Plaza Driveway approach, consider a lead left turn phase to allow a protected left turn.	Medium	Medium-Term	High	MassDOT

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Responsible Agency
Pedestrian Accommodations	Update pedestrian signal equipment to the latest Accessible Pedestrian Signal (APS) standards, including countdown pedestrian signal heads and pushbuttons.	High	Long-Term	High	MassDOT
	Evaluate the need and feasibility of a crosswalk on the west leg of Belmont Street.	Medium	Medium-Term	Medium	MassDOT
<b>Belmont St./ West St.</b>					
Traffic Signal Control, Signing and Pavement Markings	Install a YIELD sign and markings at Belmont Street channelized right turn.	High	Short-Term	Low	City of Brockton
	Replace the Object Marker sign on the triangular island with a Keep Left sign.	Low	Short-Term	Low	City of Brockton
	Provide crosswalk signs at the crosswalk at the westbound Belmont Street channelized right turn at West Street.	High	Short-Term	Low	City of Brockton
	Consider installing lane-reduction transition markings at the lane drop on Belmont Street, east of the intersection.	Low	Short-Term	Low	City of Brockton
	Inventory and replace as necessary all traffic signs which do not have adequate reflective coating.	High	Medium-Term	Medium	City of Brockton
Geometry	Provide reflectorized edge lines on all sides of the island.	High	Short-Term	Low	City of Brockton
	Redesign the island with standard setbacks from the travel way.	High	Medium-Term	Medium	City of Brockton
	Consider prohibiting a right turn from Belmont Street westbound onto West Street.	High	Medium-Term	Medium	City of Brockton



Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Responsible Agency
West Side Plaza Driveway at West Street	Improve sight lines at the West Side Plaza Driveway on West Street by working with the Our Lady of Lourdes church to trim vegetation to a height of less than 2 feet.	High	Short-Term	Low	City of Brockton
	Consider restricting the West Side Plaza Driveway on West Street to right turn in and a right turn out.	High	Medium-Term	Medium	City of Brockton
Pedestrian Accommodations	Evaluate existing pedestrian crossing times and adjust as necessary.	High	Short-Term	Low	City of Brockton
	Update pedestrian signal equipment to the latest Accessible Pedestrian Signal (APS) standards, including countdown pedestrian signal heads and pushbuttons.	High	Long-Term	High	City of Brockton
Lighting	Evaluate and enhance intersection lighting as appropriate.	High	Long-Term	High	City of Brockton

## Appendix A. RSA Meeting Agenda

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# Agenda

## Road Safety Audit

For the Intersections of:  
Route 123/West St. (south)  
Route 123/Forest Ave.  
Route 123/West St. (north)

Meeting Location: West Branch of the  
Brockton Public Library  
540 Forest Ave., Brockton, MA 02301  
Wednesday, April 13, 2016  
10:00 AM – 2:00 PM

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

**10:00 AM**                      **Welcome and Introductions**

- Meet at West Branch of the Brockton Public Library

**10:10 AM**                      **Review of Site Specific Material**

- Crash, Speed & Volume Summaries– provided in advance
- Existing Geometries and Conditions

**11:00 AM**                      **Visit the Site**

- Walk to Intersection of Route 123/West Street/Shaw’s Driveway
- As a group, identify areas for improvement

**1:00 PM**                        **Post Visit Discussion / Completion of RSA**

- Meet back at Library
- Discuss observations and finalize findings
- Discuss potential improvements and finalize recommendations

**2:00 PM**                        **Adjourn**

### Instructions for Participants:

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

## Appendix B. RSA Audit Team Contact List

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## Participating Audit Team Members

Date: April 13, 2016

Location: Brockton, MA

<b>Audit Team Members</b>	<b>Agency/Affiliation</b>	<b>Email Address</b>	<b>Phone Number</b>
John Mastera	MassDOT Highway Safety Management	john.mastera@state.ma.us	508-368-9648
Leah Nesbitt	MassDOT Highway Safety Intern	leah.nesbitt@state.ma.us	
Barbara LaChance	MassDOT District 5 Traffic	Barbara.Lachance@state.ma.us	508-884-4260
Bianca Marshall	MassDOT District 5 Traffic	Bianca.marshall@state.ma.us	508-884-4335
Shaun D. Handy	MassDOT District 5 Projects	shaun.handy@state.ma.us	508-884-4255
Jason Walters	MassDOT District 5 Projects	jason.walters@state.ma.us	508-884-4370
Kevin Galligan	Brockton Fire Department/Traffic Signals	kmgalligan@cobma.us	508-922-3137
Robert DiBari	Brockton Police Department/Traffic	rdibari@brocktonpolice.com	508 897 5134
Donald Mills	Brockton Police Department/School Division	dmills@brocktonpolice.com	508-897-9518
Tobias T. Cowans	Brockton Public Schools/Director of Readiness and Emergency Management	tobiascowans@bpsma.org	508-580-7071
Ray Guarino	Old Colony Planning Council	rguarino@ocpcrpa.org	508-583-1833
Bill McNulty	Old Colony Planning Council	wmcnulty@ocpcrpa.org	508-583-1833
Shane O'Brien	City of Brockton Planning	sobrien@cobma.us	508-580-7113
Paul Chenard	Old Colony Planning Council/Transportation Planner	pchenard@ocpcrpa.org	508 583 1833
Jim Antonizick	Tetra Tech	james.antonizick@tetrattech.com	508-786-2206
Nancy Doherty	Tetra Tech	nancy.doherty@tetrattech.com	508-786-2208
Ethan Cecelya	Tetra Tech	Ethan.Cecelya@tetrattech.com	508-786-2282

## Appendix C. Detailed Crash Data

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## Appendix D. Additional Information

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## Appendix E. Road Safety Audit References

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## Road Safety Audit References

*Massachusetts Traffic Safety Toolbox*, Massachusetts Highway Department,  
[www.mhd.state.ma.us/safetytoolbox](http://www.mhd.state.ma.us/safetytoolbox).

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

*Road Safety Audits*. Institute of Transportation Engineers and U.S. Department of Transportation, Federal Highway Administration, [www.roadwaysafetyaudits.org](http://www.roadwaysafetyaudits.org).

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

*Road Safety Audit*, 2<sup>nd</sup> edition. Austroads, 2000.

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

## Appendix C. Detailed Crash Data

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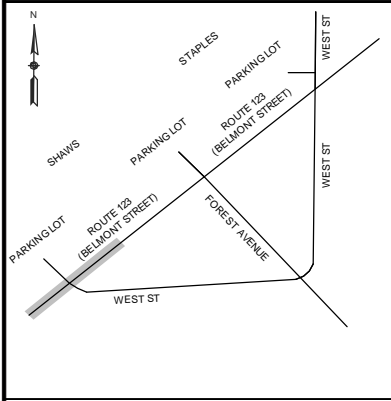
# COLLISION DIAGRAM

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

Brockton, MA

Belmont Street @ West Street (southern end)

TIME PERIOD ANALYZED: 1/1/2012 - 12/31/2014  
SOURCE OF CRASH REPORTS: Brockton Police Department



INTERSECTION LOCATION

SHAW'S PARKING LOT

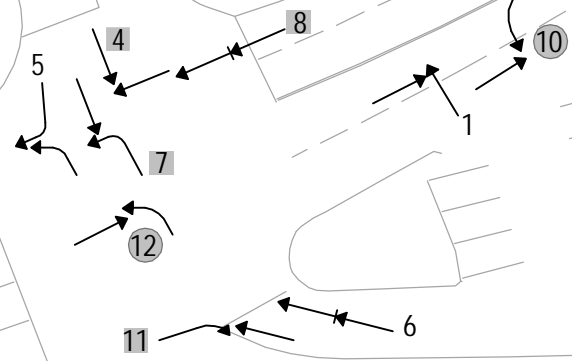
TACO BELL

ROUTE 123 (BELMONT STREET)

ROUTE 123 (BELMONT STREET)

7-11 STORE

WEST STREET



Notes:

- Collision #10 involved a motorcycle.
- Collision #11 involved a police cruiser.

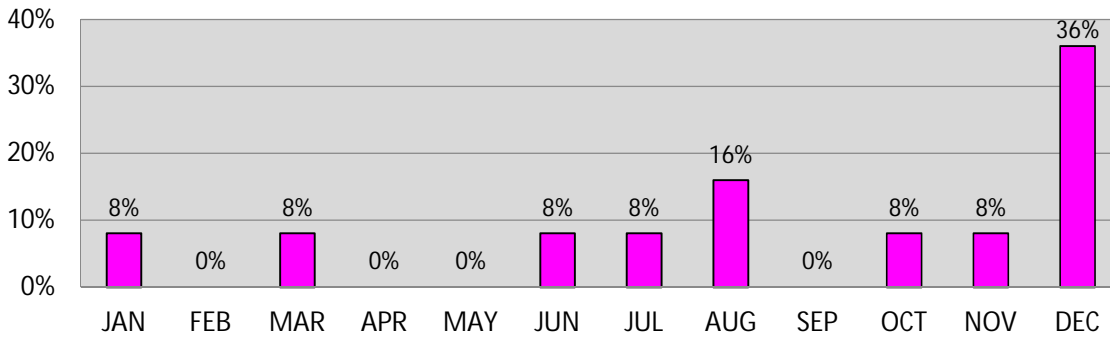
**Crash Data Summary Table**  
 Belmont Street at southern end of West Street, Brockton, MA  
 January 1, 2012 to December 31, 2014

Collision Diagram Number	Crash Date	Crash Day	Crash Time	Manner of Collision	Ambient Light	Weather Condition	Road Surface Condition	Driver Contributing Code	Injury Status	Comments
1	16-Mar-2012	Friday	11:36 AM	Angle	Daylight	Cloudy, Rain	Wet	Failed to Yield Right of Way	No Injury	Veh 1 was exiting the 7-11 parking lot while a vehicle remained stopped on the inner lane of the Belmont St EB approach. Veh 2 approached traveling EB on the outer lane on Belmont St. and collided with the exiting Veh 1.
2	11-Jul-2012	Wednesday	5:04 PM	Rear-end	Daylight	Cloudy	Dry	Followed too closely, Inattention	No Injury	Veh 1 was traveling WB on Belmont St when it rear ended Veh 2.
3	10-Oct-2012	Wednesday	1:15 PM	Rear-end	Daylight	Cloudy, Rain	Wet	Distracted	No Injury	Veh 1, 2 and 3 were traveling WB on Belmont St. Vehicles 1 and 2 were stopped at the intersection when Veh 3 rear-ended Veh 2 which then rear-ended Veh 1.
4	3-Dec-2012	Monday	8:27 PM	Angle	Dark - lighted roadway	Clear	Dry	Disregarded traffic signs, signals, road markings	No Injury	Veh 1 was traveling on Belmont St (no direction given) through the intersection with West St when Veh 2 entered the intersection from Shaws disregarding a red light.
5	3-Dec-2012	Monday	1:26 PM	Angle	Daylight	Clear	Dry	Inattention	No Injury	Veh 1 was turning left from West St onto Belmont St while Veh 2 was turning right from the Shaws parking lot onto Belmont St. Veh 1 and Veh 2 collided while both merging onto Belmont St.
6	14-Dec-2012	Friday	2:02 PM	Rear-end	Daylight	Clear	Dry	Inattention	No Injury	Veh 1 was stopped at a red light on West St heading NB. When the indication turned green, Veh 1 was unable to move due to traffic. Veh 2, stopped behind Veh 1 at the approach, attempted to move and resulted in rear-ending Veh 1.
7	19-Dec-2012	Wednesday	6:13 PM	Angle	Dark - lighted roadway	Clear	Dry	Failed to Yield Right of Way	No Injury	Veh 1 was exiting the Shaws parking lot heading SB while Veh 2 was turning left onto Belmont St from West St. Veh 2 failed to yield right of way and collided with Veh 1.
8	15-Jan-2013	Tuesday	5:51 PM	Rear-end	Dark - lighted roadway	Clear	Dry	No improper driving	No Injury	Veh 1 and 2 were traveling WB on Belmont St through the intersection with West St when Veh 1 stopped to let another vehicle enter the intersection. Veh 2 then rear-ended Veh 1
9	20-Jun-2013	Thursday	3:29 AM	Single vehicle crash	Dark - lighted roadway	Clear	Dry	Failure to keep in proper lane lane or running off road	No Injury	Veh 1 was traveling WB on Belmont St when it drove off road and struck a pole.
10	18-Aug-2013	Sunday	3:32 AM	Angle	Dark - roadway not lighted	Clear	Dry	Failed to Yield Right of Way	Non-incapacitating	Veh 1 was traveling WB on Belmont St when it turned left onto the 7-11 parking lot. While crossing over Belmont St, Veh 1 struck Veh 2 (motorcycle) who was traveling EB on Belmont St.
11	27-Aug-2013	Tuesday	4:30 AM	Head-on	Dark - lighted roadway	Cloudy, Rain	Wet	Failure to keep in proper lane lane or running off road	No Injury	Veh 1 was traveling EB on Belmont St when it turned right onto West St and failed to stay in its lane, crashing into Veh 2 which was stopped on West St at the intersection with Belmont St.
12	11-Nov-2014	Tuesday	7:54 PM	Angle	Dark - lighted roadway	Clear	Dry	Disregarded traffic signs, signals, road markings	Possible	Veh 1 was traveling NB on West St turning left onto Belmont St. Veh 2 failed to stop on red while traveling EB on Belmont St and came into the path of Veh 1.

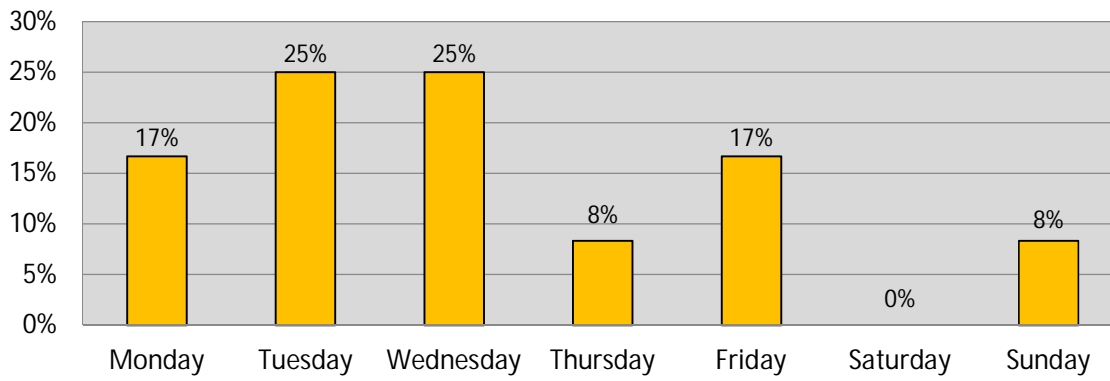
Source: Brockton Police Department Reports provided by MassDOT

Crash Data Summary Tables and Charts  
 Belmont Street at southern end of West Street, Brockton, MA

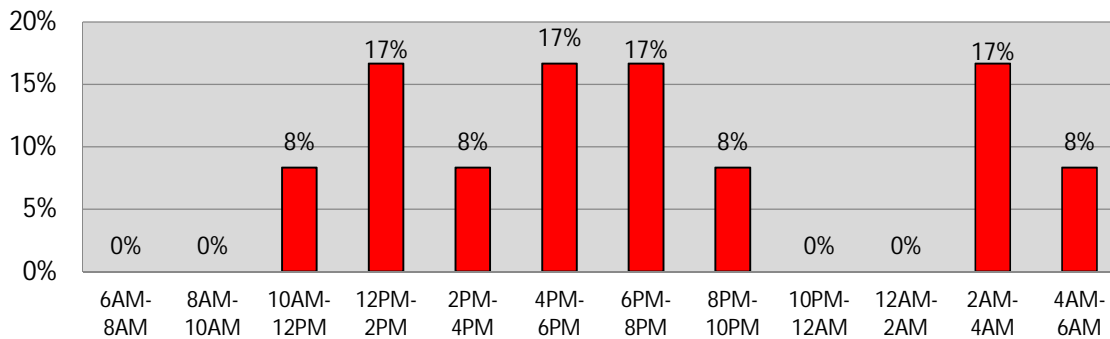
CRASH MONTH



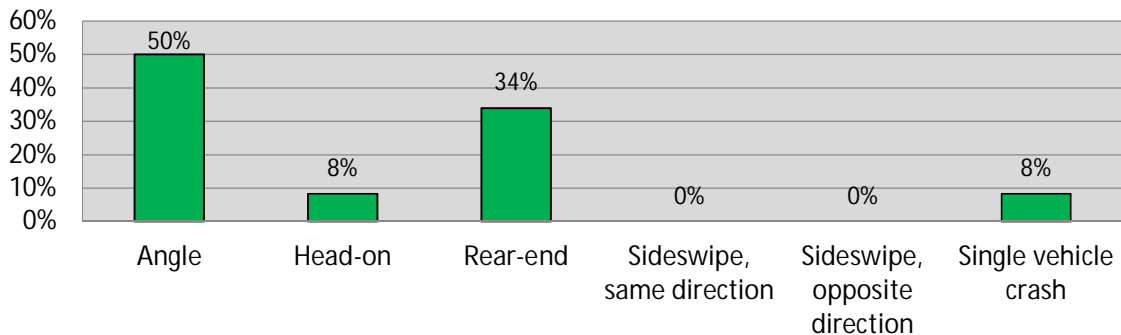
CRASH DAY OF THE WEEK



CRASH TIME OF DAY

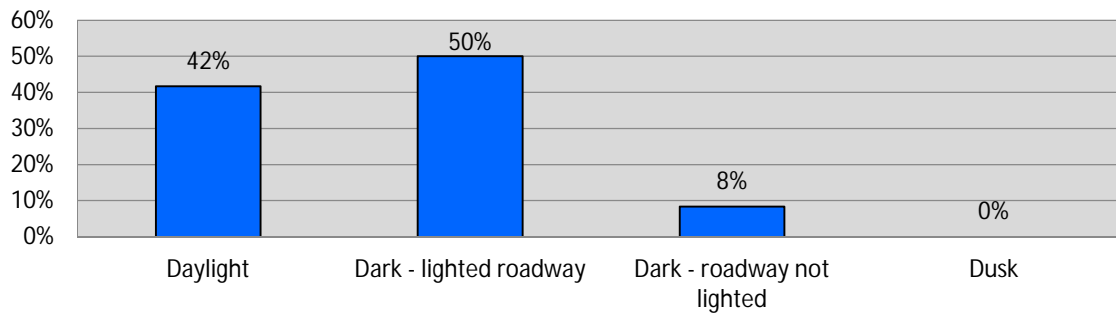


CRASH MANNER OF COLLISION

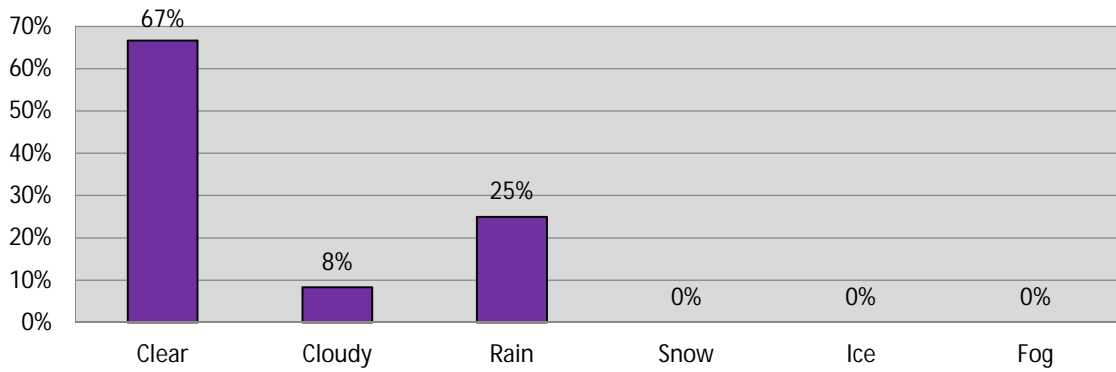


Crash Data Summary Tables and Charts  
Belmont Street at southern end of West Street, Brockton, MA

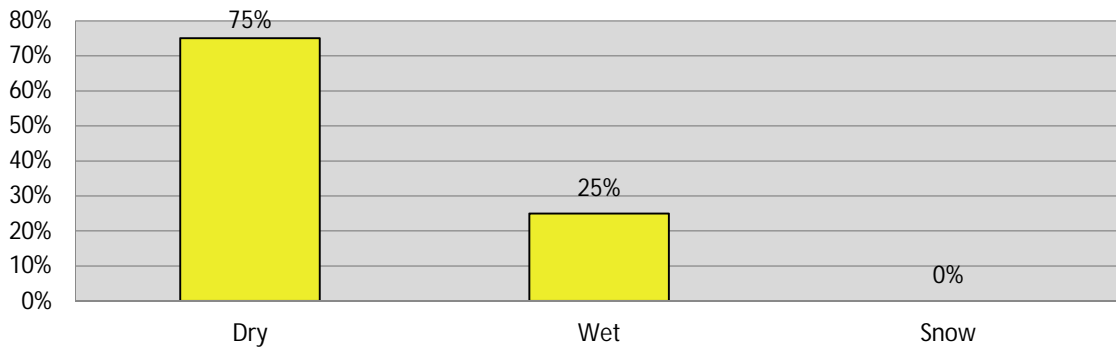
CRASH LIGHT CONDITION



CRASH WEATHER CONDITION



CRASH ROAD SURFACE





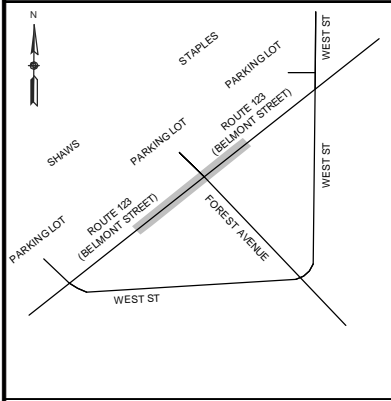
# COLLISION DIAGRAM

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

Brockton, MA

Belmont Street @ Forest Avenue

TIME PERIOD ANALYZED: 1/1/2012 - 12/31/2014  
SOURCE OF CRASH REPORTS: Brockton Police Department



INTERSECTION LOCATION

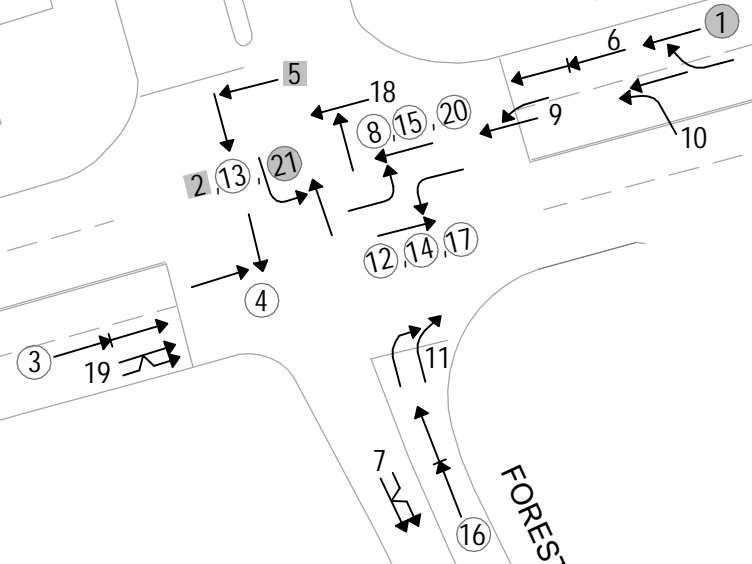
SHAW'S PARKING LOT

ROUTE 123 (BELMONT STREET)

ROUTE 123 (BELMONT STREET)

SHELL GAS STATION

FOREST AVENUE



**Crash Data Summary Table**  
 Belmont Street at Forest Avenue, Brockton, MA  
 January 1, 2012 to December 31, 2014

Collision Diagram Number	Crash Date	Crash Day	Crash Time	Manner of Collision	Ambient Light	Weather Condition	Road Surface Condition	Driver Contributing Code	Injury Status	Comments
1	18-Jan-2012	Wednesday	3:54 PM	Angle	Daylight	Clear	Dry	Failure to keep in proper lane or running off road	Possible	Veh 1 was traveling WB on Belmont St approaching the intersection with Forest Ave when it changed lanes to avoid a stopped vehicle waiting to take a left turn onto Forest Ave. Veh 2 was also traveling WB on Belmont St when Veh 1 changed lanes onto the path of Veh 2, causing the vehicles to collide.
2	9-Feb-2012	Thursday	5:19 PM	Angle	Dark - lighted roadway	Clear	Dry	Failed to Yield Right of Way	No Injury	Veh 1 was stopped on the Shaws driveway approach when the signal head turned green. Veh 1 sped up and turned left, failing to yield to the oncoming Veh 2 heading NB on Forest Ave. Veh 2 could not stop in time, causing it to collide with Veh 1.
3	15-Sep-2012	Saturday	1:00 PM	Rear-end	Daylight	Clear	Dry	Inattention	Possible	Veh 1 and Veh 2 were traveling EB on Belmont St when Veh 2 stopped at the Intersection with Forest Ave. Veh 2 was rear-ended by Veh 1.
4	5-Nov-2012	Monday	2:26 PM	Sideswipe, opposite direction	Daylight	Clear	Dry	Inattention	Possible	Veh 1 was traveling EB on Belmont St crossing the Intersection with Forest Ave. Veh 2 was exiting the parking lot area of Shaws claiming to be following a truck out of the approach which obstructed the view of traffic signals. Veh 2 proceeded into the intersection and struck Veh 1. The manner of collision seems to be more of an angle type crash.
5	21-Dec-2012	Friday	7:15 PM	Rear-end	Dark - lighted roadway	Cloudy	Wet	Disregarded traffic signs, signals, road markings.	No Injury	Veh 1 was traveling WB on Belmont St. Veh 2 failed to stop at a red light and attempted to cross the intersection with Forest Ave from the Shaws parking lot, colliding with Veh 1. The manner of collision seems to be more of an angle type crash.
6	7-Mar-2013	Thursday	4:55 PM	Rear-end	Daylight	Sleet, hail, freezing rain. Blowing sand, snow.	Snow	No improper driving	No Injury	Veh 1 was traveling WB on Belmont St when it was unable to break in time due to weather conditions, rear-ending Veh 2. Veh 2 was stopped at a red light heading WB on Belmont St.
7	10-Apr-2013	Wednesday	5:29 PM	Sideswipe, same direction	Daylight	Cloudy	Dry	Failure to keep in proper lane or running off road	No Injury	Veh 1 was traveling SB on Forest Ave behind Veh 2 when Veh 2 stopped to let a vehicle cross Forest Ave. Veh 1 proceeded to pass Veh 2 on the right side and clipped bumpers with Veh 2.
8	11-Apr-2013	Thursday	5:49 PM	Angle	Daylight	Clear	Dry	No improper driving	Non-incapacitating	Veh 1 was travel EB on Belmont St attempting to take a left into the Shaws parking lot. Veh 2 was traveling WB on Belmont St when the two vehicles crossed paths and collided. Veh 1 stated it turned in according to a green arrow indication while Veh 2 had a green indication as well.
9	8-Jun-2013	Saturday	2:51 PM	Angle	Daylight	Clear	Dry	Failed to keep in proper lane or running off road. Made an improper turn	No Injury	Veh 1 was traveling WB on Belmont St in the left lane as the light turned green. Veh 2 was traveling WB on Belmont St when it turned into the left lane and struck the right side of Veh 1.
10	30-Jan-2014	Thursday	12:04 PM	Angle	Daylight	Clear	Dry	Failed to yield right of way. Failure to keep in proper lane or running off road. Inattention	No Injury	Veh 1 was traveling WB on Belmont St in the inner lane. Veh 2 turned left out of the Shell gas station and crossed over Belmont St colliding with Veh 1.
11	14-Feb-2014	Friday	4:46 PM	Angle	Daylight	Clear	Dry	Failed to keep in proper lane or running off road	No Injury	Veh 1 was traveling NB on Forest Ave when it attempted to go to the right of Veh 2 which was stopped and attempting to take a right turn onto Belmont St. Veh 2 began to turn right and came onto the path of Veh 1.
12	26-Mar-2014	Wednesday	12:50 PM	Angle	Daylight	Cloudy	Dry	Failed to yield right of way	Possible	Veh 1 was traveling WB on Belmont St when it attempted to turn left onto Forest Ave as Veh 2 was approaching the intersection traveling EB on Belmont St. Veh 1 turned onto the path of Veh 2.
13	5-May-2014	Monday	9:48 AM	Angle	Daylight	Clear	Dry	Failed to yield right of way	Possible	Veh 1 was turning left from the Shaws parking lot onto Belmont St. Veh 2 was traveling NB on Forest Ave attempting to continue to the Shaws parking lot. Veh 1 came onto the path of Veh 2 and the two vehicles collided.
14	3-Jul-2014	Thursday	2:38 PM	Angle	Daylight	Clear	Dry	Failed to yield right of way. Inattention	Possible	Veh 1 was traveling EB on Belmont St entering the intersection with Forest Ave. Veh 2 was traveling WB on Belmont St and attempted to turn left onto Forest Ave, coming onto the path of Veh 1.
15	17-Jul-2014	Thursday	5:01 PM	Angle	Daylight	Clear	Dry	Failed to yield right of way	Possible	Veh 1 was traveling EB on Belmont St when it attempted to turn left into the Shaws parking lot. Veh 2 was traveling WB on Belmont St when Veh 1 came onto its path.
16	7-Aug-2014	Thursday	1:55 PM	Rear-end	Daylight	Clear	Dry	Followed too closely. Other improper action	Possible	Veh 1 and Veh 2 were traveling NB on Forest Ave. Veh 2 was stopped at a red light when Veh 1 rear-ended Veh 2.



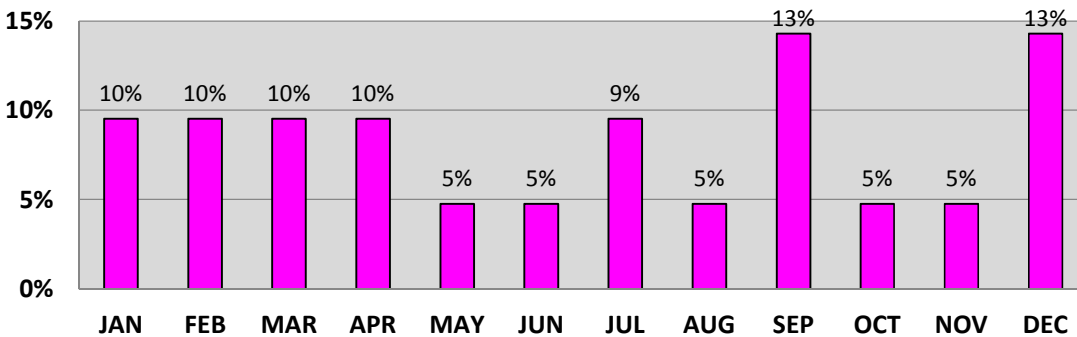
**Crash Data Summary Table**  
 Belmont Street at Forest Avenue, Brockton, MA  
 January 1, 2012 to December 31, 2014

Collision Diagram Number	Crash Date	Crash Day	Crash Time	Manner of Collision	Ambient Light	Weather Condition	Road Surface Condition	Driver Contributing Code	Injury Status	Comments
17	17-Sep-2014	Wednesday	2:05 PM	Angle	Daylight	Clear	Dry	Operating vehicle in erratic, reckless, careless, negligent, or aggressive manner. Made an improper turn	Possible	Veh 1 was traveling EB on Belmont St through the intersection with Forest Ave. Veh 2 failed to yield when traveling WB on Belmont St and turning left onto Forest Ave, coming onto the path of Veh 1 and causing the collision.
18	28-Sep-2014	Sunday	4:35 PM	Angle	Daylight	Clear	Dry	Unknown	No Injury	Veh 1 was traveling WB on Belmont St through the intersection with Forest Ave. Veh 2 was traveling NB on Forest Ave through the intersection with Belmont St at the same time as Veh 1, causing the collision. Both vehicle operators stated having a green light upon entering the intersection.
19	17-Oct-2014	Friday	2:23 PM	Sideswipe, same direction	Daylight	Clear	Dry	Disregarded traffic signs, signals, road markings.	No Injury	Veh 1 was traveling EB on Belmont St and sideswiped Veh 2. Veh 2 was stopped at a red light traveling EB on Belmont St.
20	8-Dec-2014	Monday	7:01 AM	Angle	Daylight	Clear	Dry	Failed to Yield Right of Way	Possible	Veh 1 was traveling EB on Belmont St when it attempted to turn left into the Shaws parking lot. Veh 2 was traveling WB on Belmont St when Veh 1 came onto its path.
21	24-Dec-2014	Wednesday	6:30 PM	Angle	Dark - lighted roadway	Rain	Wet	Failed to Yield Right of Way	Non-incapacitating	Veh 1 was traveling NB on Forest Ave into the intersection with Belmont St. Veh 2 was exiting the Shaws parking lot when it attempted to turn left onto Belmont St and came onto the path of Veh 1.

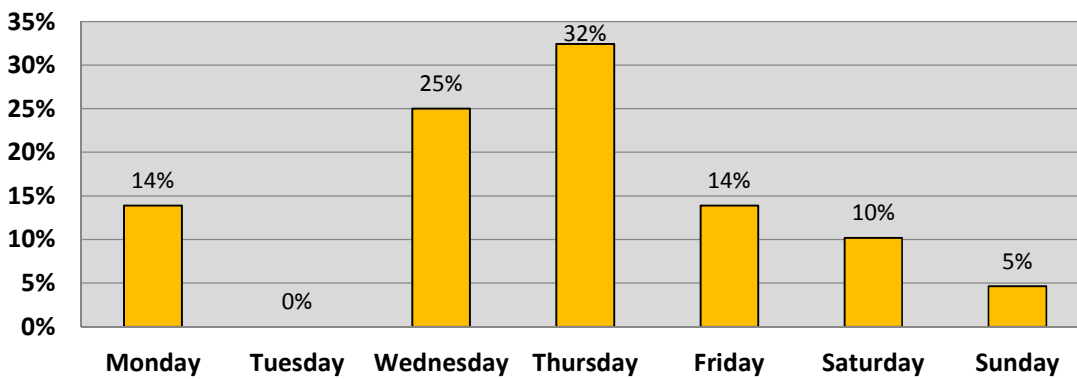
Source: Brockton Police Department Reports provided by MassDOT

**Crash Data Summary Tables and Charts**  
Belmont Street at Forest Avenue, Brockton, MA

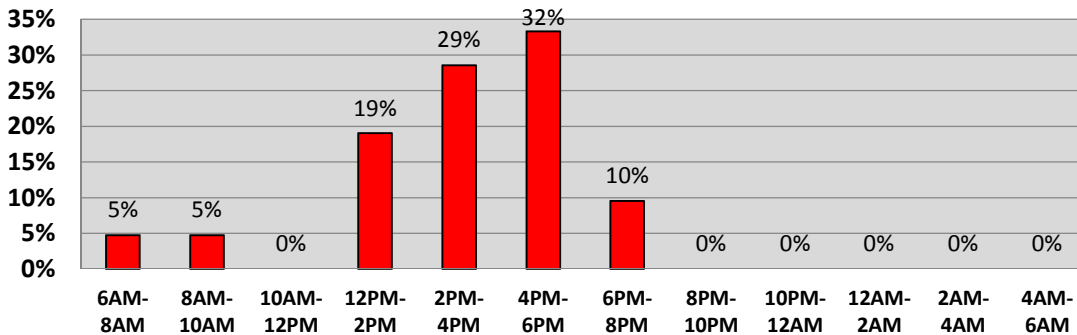
**CRASH MONTH**



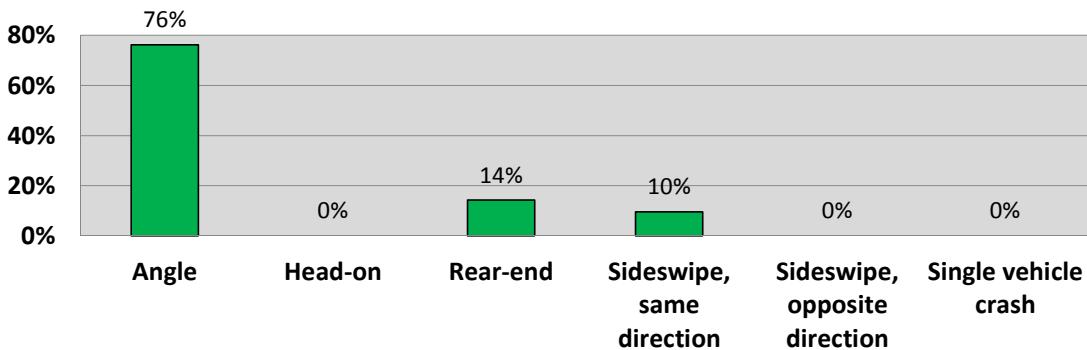
**CRASH DAY OF THE WEEK**



**CRASH TIME OF DAY**

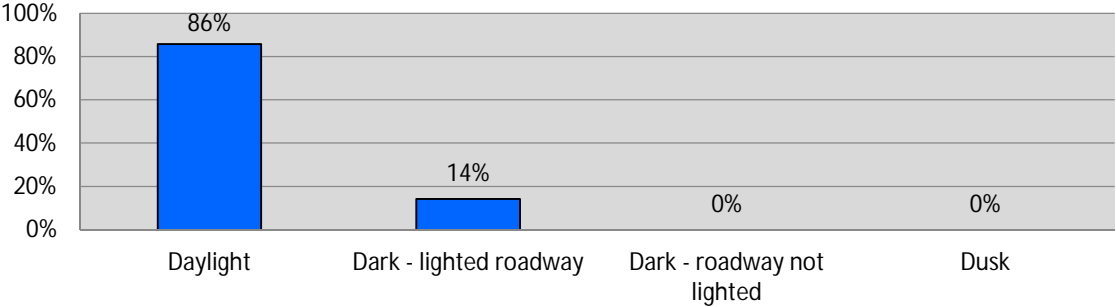


**CRASH MANNER OF COLLISION**

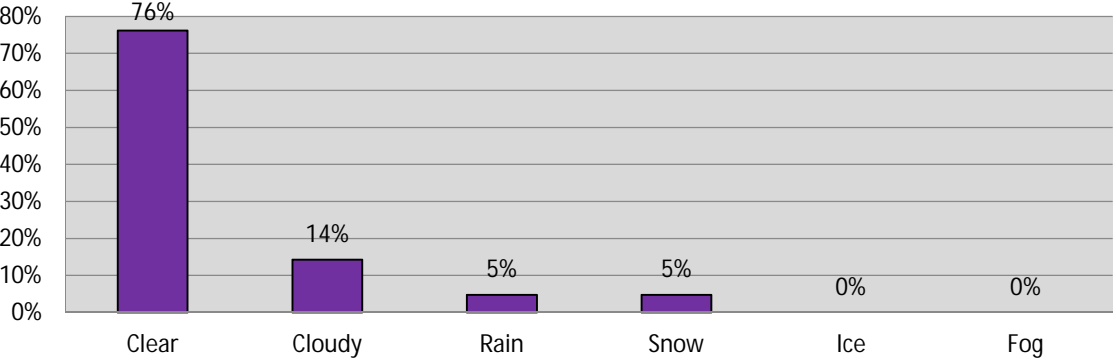


Crash Data Summary Tables and Charts  
Belmont Street at Forest Avenue, Brockton, MA

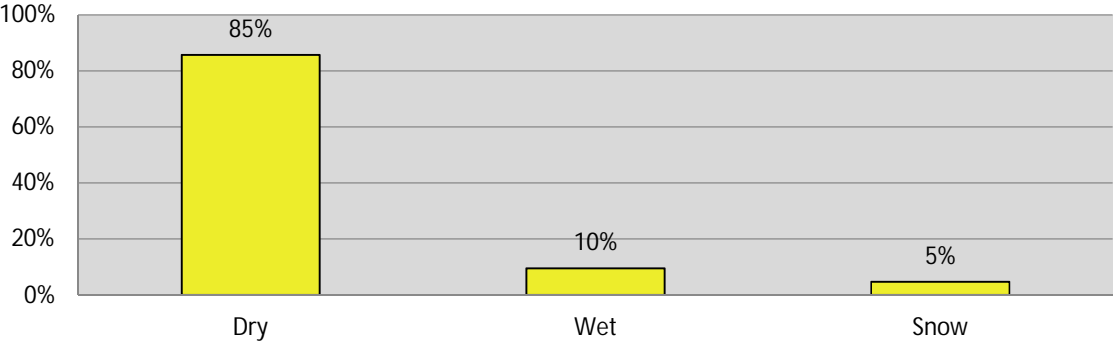
CRASH LIGHT CONDITION



CRASH WEATHER CONDITION



CRASH ROAD SURFACE





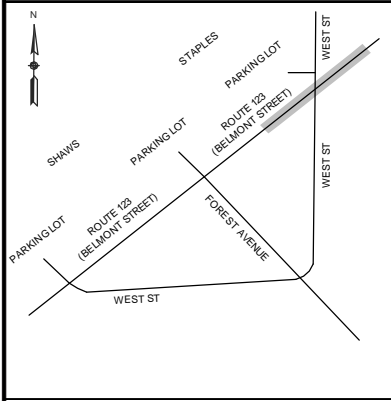
# COLLISION DIAGRAM

SYMBOLS	TYPES OF CRASH	SEVERITY

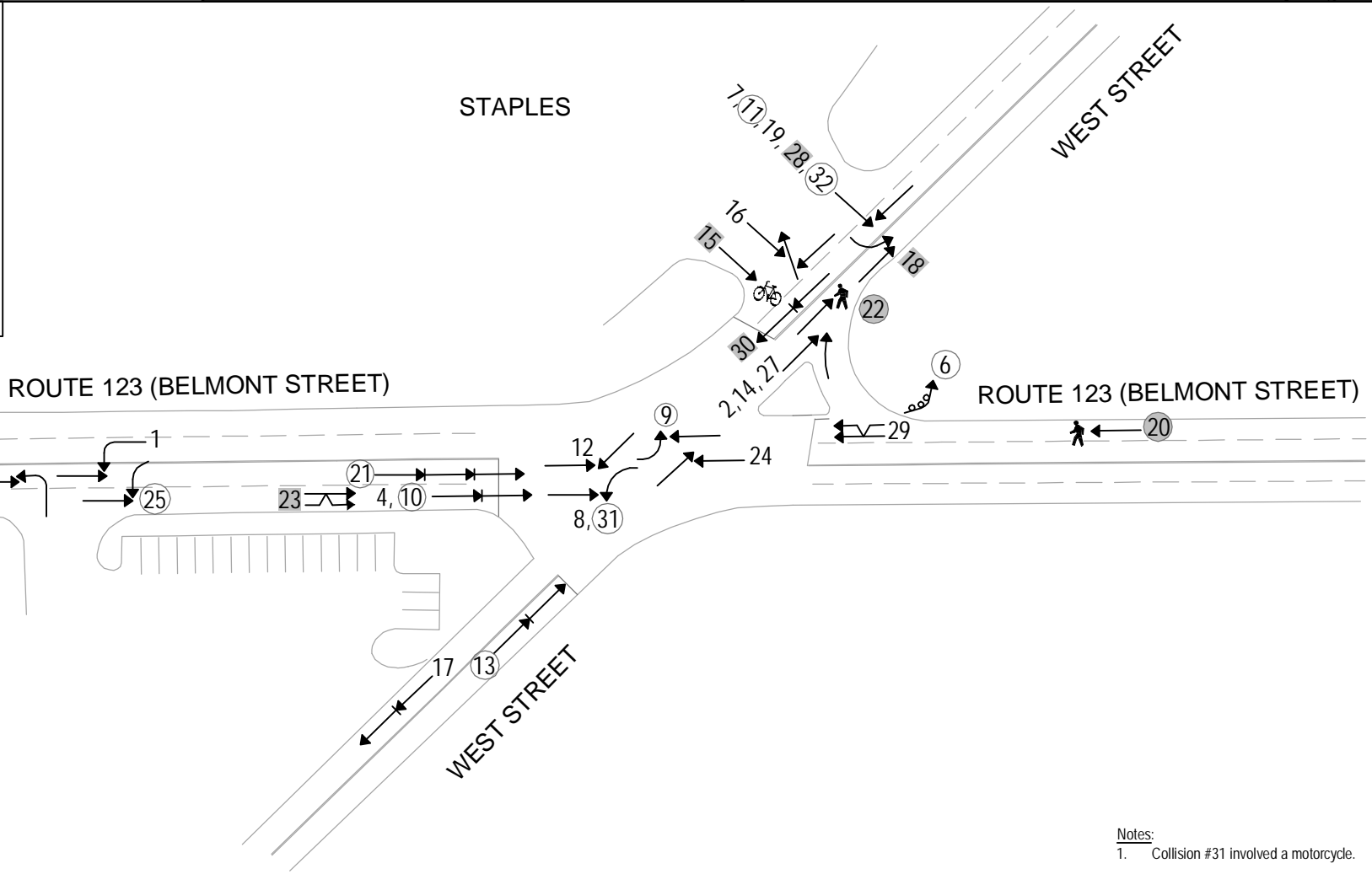
Brockton, MA

Belmont Street @ West Street (northern end)

TIME PERIOD ANALYZED: 1/1/2012 - 12/31/2014  
SOURCE OF CRASH REPORTS: Brockton Police Department



INTERSECTION LOCATION



Notes:  
1. Collision #31 involved a motorcycle.

**Crash Data Summary Table**  
 Belmont Street at northern end of West Street, Brockton, MA  
 January 1, 2012 to December 31, 2014

Collision Diagram Number	Crash Date	Crash Day	Crash Time	Manner of Collision	Ambient Light	Weather Condition	Road Surface Condition	Driver Contributing Code	Injury Status	Comments
1	2-Mar-2012	Friday	4:39 PM	Angle	Daylight	Cloudy	Dry	Failed to Yield Right of Way	No Injury	Veh 1 was traveling WB on Belmont St when it attempted to turn left into the Burger King parking lot. Veh 2 was traveling EB on Belmont St when Veh 1 turned onto the path of Veh 2.
2	2-Mar-2012	Friday	6:35 PM	Angle	Dusk	Cloudy	Wet	Failed to Yield Right of Way	No Injury	Veh 1 was traveling WB on Belmont St when it attempted to cross West St and enter the Staples parking lot. Veh 2 was traveling NB on West St when Veh 1 failed to yield to Veh 2.
3	17-Mar-2012	Saturday	12:20 PM	Angle	Daylight	Clear	Dry	Failed to Yield Right of Way	No Injury	Veh 1 was exiting the Burger King parking lot attempting to turn left onto Belmont St. Veh 2 was traveling EB on Belmont St when Veh 1 traveled onto the path of Veh 2.
4	28-Mar-2012	Wednesday	11:49 AM	Rear-end	Daylight	Cloudy	Dry	Inattention	No Injury	Veh 1 and 2 were traveling EB on Belmont St entering the intersection. Veh 1 stopped due to a vehicle turning left in front of it while Veh 2 hit the rear of Veh 1.
5	11-Apr-2012	Wednesday	4:18 PM	Angle	Daylight	Cloudy	Dry	Failed to Yield Right of Way	No Injury	Veh 1 was exiting the Burger King parking lot attempting to turn left onto Belmont St. Veh 2 was traveling EB on Belmont St when Veh 1 traveled into the path of Veh 2.
6	30-Apr-2012	Monday	1:04 PM	Single vehicle crash	Daylight	Clear	Dry	Illness	Possible	The Veh was traveling SB on West St entering the intersection with Belmont St when it swerved and stopped onto the grass near CVS at the NE corner of the Intersection.
7	1-May-2012	Tuesday	4:55 PM	Angle	Daylight	Rain	Wet	Failed to Yield Right of Way	No Injury	Veh 1 was exiting the Staples parking lot attempting to go NB on West St. Veh 2 was heading SB on West St approaching a green when Veh 1 turned onto its path and collided with Veh 2.
8	5-Jun-2012	Tuesday	2:12 PM	Angle	Daylight	Cloudy	Wet	Failed to Yield Right of Way	No Injury	Veh 1 was traveling WB on Belmont St when it attempted to turn left onto West St while the oncoming Veh 2 was entering the intersection traveling EB on Belmont St. The two vehicles collided and Veh 1 drove onto the SE curb on West St.
9	10-Jun-2012	Sunday	3:59 PM	Angle	Daylight	Clear	Dry	Failed to Yield Right of Way	Non-incapacitating	Veh 1 was traveling EB on Belmont St entering the intersection. Veh 2 was traveling WB on Belmont St continuing through the intersection when Veh 1 came onto its path attempting to turn left onto West St, causing the collision.
10	9-Aug-2012	Thursday	7:35 PM	Rear-end	Daylight	Clear	Dry	Followed too closely. Operating defective equipment	Non-incapacitating	Vehicles 1 and 2 were stopped EB on Belmont St at the intersection with West St. Veh 1 had defective brakes and rear ended Veh 2.
11	14-Aug-2012	Tuesday	6:28 PM	Angle	Daylight	Clear	Dry	Failed to Yield Right of Way	Possible	Veh 1 was exiting the Staples parking lot onto West St. Veh 2 was traveling SB on West St when Veh 1 came onto the path of Veh 2.
12	21-Aug-2012	Tuesday	11:11 AM	Single vehicle crash	Daylight	Clear	Dry	Disregarded traffic signs, signals, road markings. Failed to Yield Right of Way	No Injury	Veh 1 was traveling EB on Belmont St and disregarded a red light. Veh 2 was traveling SB on West St when Veh 1 caused Veh 2 to lose control in order to avoid a crash.
13	6-Oct-2012	Saturday	2:27 PM	Rear-end	Daylight	Clear	Dry	Inattention. Fatigued/asleep	Possible	Veh 1 was stopped on the NB approach of West St at the Intersection with Belmont St when it was rear-ended by Veh 2.
14	26-Nov-2012	Monday	3:21 PM	Angle	Daylight	Clear	Dry	Failed to Yield Right of Way	No Injury	Veh 1 was traveling NB on West St. Veh 2 was traveling from Belmont St to West attempting to cross over to the Staples parking lot when it drove onto the path of Veh 1.
15	20-Dec-2012	Thursday	5:50 PM	Single vehicle crash	Dark - lighted roadway	Clear	Dry	No improper driving	No Injury	A Vehicle was stopped at the driveway of the Staples parking lot when a cyclist crossed West St hitting the Vehicle.
16	31-Dec-2012	Monday	5:17 PM	Angle	Dusk	Cloudy	Dry	Failed to Yield Right of Way	No Injury	Veh 1 was attempting to cross West St from Belmont St and enter the parking lot. A vehicle was stopped in the outer lane of SB West St. Veh 2 was traveling SB in the inner lane when Veh 1 traveled into its path. The two vehicles collided, causing Veh 1 to spin around and strike Veh 3 which was stopped on the driveway.
17	24-Jan-2013	Thursday	2:16 PM	Rear-end	Daylight	Clear	Dry	Followed too closely. Inattention	No Injury	Veh 1 was traveling SB on West St when I was rear ended by Veh 2.
18	31-Jan-2013	Thursday	7:06 PM	Angle	Dark - roadway not lighted	Clear	Dry	Failed to Yield Right of Way	No Injury	Veh 1 was exiting the Staples parking lot attempting to turn left onto West St but failed to yield to Veh 2 traveling NB on West St, causing the collision.
19	16-Mar-2013	Saturday	12:05 PM	Angle	Daylight	Clear	Dry	Failed to Yield Right of Way. Visibility obstructed	No Injury	Veh 1 was traveling SB on West St on the outer lane. Veh 2 was attempting to exit the Staples parking lot after a bus traveling SB on West St in the inner lane stopped. As Veh 2 exited the lot, it turned and came onto the path of Veh 1.
20	28-Jun-2013	Friday	11:14 PM	Single vehicle crash	Dark - lighted roadway	Cloudy	Dry	No improper driving	Possible	Veh 1 was traveling WB on Belmont St near the CVS approaching the intersection with West St. A pedestrian was crossing Belmont St approximately 75 feet from the intersection when struck by Veh 1.
21	3-Sep-2013	Tuesday	10:27 AM	Rear-end	Daylight	Clear	Dry	Distracted	Possible	Vehicles 1 and 2 were stopped on the left lane Belmont St facing the EB direction. Veh 3 was traveling EB on Belmont St when the driver became distracted and failed to stop in time when rear-ending Veh 2 which in turn rear-ended Veh 1.
22	3-Sep-2013	Tuesday	8:10 PM	Single vehicle crash	Dark - lighted roadway	Cloudy	Dry	No improper driving	Possible	Veh 1 was traveling NB on West St having just crossed the intersection with Belmont St. A pedestrian (not traveling in a crosswalk) entered the roadway and was struck by Veh 1.
23	10-Sep-2013	Tuesday	9:25 PM	Sideswipe, same direction	Dark - lighted roadway	Clear	Dry	Failure to keep in proper lane or running off road	No Injury	Veh 1 was traveling EB on Belmont St approaching the intersection with West St in the outer lane. Veh 2 was traveling EB on Belmont St in the inner lane when it attempted to change lanes and collided with Veh 1.
24	7-Jan-2014	Tuesday	3:41 PM	Sideswipe, opposite direction	Daylight	Cloudy	Dry	Disregarded traffic signs, signals, road markings	No Injury	Veh 1 was traveling WB on Belmont St and proceeded into the intersection with West St. Veh 2 was crossing NB on West St with a green light. The two vehicles collided.

## Crash Data Summary Table

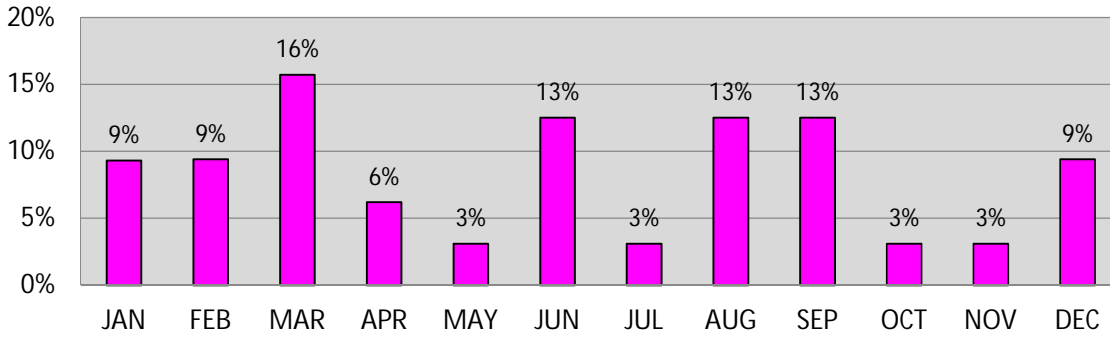
Belmont Street at northern end of West Street, Brockton, MA  
January 1, 2012 to December 31, 2014

Collision Diagram Number	Crash Date	Crash Day	Crash Time	Manner of Collision	Ambient Light	Weather Condition	Road Surface Condition	Driver Contributing Code	Injury Status	Comments
25	8-Feb-2014	Saturday	1:58 PM	Angle	Daylight	Clear	Dry	Failed to Yield Right of Way	Possible	Veh 1 was traveling WB on Belmont St and stopped to turn left into the Burger King parking lot. A vehicle traveling EB on Belmont St in the outer lane stopped, while Veh 2 was traveling EB on Belmont St in the inner lane nearing the Burger King lot. Veh 1 turned left and crossed over the path of Veh 2.
26	11-Feb-2014	Tuesday	2:12 PM	Angle	Daylight	Clear	Dry	Failed to Yield Right of Way	Incapacitating	Veh 1 was exiting the Burger King parking lot turning left onto Belmont St when Veh 2 was approaching EB on Belmont St in the outer lane. A bus was stopped in the inner lane of Belmont St as Veh 1 turned onto the path of Veh 2.
27	12-Feb-2014	Wednesday	3:49 PM	Angle	Daylight	Cloudy	Dry	Failure to keep in proper lane or running off road	No Injury	Veh 1 was turning right from Belmont St to West St (NB). Veh 2 was traveling NB on West St and went around a stopped vehicle and collided with Veh 1.
28	15-May-2013	Wednesday	8:33 PM	Angle	Dark - lighted roadway	Clear	Dry	Failed to Yield Right of Way	No Injury	Veh 1 was exiting the Staples parking lot onto West St. Veh 2 was traveling SB on West St when Veh 1 came onto the path of Veh 2.
29	27-Jun-2014	Friday	3:26 PM	Sideswipe, same direction	Daylight	Clear	Dry	Failure to keep in proper lane or running off road	No Injury	Veh 1 and 2 were traveling WB on Belmont St approaching the intersection. Veh 2's trailer crossed into the lane of Veh 1 causing a collision.
30	16-Aug-2014	Saturday	3:38 AM	Rear-end	Dark - lighted roadway	Clear	Dry	Distracted	No Injury	Veh 1 was stopped on the SB approach on West St. Veh 2 was traveling SB on West St and rear-ended Veh 1.
31	5-Sep-2014	Friday	5:46 PM	Single vehicle crash	Daylight	Clear	Dry	Unknown	Non-incapacitating	Veh 1 (motorcycle) was traveling EB on Belmont St approaching the intersection with West St. Veh 2 was traveling WB on Belmont St attempting to turn left onto West St. Veh 1 was forced to lock brakes and became airborne.
32	3-Dec-2014	Wednesday	3:13 PM	Angle	Daylight	Cloudy, Rain	Wet	Failed to Yield Right of Way	Non-incapacitating	Veh 1 was traveling SB on West St. Veh 2 exited the Staples parking lot onto the path of Veh 1.

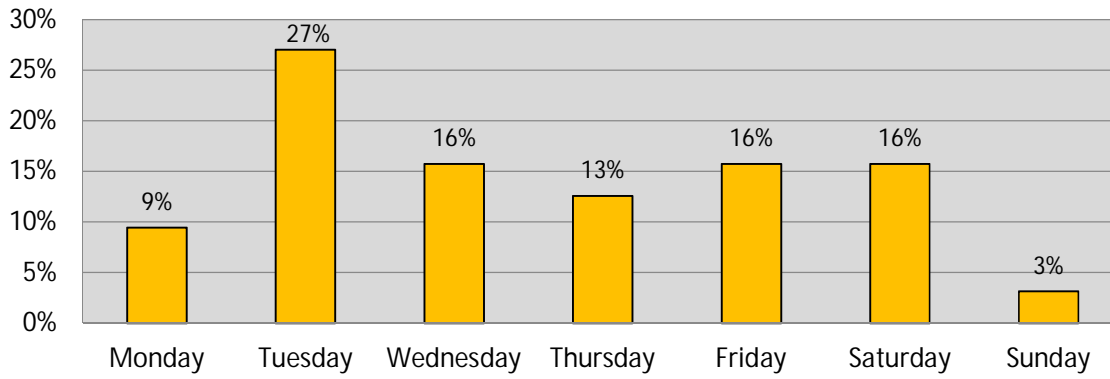
Source: Brockton Police Department Reports provided by MassDOT

Crash Data Summary Tables and Charts  
 Belmont Street at northern end of West Street, Brockton, MA

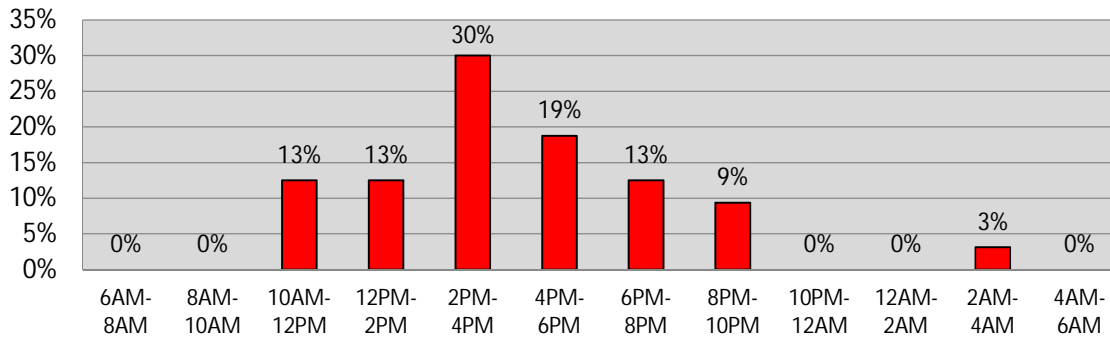
CRASH MONTH



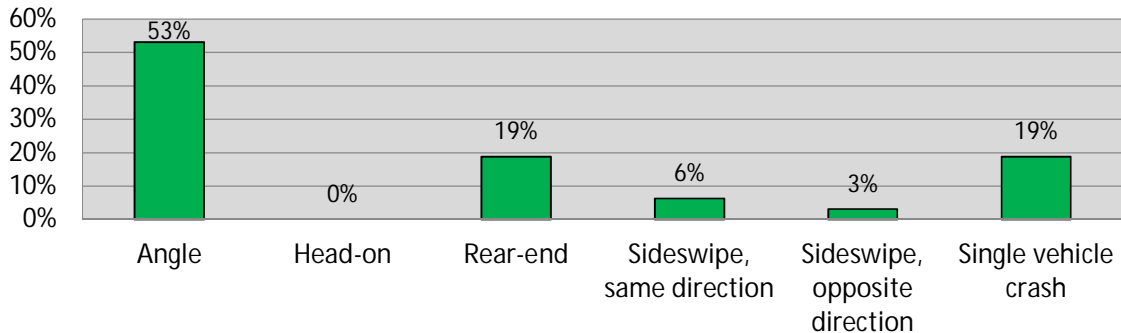
CRASH DAY OF THE WEEK



CRASH TIME OF DAY

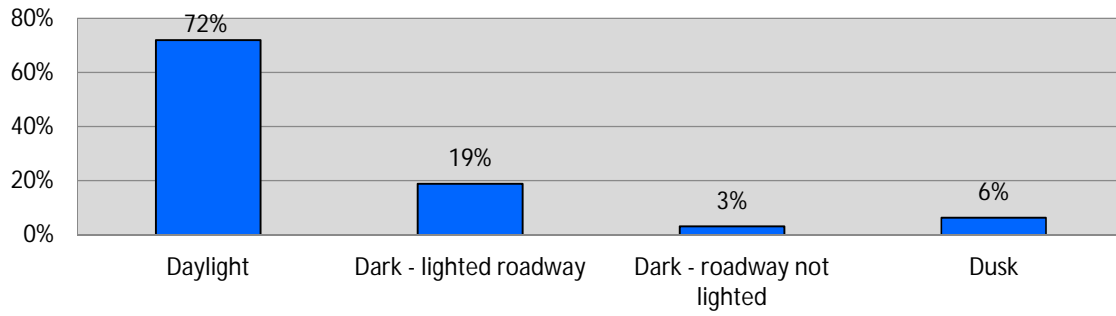


CRASH MANNER OF COLLISION

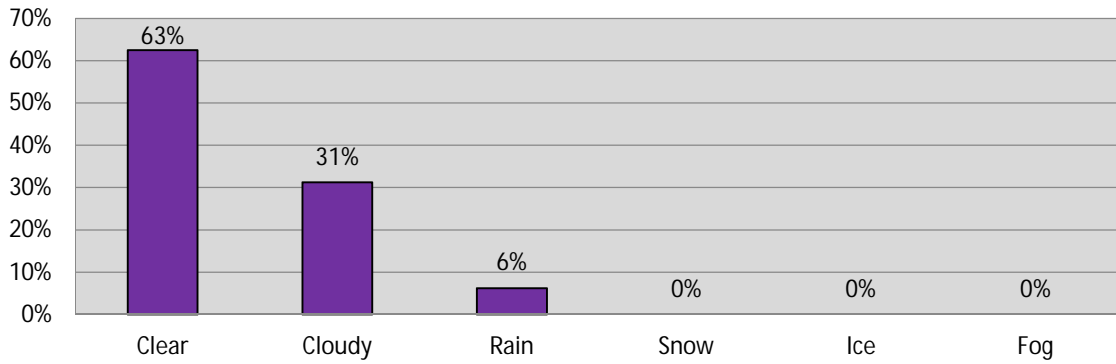


Crash Data Summary Tables and Charts  
Belmont Street at northern end of West Street, Brockton, MA

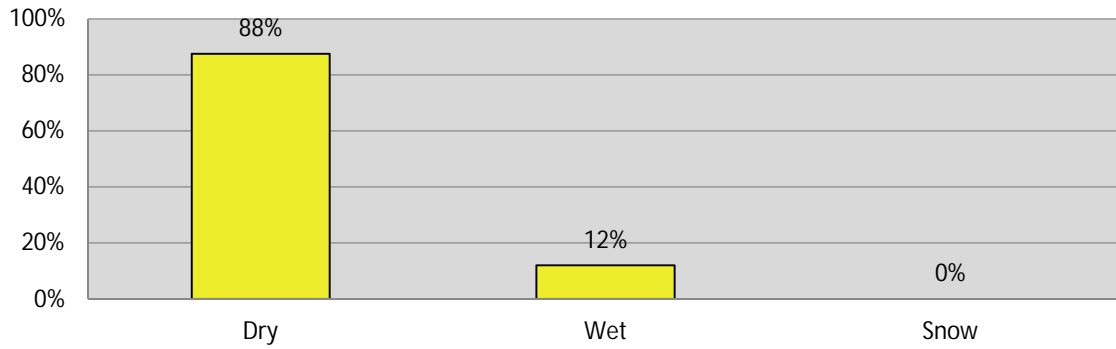
CRASH LIGHT CONDITION



CRASH WEATHER CONDITION



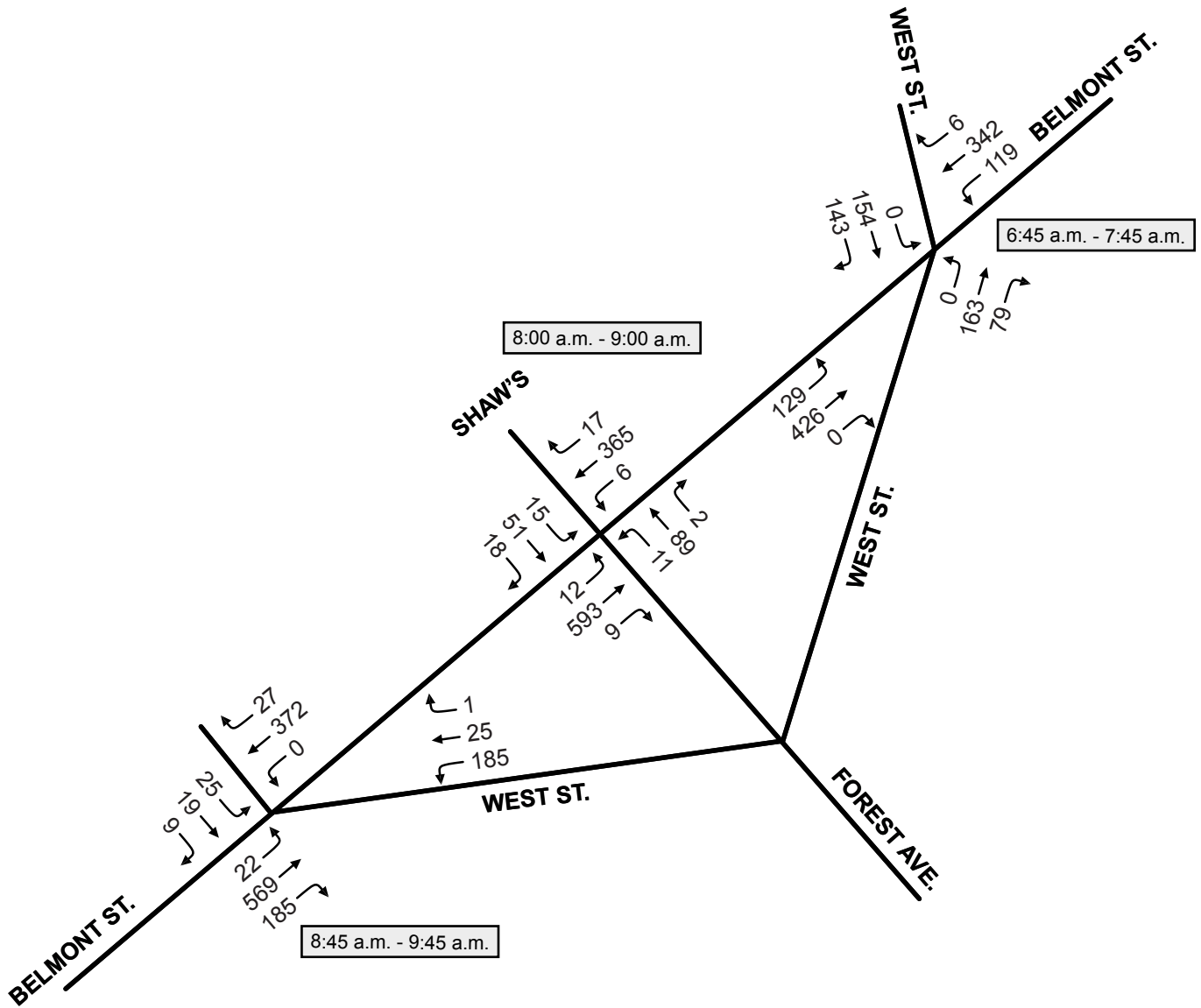
CRASH ROAD SURFACE

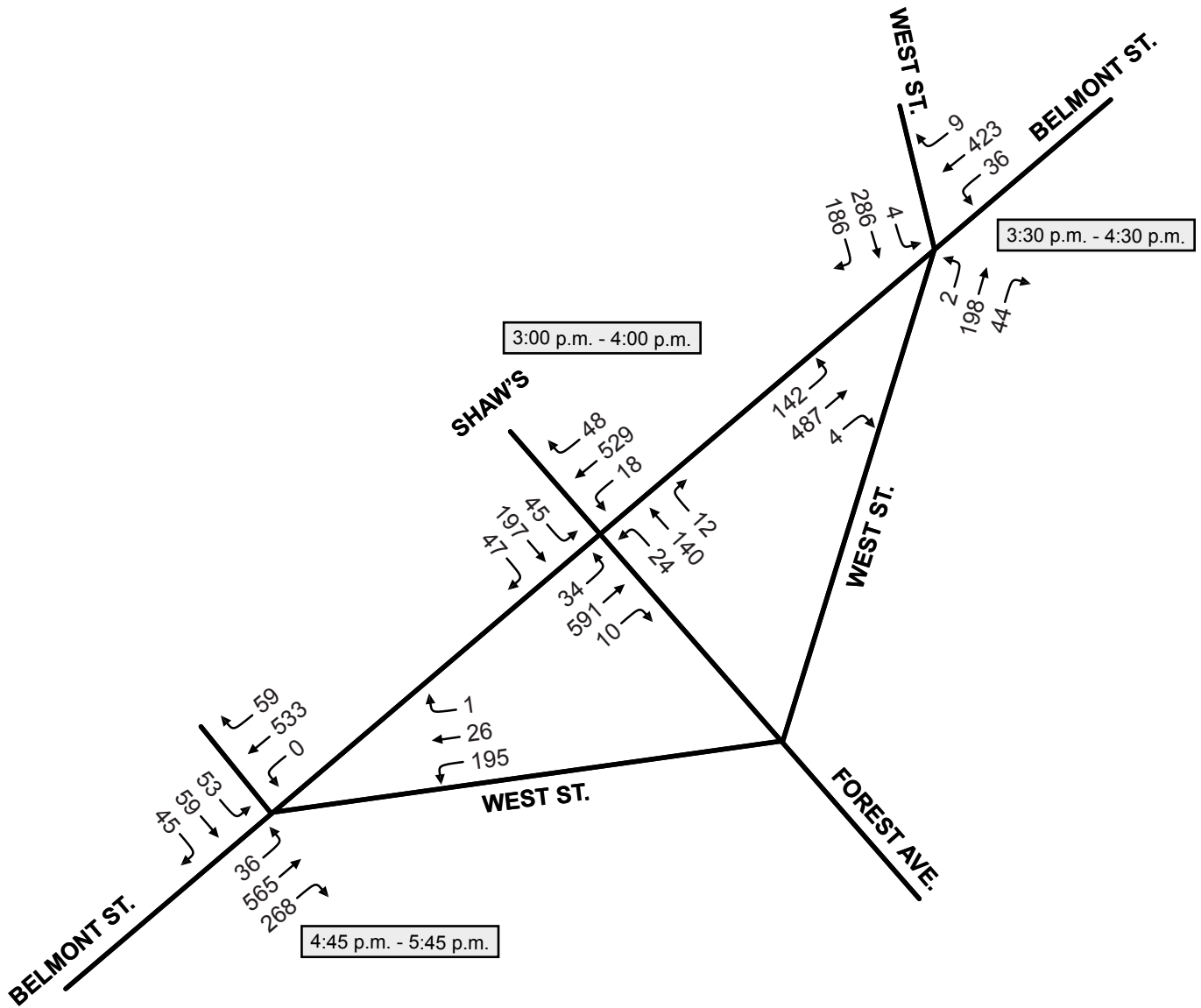




## Appendix D. Additional Information

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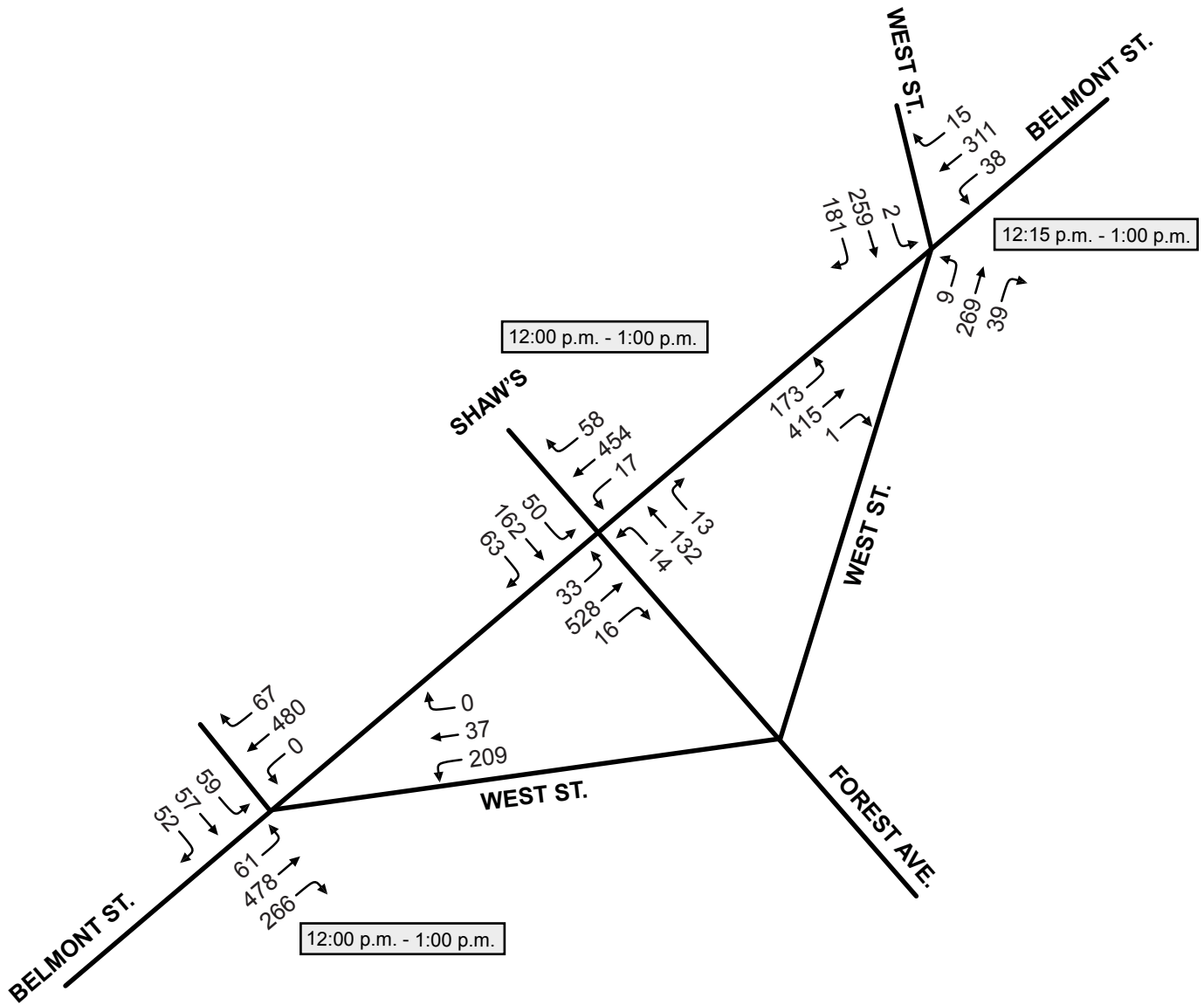


100 Nickerson Road  
 Marlborough, MA 01752  
 508.786.2200  
 www.tetratech.com



Brockton, Massachusetts

2015 Existing Afternoon Peak Hour Traffic Volumes **2** Figure



## Appendix E. Road Safety Audit References

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## Road Safety Audit References

*Massachusetts Traffic Safety Toolbox*, Massachusetts Highway Department,  
[www.mhd.state.ma.us/safetytoolbox](http://www.mhd.state.ma.us/safetytoolbox).

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

*Road Safety Audits*. Institute of Transportation Engineers and U.S. Department of Transportation, Federal Highway Administration, [www.roadwaysafetyaudits.org](http://www.roadwaysafetyaudits.org).

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

*Road Safety Audit*, 2<sup>nd</sup> edition. Austroads, 2000.

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