MEMORANDUM

To: **Larry Dunkin, Milford Town Planner** **February 17, 2011**
Joseph Frawley, MassDOT Highway District 3

From: **Chen-Yuan Wang and Efi Pagitsas**

Re: **Safety and Operations Analyses at Selected Boston Region MPO Intersections: Prospect Street at Water Street in Milford**

This memorandum summarizes safety and operations analyses and proposes improvement strategies for the intersection of Prospect Street (Route 140) at Water Street in Milford. It contains the following sections:

- Intersection Layout and Traffic Control
- Issues and Concerns
- Crash Data Analysis
- Intersection Capacity Analysis
- Preliminary Analysis of Traffic Signal Warrants
- Analysis of Traffic Signal Alternative
- Review of Roundabout Alternative
- Improvement Recommendations and Discussion

The memorandum also includes a collection of technical appendices that contain methods and data applied in the study and detailed reports of the intersection capacity analyses.

INTERSECTION LAYOUT AND TRAFFIC CONTROL

The intersection is unsignalized and located in the western section of the town, near the Hopedale/Milford border. Prospect Street, a two-lane roadway running in the north-south direction, is the major street of the intersection. It is a part of Route 140 that serves as a principal urban arterial running from Central Massachusetts (Grafton) to Southeast Massachusetts (New Bedford). Water Street, the minor street of the intersection, is a two-lane minor urban arterial running in the east-west direction and connecting Route 16 in the downtown area and Route 140 at this intersection. West of the intersection, Water Street becomes Williams Street and connects to Freedom Street, which leads to the central area of Hopedale.

Figure 1 shows the intersection layout and the area nearby. Both approaches of Prospect Street near the intersection widen to add an exclusive left-turn lane, which has a storage length of about 100 feet in the northbound direction and about 150 feet in the southbound direction. Both approaches of Water Street remain a single lane that is shared by all movements. A crosswalk is installed only on the south side of the intersection (across the Prospect Street northbound

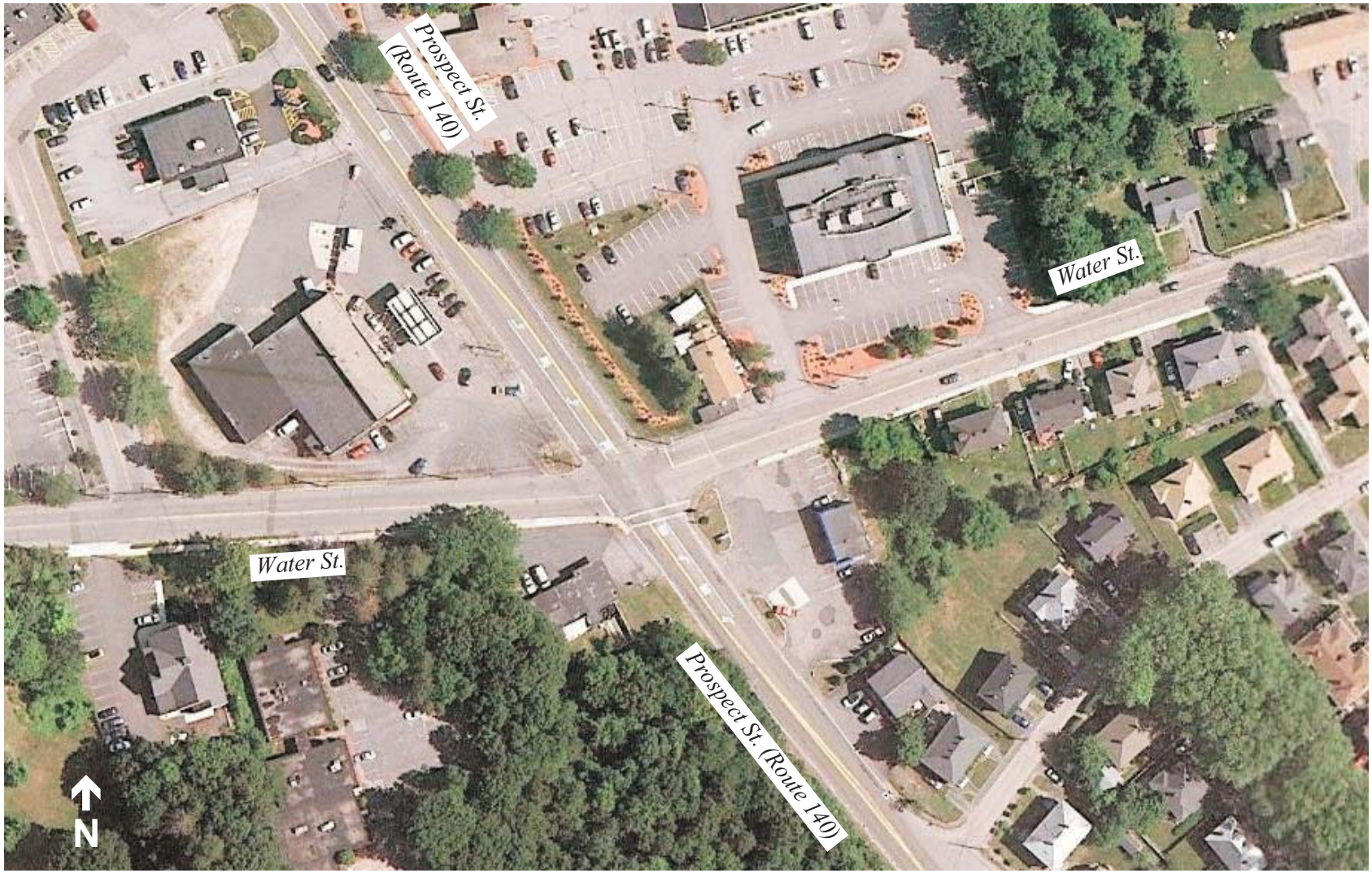

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FIGURE 1
Prospect Street at Water Street, Milford

Safety and Operations Improvements at Selected Intersections

approach). Sidewalks are installed on all approaches near the intersection. Away from the intersection, they are installed only on the east side of Prospect Street and on the south side of Water Street and Williams Street. No bike lanes are in place on any of the approaches. There are pedestrian-crossing warning signs facing Prospect Street traffic located at both ends of the crosswalk. As the intersection is not equipped with traffic signals, no pedestrian signals or push buttons are provided.

Currently the intersection is under a two-way stop control on Water Street and Williams Street, with a 24-by-24-foot stop sign placed on both approaches. In addition, an intersection traffic-control beacon mounted on a post about 7 to 8 feet tall is placed on the southwest corner of the intersection. The beacon contains four single-section signal faces: two flashing yellow beacons facing Prospect Street traffic, and two flashing red beacons facing Water Street traffic. The signal face has a diameter of about 8 inches.

The intersection is adjacent to a busy commercial section of Route 140. Its land uses are mixed, with commercial, office, and residential developments. At the intersection, there are a gas station and a dry cleaner on the northwest corner, a flower shop on the southwest corner, a small restaurant on the northeast corner, and an auto service shop on the southeast corner. North of the intersection, commercial and office developments, including Shaw's, Walgreens, Bank of America, Rite Aid Pharmacy, and other shops and professional services sprawl on both sides of Prospect Street until the signalized intersection at West Street. Slightly away from the intersection on Water Street a medical service building is located on the east side and an office park is located on the west side. Further away from the intersection are single- and multiple-family residences on Water Street and mainly vacant land on Williams Street. South of the intersection on Prospect Street are single-family residences on the east side and woodlands on the west side.

In addition to the surrounding mixed land uses, the intersection is situated on sloped terrain. Approaching the intersection from the north, Prospect Street goes very slightly downhill, while from the south it goes continuously uphill starting from Route 16, about half a mile away. Water Street goes gently uphill toward the intersection from the east and gently downhill from the west. A windshield survey indicated that the sight distances to the intersection are short from the downhill approaches. The sight line to the south of drivers near the stop line on the westbound Water Street approach is obstructed by several signs, commercial and traffic signs, on the southeast corner.

ISSUES AND CONCERNS

Comments from Milford town officers, including the Police Department, indicate that the Town is concerned about the consistently high number of crashes over the years. A review of the recent crash data indicates that the intersection has a high number of crashes and a crash rate higher than the average for unsignalized intersections in the area (see the next section for further analyses).

The section of Route 140 (Prospect Street) adjacent to the intersection carries a traffic volume of about 12,000 (south of the intersection) to 13,000 vehicles (north of the intersection) per weekday in both directions. During peak periods, heavy traffic on Prospect Street deters the traffic on Water Street from entering the intersection. Field observations indicated that during the

evening peak hour, the Water Street westbound approach frequently has five to ten vehicles backed up from the stop line. The congested conditions may compel motorists on Water Street to enter the intersection without waiting for safe traffic gaps.

Meanwhile, traffic control devices at this intersection may not be sufficient to alert drivers about approaching a stop-controlled intersection. As the intersection is located in rolling terrain and surrounded by commercial developments, drivers encountering these complicated conditions may have difficulty paying attention to the stop control even during the off-peak traffic periods. The flashing beacon signals are somewhat helpful. However, they are small and are located on a corner at a low height; they therefore are visible only from the Water Street eastbound approach. They are not conspicuous from other approaches, especially from the uphill approaches of Prospect Street and Water Street.

The issues and concerns for this intersection can be summarized as follows:

- High number of crashes and high crash rate
- Traffic congestion on the minor-street approaches during peak hours
- Short sight distance from the uphill approaches
- Insufficient traffic control devices to alert drivers
- No pedestrian signals for pedestrians crossing Prospect Street

CRASH DATA ANALYSIS

Based on the 2006-2008 MassDOT Registry of Motor Vehicles Division crash data, Table 1 shows that on average about 10 crashes occurred at the intersection each year. About one-third resulted in personal injuries (including one fatality), and about two-thirds of the total crashes involved property damage only or were not reported. The crash types, not including data that were not reported, consist of about 55% angle collisions, 20% sideswipe collisions, 10% rear-end collisions, and 10% head-on or single-vehicle collisions. No crashes involved pedestrians or bicycles. About 30% of the total crashes occurred during peak periods. About 30% of the total crashes happened when the roadway pavement was wet or icy.

Crash rate[1] is another effective tool for examining the relative safety of a particular location. Based on the 2006-2008 crash data and the recently collected traffic volume data, the crash rate for this intersection is calculated as 1.68 (see Appendix A for the calculation). This recent crash rate is still higher than the average rate for the unsignalized locations in MassDOT Highway Division District 3, which is estimated to be 0.68.[2]

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[1] Crash rates are estimated based on crash frequency (crashes per year) and vehicle exposure (traffic volumes or miles traveled). Crash rates are expressed as “crashes per million entering vehicles” for intersection locations and as “crashes per million miles traveled” for roadway segments.

[2] The average crash rates estimated by the MassDOT Highway Division (as of January 29, 2010) are based upon a database that contains intersection crash rates submitted to MassDOT as part of the review process for an Environmental Impact Report or Functional Design Report. The most recent average crash rates, which are updated on a nearly annual basis, are based on all entries in the database, not just those entries made within the past year.

TABLE 1
Summary of MassDOT Crash Data (2006-2008)

Statistics Period		**2006**	**2007**	**2008**	**3-Year**	**Annual**
Total Number of Crashes		8	11	10	29	10
Severity	Property Damage Only	4	5	4	13	4
	Personal Injury	2	3	3	8	3
	Fatality	0	1	0	1	0
	Not Reported	2	2	3	7	2
Collision Type	Angle	4	3	3	10	3
	Rear-end	1	1	0	2	1
	Sideswipe	1	1	2	4	1
	Head-on	0	0	1	1	0
	Single Vehicle	0	1	0	1	0
	Not Reported	2	5	4	11	4
Involved Pedestrian(s)		0	0	0	0	0
Involved Cyclist(s)		0	0	0	0	0
Occurred during Weekday Peak Periods*		3	2	3	8	3
Wet or Icy Pavement Conditions		2	3	4	9	3
Dark/Lighted Conditions		0	1	2	3	1

* Peak Periods defined as 7:00 - 10:00 AM and 3:30- 6:30 PM

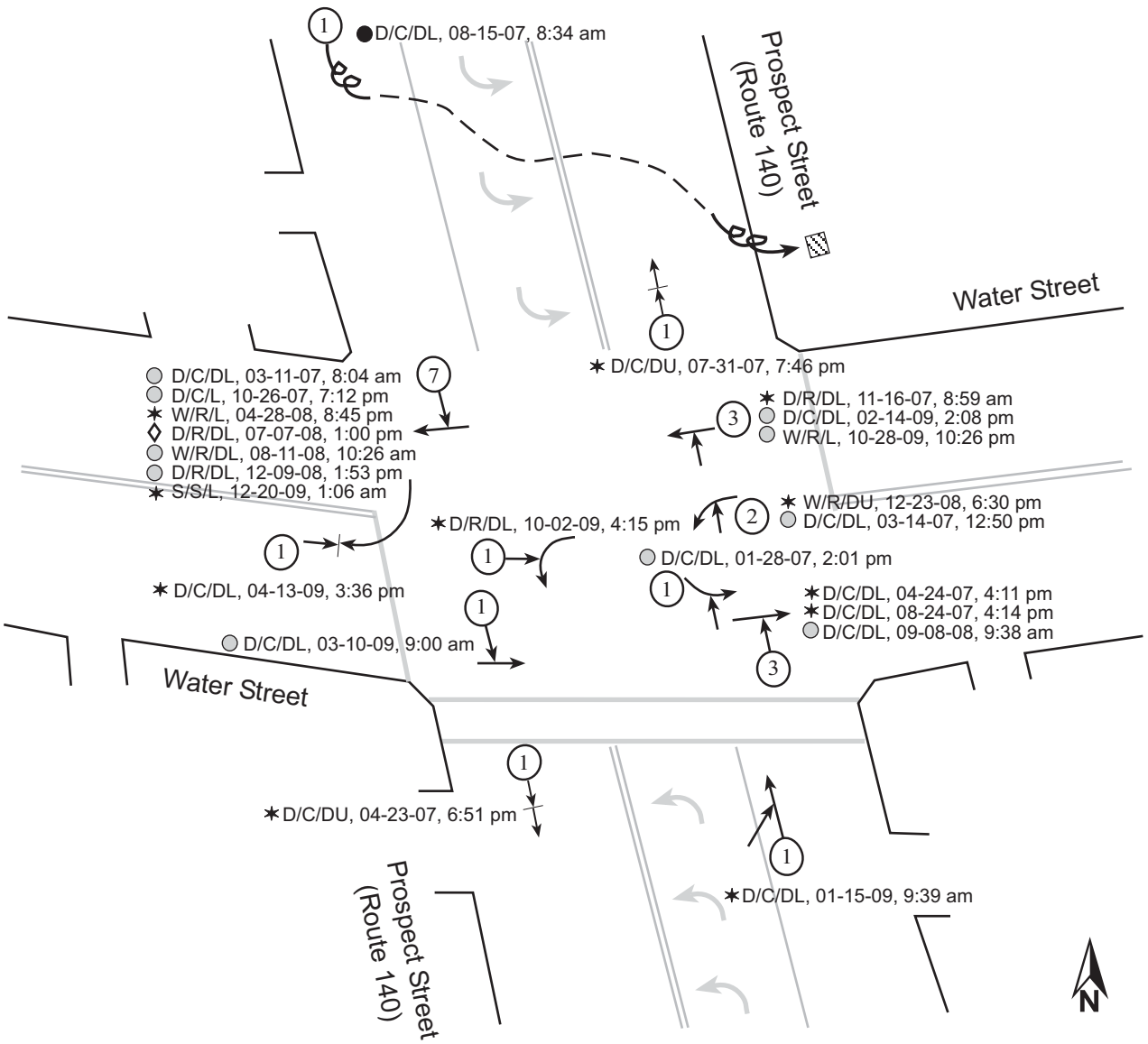
The Milford Police Department also provided collision reports for the most recent three years, from 2007 to 2009. Based on the reports, staff constructed the collision diagram for the intersection (see Figure 2) and a summary of the reports corresponding to the collision diagram (see Table 2).

The collision diagram shows a high number of angle collisions (about 70% of all collisions), which resulted from conflicts between vehicles entering the intersection from Water Street (stop controlled) and those traveling on Prospect Street (free of controls). It should be noted that three of the crashes do not appear to be related to the intersection operations. The two rear-end collisions on Prospect Street might have been caused by traffic from the nearby driveways. The single fatal out-of-control-vehicle collision in 2007 was not caused by traffic operations or roadway conditions but was due to the driver's illness.

Several factors could contribute to the angle collisions, including drivers from Water Street failing to wait for sufficient traffic gaps on Prospect Street, traffic congestion on Water Street pushing drivers to behave aggressively, drivers on Prospect Street traveling at a high speed and failing to slow down in time to avoid the collisions, as well as drivers' lack of attention to the traffic and roadway conditions.

Drivers approaching this intersection have to handle a complicated and sometimes-busy traffic conditions and may violate the law, often by not paying attention to the stop control. The collision diagram clearly shows a majority of oblique- and right-angle collisions that involved vehicles traveling on the stop-control approaches.

FIGURE 2
Collision Diagram
January 1, 2007, through December 31, 2009
Prospect Street at Water Street, Milford



SYMBOLS	PAVEMENT/WEATHER/LIGHTING		TYPES OF COLLISIONS
Moving vehicle	D	Dry	Head-on
Backing vehicle	W	Wet	Angle
Pedestrian or bicycle	S	Snowy, icy	Rear-end
Out-of-control vehicle	--	Other	Sideswipe
Fixed object	C	Clear	
Property damage only	R	Rainy/foggy/cloudy	
Injury	S	Snow/sleet	
Fatality	--	Other	
No damage or injury	DL	Daylight	
Not reported	L	Dark, lights	
(#) Number of accidents	N	Dark, no lights	
	DU	Dusk	
	DW	Dawn	

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TABLE 2
Summary of Crash Reports from Milford Police Department (2007-2009)

Statistics Period		**2007**	**2008**	**2009**	**3-Year**	**Annual**
Total Number of Crashes		10	6	7	23	8
Severity	Property Damage Only	6	2	4	12	4
	Personal Injury	3	3	3	9	3
	Fatality	1	0	0	1	0
	Not Reported	0	1	0	1	0
Collision Type	Angle	7	6	5	18	6
	Rear-end	2	0	0	2	1
	Sideswipe	0	0	1	1	0
	Head-on	0	0	1	1	0
	Single Vehicle	1	0	0	1	0
	Not Reported	0	0	0	0	0
Involved Pedestrian(s)		0	0	0	0	0
Involved Cyclist(s)		0	0	0	0	0
Occurred during Weekday Peak Periods*		4	3	4	11	4
Wet or Icy Pavement Conditions		0	3	2	5	2
Dark/Lighted Conditions		3	2	2	7	2

* Peak periods are defined as 7:00-10:00 AM and 3:30-6:30 PM.
Note: All 2007 crashes in this table are included in Table 1 (MassDOT Crash Data 2006-2008).
All 2008 crashes, except two (7/7/2008 and 12/23/2008), in this table are included in Table 1.
None of the 2009 crashes in this table are included in Table 1.

INTERSECTION CAPACITY ANALYSIS

MPO staff collected turning movement counts at the intersection on June 3, 2010. The data were recorded in 15-minute intervals for the peak traffic periods in the morning, from 7:00 to 9:00, and in the evening, from 4:00 to 6:00. The intersection carried about 1,180 vehicles in the morning peak hour, from 7:30 to 8:30, and about 1,420 vehicles in the evening peak hour, from 4:00 to 5:00 (see Table 3). Six pedestrians and four pedestrians were observed during the AM and PM peak hour, respectively. No cyclists were observed in the AM peak hour, and one westbound through cyclist was observed in the PM peak hour (not shown in Table 3).

TABLE 3
AM and PM Peak-Hour Traffic Volumes and Pedestrian Crossings

Street name		**Prospect Street**						**Water Street**						**Total**
Direction		**Northbound**			**Southbound**			**Eastbound**			**Westbound**			
Turning movement		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM peak hour	**Turning volume**	37	358	31	71	412	30	11	35	73	14	22	82	1176
	Approach volume	426			513			119			118			
	Ped. crossings	2			1			1			2			6
PM peak hour	**Turning volume**	58	448	35	83	448	32	12	42	49	34	31	104	1416
	Approach volume	581			563			103			169			
	Ped. crossings	2			0			2			0			4

Based on the turning movement counts and the signal timings measured on the site, the intersection capacity was analyzed by using an intersection capacity analysis program, Synchro.[3] The intersection was modeled as an unsignalized intersection with a stop control on Water Street. As Table 4 shows, the operations on Water Street were found to operate at level of service (LOS) D with an average delay of about half a minute in the AM peak hour, and to operate at LOS F with an average delay of about one to one and half minutes in the PM peak hour. The criteria for the level of service are based on Highway Capacity Manual 2000.[4] The LOS analysis indicates that drivers on Water Street experience some acceptable delays in the AM peak hour but experience undesirable delays in the PM peak hour. Detailed analysis settings and results for both the AM and PM peak hour are included in Appendix B.

TABLE 4
Intersection Capacity Analysis, Existing Conditions

Street name		**Prospect Street**						**Water Street**					
Direction		**Northbound**			**Southbound**			**Eastbound**			**Westbound**		
Turning movement		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
AM peak hour	**LOS**	**A**			**A**			**D**			**D**		
	Delay (sec/veh)	1			1			31			28		
PM peak hour	**LOS**	**A**			**A**			**F**			**F**		
	Delay (sec/veh)	1			1			57			109		

PRELIMINARY ANALYSIS OF TRAFFIC SIGNAL WARRANTS

According to Manual for Uniform Traffic Control Devices(MUTCD),[5] an engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location should be performed to determine whether installation of a traffic control signal is justified at a particular location. The investigation should include applicable factors contained in the following traffic signal warrants and other factors related to existing operations and safety at the study location:

1. Eight-Hour Vehicular Volume Warrant
2. Four-Hour Vehicular Volume Warrant
3. Peak-Hour Warrant
4. Pedestrian Volume Warrant
5. School Crossing Warrant
6. Coordinated Signal System Warrant
7. Crash Experience Warrant
8. Roadway Network Warrant
9. Intersection Near a Grade Crossing

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[3] Synchro is developed and distributed by Trafficware, Ltd. It can perform capacity analysis and traffic simulation (when combined with SimTraffic) for an individual intersection or a series of intersections.

[4] Transportation Research Board, *Highway Capacity Manual 2000*, Nation Research Council, Washington D. C., 2000.

[5] Federal Highway Administration, U.S. Department of Transportation, *Chapter 4C. Traffic Control Signal Needs*, 2009 Edition, December 2009.

A traffic control signal should not be installed unless one or more of the factors reflected in these warrants are met. Moreover, the satisfaction of a warrant or warrants in itself does not justify signal installation unless an engineering study indicates that the installation will improve the overall safety and/or operation of the intersection.

In this study, we performed a preliminary analysis of the applicable traffic signal warrants based on available traffic data. The applicable factors for this intersection are contained in Warrants 1, 2, and 7. Warrant 3 is intended for unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy-vehicle facilities that attract or discharge large numbers of vehicles over a short time. The intersection is regarded as a stand-alone location, not a part of a coordinated traffic system, where pedestrian volume is low and is not close to any schools or near a grade crossing. Therefore Warrants 3, 4, 5, 6, 8, and 9 were not tested.

Table 5 shows the examination of Warrants 1, 2, and 7 based on hourly volumes of an average day, which were derived from three mid-week days' 24-hour automatic traffic counts. The counts were collected by MassDOT's Highway Division in the week of June 7, 2010; the volumes were considered typical for the season or even slightly higher than average (see Appendix C for the detailed summary of hourly volumes from all the approaches at the intersection).

TABLE 5
Summary of Hourly Volumes and Warrant Fulfillment

Hourly Period Starting	Prospect St. (main street)		Water/Williams St. (minor street)		Sum of main street	Higher of minor street	Volumes above the minimum requirement		
	EB	WB	SB	NB			Warrant 1	Warrant 2	Warrant 7
6:00	50	71	23	26	121	26			
7:00	167	267	56	60	434	60			X
8:00	349	422	114	90	771	114	X		X
9:00	399	475	138	111	874	138	X		X
10:00	408	467	133	106	875	133	X		X
11:00	421	444	110	116	865	116	X		X
12:00	452	443	144	125	895	144	X		X
13:00	479	482	142	133	961	142	X		X
14:00	479	463	117	144	942	144	X		X
15:00	510	537	142	145	1047	145	X	X	X
16:00	562	559	136	154	1121	154	X	X	X
17:00	548	532	139	155	1080	155	X	X	X
18:00	540	504	124	144	1044	144	X	X	X
19:00	452	430	95	106	882	106	X		X

Note: **Warrant 1 is fulfilled.** It requires that the traffic conditions (observed vehicular volumes higher than the specified minimum volumes) exist for each of any 8 hours of an average day. Conditions B was applied in this case.
Warrant 2 is fulfilled. It requires that the traffic conditions (minimum volumes specified differently from Warrant 1) exist for each of any 4 hours of an average day.
Warrant 7 (Crash Experience) is fulfilled. It requires that the traffic conditions (vehicular volumes higher than 80 percent of the volumes specified in Warrant 1 Condition B), in addition to the requirement of five or more correctable crashes in recent 12-month period.

The analysis indicates that the intersection meets the conditions required by Warrants 1 (Eight-Hour Vehicular Volume Warrant) and 2 (Four-Hour Vehicular Volume Warrant). Warrant 7 is also satisfied, as the traffic conditions meet the required criteria and the 2008 crashes include five angle collisions that are susceptible to correction.

ANALYSIS OF TRAFFIC SIGNAL ALTERNATIVE

The preliminary traffic signal warrants analysis shows that the required traffic conditions exist for Warrants 1, 2 and 7 to be satisfied at this intersection. This section will examine if and how a traffic signal control would work at this intersection.

Synchro tests of the installation of a traffic signal control indicate that under the existing layout the intersection would operate at an overall level of service (LOS) B in both the AM and PM peak hours, with all individual approaches running at a desirable LOS B or better (see Table 6). The signal was modeled as a three-phase operation, with the north-south approaches led by protected and permissive left turns, under a total cycle of 67 seconds consisting of 45 seconds of traffic phases and an on-call exclusive pedestrian signal phase of 22 seconds (see Appendix D for details of the analysis for both AM and PM peak hours).

TABLE 6
Intersection Capacity Analysis
Traffic Signal Option under Existing Traffic Conditions

Street name		**Prospect Street**						**Water Street**						**Overall**
Direction		**Northbound**			**Southbound**			**Eastbound**			**Westbound**			
Turning movement		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM peak hour	LOS	**A**	**B**		**A**	**B**		**B**			**B**			**B**
	Delay (sec/veh)	7	14		7	14		19			17			14
PM peak hour	LOS	**A**	**B**		**A**	**B**		**B**			**B**			**B**
	Delay (sec/veh)	8	20		9	19		17			19			18

In addition, a future-year scenario of 15% growth over a 20-year planning horizon was tested for the traffic signal option. The growth assumption is based on a review of the traffic projections at the intersection from the recent Boston Region MPO transportation-planning model. As shown in Table 7, the signalized intersection, without any major geometric design modifications, would still operate at a desirable LOS B in the AM peak hour and LOS C in the PM peak hour under the projected traffic conditions (see Appendix E for details of the analysis results).

The above analyses show that a traffic signal would operate acceptably at this intersection. The traffic signal would interrupt traffic on Prospect Street at intervals to permit traffic from Water Street to proceed. Traffic operations on Water Street would be significantly improved with much reduced delays. Although delays on Prospect Street would increase somewhat, it would still maintain a desirable level of service for both approaches.

In addition, the signal is expected to reduce the frequency and severity of certain types of crashes, especially right-angle collisions. Currently the flashing beacon is located at a corner of the

TABLE 7
Intersection Capacity Analysis
Traffic Signal Option under 2030 Projected Traffic Conditions

Street name		**Prospect Street**						**Water Street**						**Overall**
Direction		**Northbound**			**Southbound**			**Eastbound**			**Westbound**			
Turning movement		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM peak hour	LOS	**A**	**B**		**A**	**B**		**C**			**B**			**B**
	Delay (sec/veh)	7	15		7	15		20			18			15
PM peak hour	LOS	**A**	**C**		**B**	**C**		**B**			**C**			**C**
	Delay (sec/veh)	8	25		11	21		18			23			21

intersection. The future overhead signal indications would increase the awareness and visibility of the intersection, especially from the uphill approaches. These measures are further discussed in the section on recommendations and discussion.

REVIEW OF ROUNDABOUT ALTERNATIVE

Another improvement option considered for this intersection is the installation of a modern roundabout. Modern roundabouts have the advantages of slowing down traffic, reducing crash severity, and requiring minimal maintenance costs. This section will evaluate whether a modern roundabout would work for this intersection.

Synchro tests of a single-lane roundabout under the existing traffic conditions indicate that a modern roundabout would operate satisfactorily in both AM and PM peak hours. All the approaches would operate under 85% of the estimated capacity, which is regarded as the threshold for roundabout operations.[6] Detailed analyses of individual approaches for both peak hours are shown in Appendix F.

In addition, a future-year scenario of 15% growth over a 20-year planning horizon was tested for the single-lane roundabout option. The assumed roundabout intersection would still operate acceptably, with volume-to-capacity ratios under 85% for all approaches in both of the peak hours under the projected traffic conditions.

The above analyses show that a modern roundabout at this location is operationally feasible under the existing and projected traffic conditions. However, further review of the geometric design elements and the surrounding land use characteristics indicates that the roundabout option is not favorable for this intersection.

As the future roundabout would be located in the middle of a principal urban arterial with a prevailing traffic speed of 35 MPH or higher within a limited space, the following basic design elements were considered:[7]

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[6] Federal Highway Administration, U.S. Department of Transportation, *Roundabouts: An Informational Guide, Chapter 4: Operation*, FHWA-RD-00-67, June 2000.

[7] Federal Highway Administration, U.S. Department of Transportation, *Roundabouts: An Informational Guide, Chapter 6: Geometric Design*, FHWA-RD-00-67, June 2000.

- Single entry/exit lane from all approaches
- 25 MPH maximum speed of the entry design
- 115 to 130 feet inscribed circle diameter
- Raised and extended splitter islands with crosswalk cuts
- Up to 20,000 vehicles daily service volumes

Based on these design elements, the roundabout conversion would likely require some land-takings at and near the intersection.[8] In addition, the vertical curves on both streets could complicate the roundabout maneuver during snowy or icy conditions. It would also require sufficient distance on Prospect Street for vehicles to slow down from 35 MPH to 25 MPH. Last but not least, it would not be compatible with the existing surroundings, where signalized intersections already exist north and south of this intersection and adjacent commercial developments require several access/egress driveways near the intersection. Therefore, the modern roundabout option is considered to be unfavorable at this location.

OTHER IMPROVEMENT ALTERNATIVES

In the study review session, some improvement ideas costing less than the traffic signal and the roundabout alternatives and focusing on reducing the severity of collisions were discussed:

- Make Prospect Street (Route 140) a single shared through-left lane by removing the left-turn lane in both directions (which would potentially help eliminate the major safety issue of the queued left-turning traffic blocking the sight lines for the Water Street traffic)
- Prohibit left turns at the intersection (presumably drivers could use the signalized intersection to the north to make the necessary movements)
- Make the intersection a four-way stop operation

A quick review found that the first and the third ideas would have significant impacts on the capacity of Route 140 and have uncertain safety benefits as traffic congestion on Route 140 potentially would increase the number of crashes at the intersection. The second idea is also not feasible, as the Town indicated that there are no sufficient alternative routes in the current street system for the left turners if they are prohibited from turning left at this intersection. For these reasons, these three ideas were not considered for this intersection.

IMPROVEMENT RECOMMENDATIONS AND DISCUSSION

The above safety and operations analyses indicate that the existing two-way stop control is not effective for the roadway and traffic conditions at this intersection. To improve safety and operations at this intersection, this study reviewed two major improvement alternatives: (1) to install a traffic signal in place of the STOP control, and (2) to convert the intersection to a modern roundabout. The conversion to a roundabout would involve design modifications with potential land takings and was considered unfavorable through a review of the existing roadway and land use conditions.

[8] A review of the State Roadway Inventory file indicates that near the intersection, Prospect Street has a 40-foot right-of-way (ROW), Water Street has a 50-foot ROW, and Williams Street has a 40-foot ROW. The intersection space is insufficient for accommodating an inscribed circle of 115 to 130 feet in diameter.

The installation of a traffic signal was analyzed as justified and was determined to be operationally acceptable. The preliminary traffic signal warrants analysis shows that the required traffic conditions of Warrants 1, 2, and 7 are all satisfied for this intersection. The capacity analyses of the signalized intersection under the existing layout indicate that Water Street traffic operations would be significantly improved, with much reduced delays, and Prospect Street would still maintain a desirable level of service (LOS) with slightly increased delays. The intersection would operate at a desirable overall LOS B with a reduced average delay per vehicle.

In addition, the signal would reduce conflicts between Prospect Street and Water Street traffic and thus reduce the frequency and severity of certain types of crashes (mainly right-angle collisions). More significantly, it would improve the pedestrian safely at this intersection as it could stop all the traffic at intervals and provide an exclusive signal phase for pedestrians to cross the intersection. We therefore recommend the installation of a traffic signal at this intersection with the following major features:

- Install a fully actuated traffic signal system with pedestrian signal heads
- Install overhead signal indications supported by mast arms, which can be clearly viewed from all approaches
- Maintain the existing 100- and 150-foot storage lengths for the northbound and the southbound left-turn pockets
- Install pedestrian signal heads and push buttons at all corners of the intersection
- Install crosswalks on the three approaches that lack crosswalks (there is an existing crosswalk on the northbound approach)
- Install wheelchair ramps that meet ADA (American with Disabilities Act)/AAB (Massachusetts Architectural Access Board) standards at all corners of the intersection
- Upgrade any substandard sidewalks connected to the intersection
- Consolidate or modify the driveways of the nearby commercial developments so that they would not be too close to the intersection's functional (turning) areas
- Widen the shoulders on Route 140 to a minimum of 4 feet to accommodate bicycles[9]

The State Roadway Inventory file indicates that Prospect Street (Route 140) in the vicinity of the intersection has a right-of-way width of about 40 feet. It appears to be insufficient for the inclusion of a 4-foot shoulder on both sides of Route 140. The right-of-way impacts of this and the potential sidewalk upgrades should be further examined in the functional design stage for this intersection.

At this preliminary planning stage, the total cost of the signal installation and the intersection reconstruction can be roughly estimated as $500,000 to $750,000 barring no land-taking costs. Currently Prospect Street (Route 140) is under the jurisdiction of MassDOT, and Water Street is owned by the Town of Milford. The implementation would require the town to work closely with MassDOT through the project implantation process (see Appendix G). The Town can prepare the Project Need Form (PNF) and Project Initiation Form (PIF) for improvements to be implemented at this location, as an important part of the Needs Identification/Project Initiation process, to gather public consensus for a conceptual design. The MassDOT Highway Division District office will assist the Town in preparing these forms. In addition, the Town will have to request

[9] This is required by MassDOT's engineering directive E-09-005, unless the project is small enough to be exempt from the design criteria.

that the Boston Region MPO place any proposed project for this location in the Transportation Improvement Program.

In the short term, the following measures can help to improve the existing traffic operations:

- Replace the existing 24-by-24-foot stop signs with 30-by-30-foot signs
- Install a solar powered flashing red beacon on the top of the new stop sign on the Water Street westbound approach
- Relocate the traffic signs and commercial signs on the southeast corner of the intersection[10]
- Install an intersection-ahead warning sign (W2-1)[11] on the northbound approach about 500 feet from the intersection

These short-term measures would increase drivers' awareness of and attention to the traffic conditions and regulations at the intersection.

[10] There are two traffic signs at the location. The pedestrian crossing warning sign can be relocated about 15 to 20 feet further south. The "Left Lane Must Turn Left" sign is too close to the intersection and should be relocated about 100 feet from the intersection.

[11] Federal Highway Administration, U.S. Department of Transportation, *Chapter 2C. Warning Signs*, 2009 Edition, December 2009.

Appendix A

Intersection Crash Rate Calculation
Prospect Street at Water Street, Milford

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Milford | COUNT DATE : 6/3/10

DISTRICT : 3 | UNSIGNALIZED : X | SIGNALIZED :

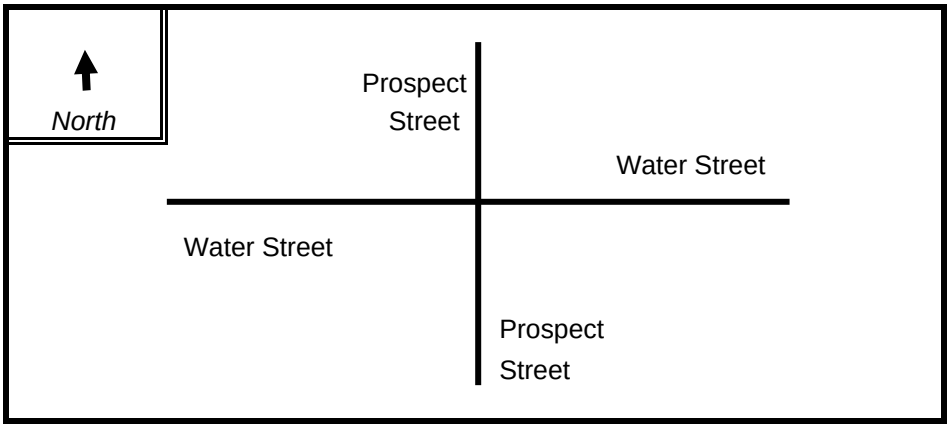
~ INTERSECTION DATA ~

MAJOR STREET : Prospect Street (Route 140)

MINOR STREET(S) : Water Street

Williams Street

INTERSECTION DIAGRAM (Label Approaches)



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	NB	SB	EB	WB		
PEAK HOURLY VOLUMES (AM/PM) :	581	563	103	169		**1,416**

" K " FACTOR : **0.090** | INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **15,733**

TOTAL # OF CRASHES : 29 | # OF YEARS : 3 | AVERAGE # OF CRASHES PER YEAR (**A**) : **9.67**

CRASH RATE CALCULATION : **1.68**

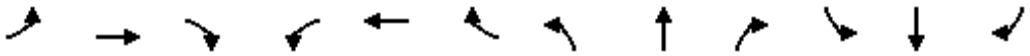
$$\text{RATE} = \frac{(A * 1{,}000{,}000)}{(V * 365)}$$

Comments : MassDOT District 3 Average Rate = 0.68

Project Title & Date: Safety and Operations Analyses at Selceted Intersections

Appendix B

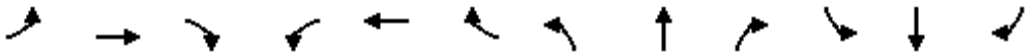
AM/PM Peak Hour Intersection Capacity Analysis
Existing Traffic Conditions
Prospect Street at Water Street, Milford



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	11	35	73	14	22	82	37	358	31	71	412	30
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	12	40	83	16	25	93	42	407	35	81	468	34
Pedestrians		1			2			2			1	
Lane Width (ft)		12.0			12.0			12.0			12.0	
Walking Speed (ft/s)		4.0			4.0			4.0			4.0	
Percent Blockage		0			0			0			0	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1245	1176	488	1245	1175	427	503			444		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1245	1176	488	1245	1175	427	503			444		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	88	76	86	83	85	85	96			93		
cM capacity (veh/h)	103	169	576	96	169	624	1050			1104		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	135	134	42	442	81	502
Volume Left	12	16	42	0	81	0
Volume Right	83	93	0	35	0	34
cSH	270	290	1050	1700	1104	1700
Volume to Capacity	0.50	0.46	0.04	0.26	0.07	0.30
Queue Length 95th (ft)	65	58	3	0	6	0
Control Delay (s)	30.9	27.7	8.6	0.0	8.5	0.0
Lane LOS	D	D	A		A	
Approach Delay (s)	30.9	27.7	0.7		1.2	
Approach LOS	D	D				

Intersection Summary				
Average Delay	6.7			
Intersection Capacity Utilization	46.9%	ICU Level of Service		A
Analysis Period (min)	15			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	12	42	49	34	31	104	58	488	35	83	448	32
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	13	45	52	36	33	111	62	519	37	88	477	34
Pedestrians		2						2				
Lane Width (ft)		12.0						12.0				
Walking Speed (ft/s)		4.0						4.0				
Percent Blockage		0						0				
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1442	1352	498	1391	1350	538	513			556		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1442	1352	498	1391	1350	538	513			556		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	80	65	91	49	74	80	94			91		
cM capacity (veh/h)	63	129	573	71	129	543	1051			1004		

Direction, Lane #	EB 1	WB 1	NB 1	NB 2	SB 1	SB 2
Volume Total	110	180	62	556	88	511
Volume Left	13	36	62	0	88	0
Volume Right	52	111	0	37	0	34
cSH	172	186	1051	1700	1004	1700
Volume to Capacity	0.64	0.97	0.06	0.33	0.09	0.30
Queue Length 95th (ft)	90	196	5	0	7	0
Control Delay (s)	57.1	109.2	8.6	0.0	8.9	0.0
Lane LOS	F	F	A		A	
Approach Delay (s)	57.1	109.2	0.9		1.3	
Approach LOS	F	F				

Intersection Summary				
Average Delay	18.1			
Intersection Capacity Utilization	58.6%	ICU Level of Service	B	
Analysis Period (min)	15			

Appendix C

Summary of hourly traffic volumes
June 7, 2010
Prospect Street at Water Street, Milford

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 6/7/2010

STA. 1 NB

Site Reference: 000000000544
Site ID: 000000000101
Location: RTE. 140 SOUTH OF WATER/WILLIAMS STS.
Direction: NORTH

File: 101.prn
City: MILFORD
County: VOL N.B.

TIME	MON 7	TUE 8	WED 9	THU 10	FRI 11	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		37	46	44	57	46			46	184
02:00		27	19	16	26	22			22	88
03:00		16	8	13	13	12			12	50
04:00		10	5	5	5	6			6	25
05:00		17	14	25	24	20			20	80
06:00		45	50	48	57	50			50	200
07:00		166	179	157	166	167			167	668
08:00		341	365	339	353	349			349	1398
09:00		391	403	381	424	399			399	1599
10:00		398	400	427		408			408	1225
11:00		412	419	433		421			421	1264
12:00	466	447	466	432		452			452	1811
13:00	455	502	475	486		479			479	1918
14:00	513	472	493	438		479			479	1916
15:00	525	516	503	499		510			510	2043
16:00	556	561	585	549		562			562	2251
17:00	544	588	572	490		548			548	2194
18:00	535	557	529	540		540			540	2161
19:00	438	459	428	483		452			452	1808
20:00	399	365	354	424		385			385	1542
21:00	276	318	298	308		300			300	1200
22:00	181	160	172	183		174			174	696
23:00	101	105	94	104		101			101	404
24:00	78	87	73	89		81			81	327
TOTALS	5067	6997	6950	6913	1125	6963	0	0	6963	27052
% AVG WKDY	72.7	100.4	99.8	99.2	16.1					
% AVG WEEK	72.7	100.4	99.8	99.2	16.1					
AM Times	12:00	12:00	12:00	11:00	09:00	12:00			12:00	
AM Peaks	466	447	466	433	424	452			452	
PM Times	16:00	17:00	16:00	16:00		16:00			16:00	
PM Peaks	556	588	585	549		562			562	

U3

NB 6963
SB 6742
COMB AWD 13705
FAC .90 (.97)
COMB ADT 12,000

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 6/7/2010

STA. 1SB

Site Reference: 000000000689
Site ID: 000000000102
Location: RTE. 140 SOUTH OF WATER/WILLIAMS STS.
Direction: SOUTH

File: 102.prn
City: MILFORD
County: VOL S.B.

TIME	MON 7	TUE 8	WED 9	THU 10	FRI 11	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		22	36	17	29	26			26	104
02:00		6	15	15	17	13			13	53
03:00		15	9	8	13	11			11	45
04:00		10	6	8	8	8			8	32
05:00		23	20	24	25	23			23	92
06:00		77	76	68	70	72			72	291
07:00		284	286	265	266	275			275	1101
08:00		429	427	415	418	422			422	1689
09:00		468	442	446	427	445			445	1783
10:00		440	424	433		432			432	1297
11:00		437	403	429		423			423	1269
12:00	406	410	478	464		439			439	1758
13:00	474	486	439	455		463			463	1854
14:00	469	407	421	422		429			429	1719
15:00	520	519	509	493		510			510	2041
16:00	524	499	483	476		495			495	1982
17:00	510	532	504	517		515			515	2063
18:00	483	479	463	505		482			482	1930
19:00	423	371	412	432		409			409	1638
20:00	316	303	335	315		317			317	1269
21:00	242	254	220	266		245			245	982
22:00	161	135	138	152		146			146	586
23:00	91	103	80	107		95			95	381
24:00	48	43	44	54		47			47	189
TOTALS	4667	6752	6670	6786	1273	6742	0	0	6742	26148
% AVG WKDY	69.2	100.1	98.9	100.6	18.8					
% AVG WEEK	69.2	100.1	98.9	100.6	18.8					
AM Times	12:00	09:00	12:00	12:00	09:00	09:00			09:00	
AM Peaks	406	468	478	464	427	445			445	
PM Times	16:00	17:00	15:00	17:00		17:00			17:00	
PM Peaks	524	532	509	517		515			515	

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 6/22/2010

STA. 2 NB

Site Reference: 000000000560
Site ID: 000000000201
Location: RTE. 140 NORTH OF WATER ST.
Direction: NORTH

File: 201.prn
City: MILFORD
County: VOL N.B.

TIME	MON	TUE 22	WED 23	THU 24	FRI 25	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00			43	53	55	50			50	151
02:00			29	39	40	36			36	108
03:00			13	20	19	17			17	52
04:00			9	11	15	11			11	35
05:00			24	24	25	24			24	73
06:00			71	83	65	73			73	219
07:00			182	177	161	173			173	520
08:00			353	330	329	337			337	1012
09:00			446	460	441	449			449	1347
10:00			444	480	452	458			458	1376
11:00		442	520	510		490			490	1472
12:00		474	509	497		493			493	1480
13:00		537	517	534		529			529	1588
14:00		479	549	549		525			525	1577
15:00		498	560	516		524			524	1574
16:00		538	551	546		545			545	1635
17:00		584	569	601		584			584	1754
18:00		577	562	579		572			572	1718
19:00		443	479	526		482			482	1448
20:00		390	462	412		421			421	1264
21:00		329	379	326		344			344	1034
22:00		258	262	260		260			260	780
23:00		130	150	172		150			150	452
24:00		94	103	106		101			101	303
TOTALS	0	5773	7786	7811	1602	7648	0	0	7648	22972
% AVG WKDY		75.4	101.8	102.1	20.9					
% AVG WEEK		75.4	101.8	102.1	20.9					
AM Times		12:00	11:00	11:00	10:00	12:00			12:00	
AM Peaks		474	520	510	452	493			493	
PM Times		17:00	17:00	17:00		17:00			17:00	
PM Peaks		584	569	601		584			584	

M3

NB 7648
SB 7085
COMB AWD 14733
FAC .90 (.97)
COMB ADT 12,900

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 6/7/2010

STA. 2 SB

Site Reference: 000000000516
Site ID: 000000000202
Location: RTE. 140 NORTH OF WATER ST.
Direction: SOUTH

File: 202.prn
City: MILFORD
County: VOL S.B.

TIME	MON 7	TUE 8	WED 9	THU 10	FRI 11	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		22	35	19	32	27			27	108
02:00		9	15	11	18	13			13	53
03:00		15	11	6	10	10			10	42
04:00		9	5	7	8	7			7	29
05:00		23	24	23	26	24			24	96
06:00		78	82	65	62	71			71	287
07:00		277	275	254	265	267			267	1071
08:00		436	425	400	428	422			422	1689
09:00		503	448	478	474	475			475	1903
10:00		471	453	436	511	467			467	1871
11:00		450	420	462		444			444	1332
12:00	418	426	460	469		443			443	1773
13:00	474	513	441	500		482			482	1928
14:00	493	455	452	453		463			463	1853
15:00	538	542	532	536		537			537	2148
16:00	565	577	547	550		559			559	2239
17:00	531	538	523	537		532			532	2129
18:00	496	507	492	524		504			504	2019
19:00	453	394	421	453		430			430	1721
20:00	336	341	359	330		341			341	1366
21:00	272	274	242	278		266			266	1066
22:00	169	140	149	162		155			155	620
23:00	102	98	77	106		95			95	383
24:00	57	47	46	56		51			51	206
TOTALS	4904	7145	6934	7115	1834	7085	0	0	7085	27932
% AVG WKDY	69.2	100.8	97.8	100.4	25.8					
% AVG WEEK	69.2	100.8	97.8	100.4	25.8					
AM Times	12:00	09:00	12:00	09:00	10:00	09:00			09:00	
AM Peaks	418	503	460	478	511	475			475	
PM Times	16:00	16:00	16:00	16:00		16:00			16:00	
PM Peaks	565	577	547	550		559			559	

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 6/7/2010

STA. 3 EB

Site Reference: 000000000803
Site ID: 000000000303
Location: WILLIAMS ST. WEST OF RTE. 140 .
Direction: EAST

File: 303.prn
City: MILFORD
County: VOL E.B.

TIME	MON 7	TUE 8	WED 9	THU 10	FRI 11	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		9	4	8	7	7			7	28
02:00		1	3	3	3	2			2	10
03:00		5	1	1	3	2			2	10
04:00		4	1	2	0	1			1	7
05:00		6	10	6	6	7			7	28
06:00		25	20	23	25	23			23	93
07:00		59	58	57	50	56			56	224
08:00		114	109	117	118	114			114	458
09:00		134	136	154	131	138			138	555
10:00		125	153	121		133			133	399
11:00		102	117	113		110			110	332
12:00	162	124	140	152		144			144	578
13:00	151	141	142	134		142			142	568
14:00	128	125	118	98		117			117	469
15:00	152	151	145	121		142			142	569
16:00	127	148	139	133		136			136	547
17:00	127	157	145	127		139			139	556
18:00	140	111	116	132		124			124	499
19:00	93	77	98	112		95			95	380
20:00	100	85	57	55		74			74	297
21:00	53	64	53	64		58			58	234
22:00	26	28	30	39		30			30	123
23:00	14	15	25	20		18			18	74
24:00	7	15	7	7		9			9	36
TOTALS	1280	1825	1827	1799	343	1821	0	0	1821	7074
% AVG WKDY	70.2	100.2	100.3	98.7	18.8					
% AVG WEEK	70.2	100.2	100.3	98.7	18.8					
AM Times	12:00	09:00	10:00	09:00	09:00	12:00			12:00	
AM Peaks	162	134	153	154	131	144			144	
PM Times	15:00	17:00	15:00	13:00		13:00			13:00	
PM Peaks	152	157	145	134		142			142	

US

EB 1821
WB 1976
COMB AWD 3797
FAC .90(.98)
COMB ADT 3,300

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 6/7/2010

STA. 3 WB

Site Reference: 000000000736
Site ID: 000000000304
Location: WILLIAMS ST. WEST OF RTE. 140 .
Direction: WEST

File: 304.prn
City: MILFORD
County: VOL W.B.

TIME	MON 7	TUE 8	WED 9	THU	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		11	15			13			13	26
02:00		2	4			3			3	6
03:00		4	1			2			2	5
04:00		2	0			1			1	2
05:00		3	2			2			2	5
06:00		7	8			7			7	15
07:00		29	28			28			28	57
08:00		77	90			83			83	167
09:00		123	106			114			114	229
10:00		110	133			121			121	243
11:00		104	119			111			111	223
12:00	132	131	124			129			129	387
13:00	137	123	126			128			128	386
14:00	145	160	137			147			147	442
15:00	153	147	155			151			151	455
16:00	164	178	185			175			175	527
17:00	190	185	176			183			183	551
18:00	180	158				169			169	338
19:00	148	116				132			132	264
20:00	114	107				110			110	221
21:00	74	87				80			80	161
22:00	50	50				50			50	100
23:00	22	21				21			21	43
24:00	16	17				16			16	33
TOTALS	1525	1952	1409	0	0	1976	0	0	1976	4886
% AVG WKDY	77.1	98.7	71.3							
% AVG WEEK	77.1	98.7	71.3							
AM Times	12:00	12:00	10:00			12:00			12:00	
AM Peaks	132	131	133			129			129	
PM Times	17:00	17:00	16:00			17:00			17:00	
PM Peaks	190	185	185			183			183	

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 6/7/2010

STA. 4 EB

Site Reference: 000000000452
Site ID: 000000000403
Location: WATER ST. EAST OF RTE. 140 .
Direction: EAST

File: 403.prn
City: MILFORD
County: VOL E.B.

TIME	MON 7	TUE 8	WED 9	THU 10	FRI 11	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		7	3	6	13	7			7	29
02:00		5	6	1	4	4			4	16
03:00		5	1	1	2	2			2	9
04:00		3	2	2	3	2			2	10
05:00		6	11	9	8	8			8	34
06:00		23	23	22	21	22			22	89
07:00		57	52	47	49	51			51	205
08:00		93	78	79	80	82			82	330
09:00		120	101	122	110	113			113	453
10:00		132	129	120	118	124			124	499
11:00	124	106	109	131		117			117	470
12:00	147	139	136	151		143			143	573
13:00	143	173	125	156		149			149	597
14:00	140	136	126	103		126			126	505
15:00	143	137	151	155		146			146	586
16:00	157	162	145	179		160			160	643
17:00	141	143	130	145		139			139	559
18:00	133	157	151	143		146			146	584
19:00	111	101	97	128		109			109	437
20:00	109	124	116	102		112			112	451
21:00	101	110	88	86		96			96	385
22:00	62	66	56	62		61			61	246
23:00	30	26	31	25		28			28	112
24:00	23	19	14	24		20			20	80
TOTALS	1564	2050	1881	1999	408	1967	0	0	1967	7902
% AVG WKDY	79.5	104.2	95.6	101.6	20.7					
% AVG WEEK	79.5	104.2	95.6	101.6	20.7					
AM Times	12:00	12:00	12:00	12:00	10:00	12:00			12:00	
AM Peaks	147	139	136	151	118	143			143	
PM Times	16:00	13:00	15:00	16:00		16:00			16:00	
PM Peaks	157	173	151	179		160			160	

US

EB 1967
WB 1961
COMB AWD 3928
FAC .90(.98)
COMB ADT 3,500

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 6/7/2010

STA. 4 WB

Site Reference: 000000000587
Site ID: 000000000404
Location: WATER ST. EAST OF RTE. 140 .
Direction: WEST

File: 404.prn
City: MILFORD
County: VOL W.B.

TIME	MON 7	TUE 8	WED 9	THU 10	FRI 11	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		13	15	12	14	13			13	54
02:00		5	6	8	9	7			7	28
03:00		6	1	5	8	5			5	20
04:00		4	1	0	4	2			2	9
05:00		5	8	9	6	7			7	28
06:00		27	29	25	23	26			26	104
07:00		56	58	57	71	60			60	242
08:00		98	77	88	98	90			90	361
09:00		116	118	110	103	111			111	447
10:00		100	102	108	115	106			106	425
11:00	123	102	119	122		116			116	466
12:00	119	121	136	127		125			125	503
13:00	140	150	125	119		133			133	534
14:00	151	155	137	136		144			144	579
15:00	139	147	152	143		145			145	581
16:00	148	161	156	152		154			154	617
17:00	154	154	138	174		155			155	620
18:00	143	140	128	166		144			144	577
19:00	102	108	99	118		106			106	427
20:00	109	107	87	123		106			106	426
21:00	96	104	83	87		92			92	370
22:00	60	61	62	54		59			59	237
23:00	38	35	32	34		34			34	139
24:00	23	15	23	24		21			21	85
TOTALS	1545	1990	1892	2001	451	1961	0	0	1961	7879
% AVG WKDY	78.7	101.4	96.4	102	22.9					
% AVG WEEK	78.7	101.4	96.4	102	22.9					
AM Times	11:00	12:00	12:00	12:00	10:00	12:00			12:00	
AM Peaks	123	121	136	127	115	125			125	
PM Times	17:00	16:00	16:00	17:00		17:00			17:00	
PM Peaks	154	161	156	174		155			155	

Appendix D

AM/PM Peak Hour Intersection Capacity Analysis
Traffic Signal Alternative
Under Existing Traffic Conditions
Prospect Street at Water Street, Milford

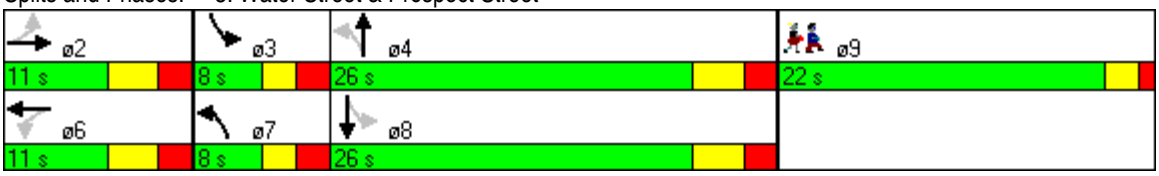
Intersection Capacity Analysis
Prospect St @ Water St, Milford

9/8/2010

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	11	35	73	14	22	82	37	358	31	71	412	30
Confl. Peds. (#/hr)	1		2	2		1	1		2	2		1
Confl. Bikes (#/hr)												
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	4%	4%	4%	4%	4%	4%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		7	4		3	8	
Permitted Phases	2			6			4			8		
Detector Phase	2	2		6	6		7	4		3	8	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		2.0	4.0		2.0	4.0	
Minimum Split (s)	9.0	9.0		9.0	9.0		8.0	9.0		8.0	9.0	
Total Split (s)	11.0	11.0	0.0	11.0	11.0	0.0	8.0	26.0	0.0	8.0	26.0	0.0
Total Split (%)	16.4%	16.4%	0.0%	16.4%	16.4%	0.0%	11.9%	38.8%	0.0%	11.9%	38.8%	0.0%
Yellow Time (s)	3.0	3.0		3.0	3.0		2.0	3.0		2.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	4.0	5.0	5.0	4.0	4.0	5.0	4.0	4.0	5.0	4.0
Lead/Lag							Lead	Lag		Lead	Lag	
Lead-Lag Optimize?							Yes	Yes		Yes	Yes	
Recall Mode	None	None		None	None		None	Max		None	Max	
Act Effct Green (s)		6.2			6.2		28.5	26.4		29.3	28.1	
Actuated g/C Ratio		0.13			0.13		0.61	0.56		0.63	0.60	
v/c Ratio		0.48			0.47		0.08	0.43		0.14	0.46	
Control Delay		18.6			17.0		6.6	13.7		6.7	13.8	
Queue Delay		0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay		18.6			17.0		6.6	13.7		6.7	13.8	
LOS		B			B		A	B		A	B	
Approach Delay		18.6			17.0			13.1			12.9	
Approach LOS		B			B			B			B	

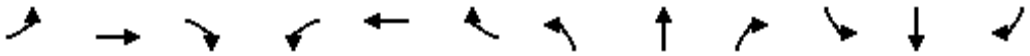
Intersection Summary			
Cycle Length: 67			
Actuated Cycle Length: 46.8			
Natural Cycle: 65			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.48			
Intersection Signal Delay: 13.9		Intersection LOS: B	
Intersection Capacity Utilization 48.6%		ICU Level of Service A	
Analysis Period (min) 15			

Splits and Phases: 3: Water Street & Prospect Street



Lane Group	ø9
Lane Configurations	
Volume (vph)	
Confl. Peds. (#/hr)	
Confl. Bikes (#/hr)	
Peak Hour Factor	
Growth Factor	
Heavy Vehicles (%)	
Bus Blockages (#/hr)	
Parking (#/hr)	
Mid-Block Traffic (%)	
Shared Lane Traffic (%)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	4.0
Minimum Split (s)	22.0
Total Split (s)	22.0
Total Split (%)	33%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	None
Act Effct Green (s)	
Actuated g/C Ratio	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
LOS	
Approach Delay	
Approach LOS	

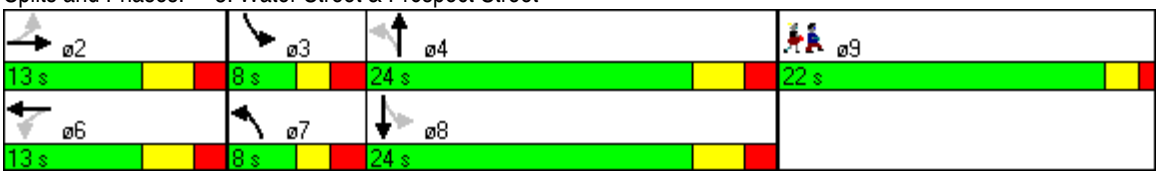
Intersection Summary



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	12	42	49	34	31	104	58	488	35	83	448	32
Confl. Peds. (#/hr)			2	2			2					2
Confl. Bikes (#/hr)												
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	1%	1%	1%	2%	2%	2%	2%	2%	2%	4%	4%	4%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		7	4		3	8	
Permitted Phases	2			6			4			8		
Detector Phase	2	2		6	6		7	4		3	8	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		2.0	4.0		2.0	4.0	
Minimum Split (s)	9.0	9.0		9.0	9.0		8.0	9.0		8.0	9.0	
Total Split (s)	13.0	13.0	0.0	13.0	13.0	0.0	8.0	24.0	0.0	8.0	24.0	0.0
Total Split (%)	19.4%	19.4%	0.0%	19.4%	19.4%	0.0%	11.9%	35.8%	0.0%	11.9%	35.8%	0.0%
Yellow Time (s)	3.0	3.0		3.0	3.0		2.0	3.0		2.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	4.0	5.0	5.0	4.0	4.0	5.0	4.0	4.0	5.0	4.0
Lead/Lag							Lead	Lag		Lead	Lag	
Lead-Lag Optimize?							Yes	Yes		Yes	Yes	
Recall Mode	None	None		None	None		None	Min		None	Min	
Act Effct Green (s)		7.5			7.5		26.0	22.7		26.0	22.7	
Actuated g/C Ratio		0.16			0.16		0.54	0.47		0.54	0.47	
v/c Ratio		0.37			0.55		0.14	0.64		0.23	0.60	
Control Delay		16.9			18.8		7.8	19.6		8.6	18.7	
Queue Delay		0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay		16.9			18.8		7.8	19.6		8.6	18.7	
LOS		B			B		A	B		A	B	
Approach Delay		16.9			18.8			18.4			17.2	
Approach LOS		B			B			B			B	

Intersection Summary			
Cycle Length: 67			
Actuated Cycle Length: 48.3			
Natural Cycle: 70			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.64			
Intersection Signal Delay: 17.9		Intersection LOS: B	
Intersection Capacity Utilization 60.2%		ICU Level of Service B	
Analysis Period (min) 15			

Splits and Phases: 3: Water Street & Prospect Street



Lane Group	ø9
Lane Configurations	
Volume (vph)	
Confl. Peds. (#/hr)	
Confl. Bikes (#/hr)	
Peak Hour Factor	
Growth Factor	
Heavy Vehicles (%)	
Bus Blockages (#/hr)	
Parking (#/hr)	
Mid-Block Traffic (%)	
Shared Lane Traffic (%)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	4.0
Minimum Split (s)	22.0
Total Split (s)	22.0
Total Split (%)	33%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	None
Act Effct Green (s)	
Actuated g/C Ratio	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
LOS	
Approach Delay	
Approach LOS	

Intersection Summary

Appendix E

AM/PM Peak Hour Intersection Capacity Analysis
Traffic Signal Alternative
Under Projected 2030 Traffic Conditions
Prospect Street at Water Street, Milford

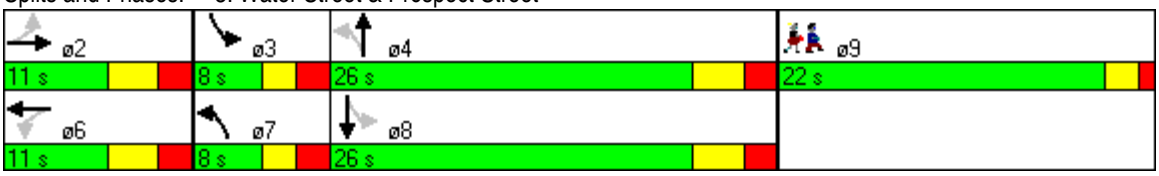
Intersection Capacity Analysis
Prospect St @ Water St, Milford

9/8/2010

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	11	35	73	14	22	82	37	358	31	71	412	30
Confl. Peds. (#/hr)	1		2	2		1	1		2	2		1
Confl. Bikes (#/hr)												
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	3%	3%	3%	3%	3%	3%	4%	4%	4%	4%	4%	4%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		7	4		3	8	
Permitted Phases	2			6			4			8		
Detector Phase	2	2		6	6		7	4		3	8	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		2.0	4.0		2.0	4.0	
Minimum Split (s)	9.0	9.0		9.0	9.0		8.0	9.0		8.0	9.0	
Total Split (s)	11.0	11.0	0.0	11.0	11.0	0.0	8.0	26.0	0.0	8.0	26.0	0.0
Total Split (%)	16.4%	16.4%	0.0%	16.4%	16.4%	0.0%	11.9%	38.8%	0.0%	11.9%	38.8%	0.0%
Yellow Time (s)	3.0	3.0		3.0	3.0		2.0	3.0		2.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	4.0	5.0	5.0	4.0	4.0	5.0	4.0	4.0	5.0	4.0
Lead/Lag							Lead	Lag		Lead	Lag	
Lead-Lag Optimize?							Yes	Yes		Yes	Yes	
Recall Mode	None	None		None	None		None	Max		None	Max	
Act Effct Green (s)		6.3			6.3		27.8	25.8		28.6	27.5	
Actuated g/C Ratio		0.14			0.14		0.61	0.56		0.62	0.60	
v/c Ratio		0.52			0.51		0.10	0.50		0.18	0.53	
Control Delay		20.1			17.8		6.7	15.3		7.0	15.3	
Queue Delay		0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay		20.1			17.8		6.7	15.3		7.0	15.3	
LOS		C			B		A	B		A	B	
Approach Delay		20.1			17.8			14.6			14.2	
Approach LOS		C			B			B			B	

Intersection Summary			
Cycle Length: 67			
Actuated Cycle Length: 45.8			
Natural Cycle: 75			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.53			
Intersection Signal Delay: 15.3		Intersection LOS: B	
Intersection Capacity Utilization 53.6%		ICU Level of Service A	
Analysis Period (min) 15			

Splits and Phases: 3: Water Street & Prospect Street



Lane Group	ø9
Lane Configurations	
Volume (vph)	
Confl. Peds. (#/hr)	
Confl. Bikes (#/hr)	
Peak Hour Factor	
Growth Factor	
Heavy Vehicles (%)	
Bus Blockages (#/hr)	
Parking (#/hr)	
Mid-Block Traffic (%)	
Shared Lane Traffic (%)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	4.0
Minimum Split (s)	22.0
Total Split (s)	22.0
Total Split (%)	33%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	None
Act Effct Green (s)	
Actuated g/C Ratio	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
LOS	
Approach Delay	
Approach LOS	

Intersection Summary

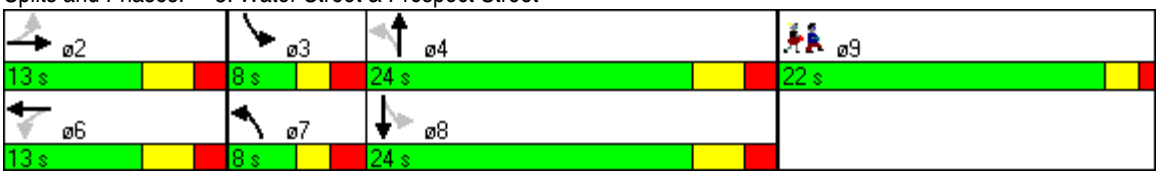
Intersection Capacity Analysis
Prospect St @ Water St, Milford

9/8/2010

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	12	42	49	34	31	104	58	488	35	83	448	32
Confl. Peds. (#/hr)			2	2			2					2
Confl. Bikes (#/hr)												
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Growth Factor	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%	115%
Heavy Vehicles (%)	1%	1%	1%	2%	2%	2%	2%	2%	2%	4%	4%	4%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)												
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Turn Type	Perm			Perm			pm+pt			pm+pt		
Protected Phases		2			6		7	4		3	8	
Permitted Phases	2			6			4			8		
Detector Phase	2	2		6	6		7	4		3	8	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		2.0	4.0		2.0	4.0	
Minimum Split (s)	9.0	9.0		9.0	9.0		8.0	9.0		8.0	9.0	
Total Split (s)	13.0	13.0	0.0	13.0	13.0	0.0	8.0	24.0	0.0	8.0	24.0	0.0
Total Split (%)	19.4%	19.4%	0.0%	19.4%	19.4%	0.0%	11.9%	35.8%	0.0%	11.9%	35.8%	0.0%
Yellow Time (s)	3.0	3.0		3.0	3.0		2.0	3.0		2.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	4.0	5.0	5.0	4.0	4.0	5.0	4.0	4.0	5.0	4.0
Lead/Lag							Lead	Lag		Lead	Lag	
Lead-Lag Optimize?							Yes	Yes		Yes	Yes	
Recall Mode	None	None		None	None		None	Min		None	Min	
Act Effct Green (s)		7.9			7.9		26.7	22.4		27.6	24.2	
Actuated g/C Ratio		0.16			0.16		0.53	0.45		0.55	0.48	
v/c Ratio		0.43			0.63		0.19	0.78		0.33	0.67	
Control Delay		18.3			23.4		8.2	25.0		10.6	20.7	
Queue Delay		0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay		18.3			23.4		8.2	25.0		10.6	20.7	
LOS		B			C		A	C		B	C	
Approach Delay		18.3			23.4			23.3			19.2	
Approach LOS		B			C			C			B	

Intersection Summary			
Cycle Length: 67			
Actuated Cycle Length: 50.3			
Natural Cycle: 80			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.78			
Intersection Signal Delay: 21.3		Intersection LOS: C	
Intersection Capacity Utilization 67.0%		ICU Level of Service C	
Analysis Period (min) 15			

Splits and Phases: 3: Water Street & Prospect Street

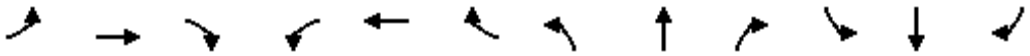


Lane Group	ø9
Lane Configurations	
Volume (vph)	
Confl. Peds. (#/hr)	
Confl. Bikes (#/hr)	
Peak Hour Factor	
Growth Factor	
Heavy Vehicles (%)	
Bus Blockages (#/hr)	
Parking (#/hr)	
Mid-Block Traffic (%)	
Shared Lane Traffic (%)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	4.0
Minimum Split (s)	22.0
Total Split (s)	22.0
Total Split (%)	33%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	None
Act Effct Green (s)	
Actuated g/C Ratio	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
LOS	
Approach Delay	
Approach LOS	

Intersection Summary

Appendix F

AM/PM Peak Hour Intersection Capacity Analysis
Modern Roundabout Alternative
Under Existing Traffic Conditions
Prospect Street at Water Street, Milford

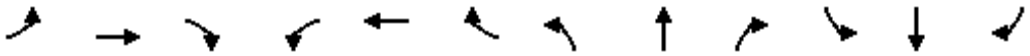


Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Right Turn Channelized												
Volume (veh/h)	11	35	73	14	22	82	37	358	31	71	412	30
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	13	40	83	16	25	93	42	407	35	81	468	34
Approach Volume (veh/h)		135			134			484			583	
Crossing Volume (veh/h)		565			461			133			83	
High Capacity (veh/h)		886			963			1248			1298	
High v/c (veh/h)		0.15			0.14			0.39			0.45	
Low Capacity (veh/h)		713			780			1037			1082	
Low v/c (veh/h)		0.19			0.17			0.47			0.54	

Intersection Summary					
Maximum v/c High	0.45				
Maximum v/c Low	0.54				
Intersection Capacity Utilization	58.8%	ICU Level of Service		B	

HCM Unsignalized Intersection Capacity Analysis
Prospect St @ Water St, Milford

9/8/2010



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Right Turn Channelized												
Volume (veh/h)	12	42	49	34	31	104	58	488	35	83	448	32
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	13	45	52	36	33	111	62	519	37	88	477	34
Approach Volume (veh/h)		110			180			618			599	
Crossing Volume (veh/h)		601			594			146			131	
High Capacity (veh/h)		861			866			1236			1250	
High v/c (veh/h)		0.13			0.21			0.50			0.48	
Low Capacity (veh/h)		690			695			1026			1039	
Low v/c (veh/h)		0.16			0.26			0.60			0.58	

Intersection Summary					
Maximum v/c High	0.50				
Maximum v/c Low	0.60				
Intersection Capacity Utilization	68.2%	ICU Level of Service		C	

Appendix G

MassDOT Project Implementation Process

The following description of the implementation process is based on Chapter 2 of the *MassDOT Highway Division's Project Development and Design Guide (2005).* The text below borrows heavily from that document.

1 NEEDS IDENTIFICATION

For each of the locations at which an improvement is to be implemented, MassDOT Highway Division leads an effort to define the problem, establishes project goals and objectives, and defines the scope of the planning needed for implementation. To that end, it has to complete a Project Need Form (PNF), which states in general terms the deficiencies or needs related to the transportation facility or location. The PNF documents the problems and explains why corrective action is needed. For this study, the information defining the need for the project will be drawn primarily, perhaps exclusively, from the present report. Also, at this point in the process, MassDOT Highway Division meets with potential participants, such as the Boston Region Metropolitan Planning Organization (MPO) and community members, to allow for an informal review of the project.

The PNF is reviewed by the MassDOT Highway Division district office whose jurisdiction includes the location of the proposed project. MassDOT Highway Division also sends the PNF to the MPO, for informational purposes. The outcome of this step determines whether the project requires further planning, whether it is already well supported by prior planning studies, and, therefore, whether it is ready to move forward into the design phase, or whether it should be dismissed from further consideration.

2 PLANNING

This phase will likely not be required for the implementation of the improvements proposed in this planning study, as this planning report should constitute the outcome of this step. However, in general, the purpose of this implementation step is for the project proponent to identify issues, impacts, and approvals that may need to be obtained, so that the subsequent design and permitting processes are understood.

The level of planning needed will vary widely, based on the complexity of the project. Typical tasks include: define the existing context, confirm project need, establish goals and objectives, initiate public outreach, define the project, collect data, develop and analyze alternatives, make recommendations, and provide documentation. Likely outcomes include consensus on the project definition to enable it to move forward into environmental documentation (if needed) and design, or a recommendation to delay the project or dismiss it from further consideration.

3 PROJECT INITIATION

At this point in the process, the proponent, MassDOT Highway Division, fills out, for each improvement, a Project Initiation Form (PIF), which is reviewed by its Project Review Committee (PRC) and the MPO. The PRC is composed of the Chief

Engineer, each District Highway Director, and representatives of the Project Management, Environmental, Planning, Right-of-Way, Traffic, and Bridge departments, and the Capital Expenditure Program Office (CEPO). The PIF documents the project type and description, summarizes the project planning process, identifies likely funding and project management responsibility, and defines a plan for interagency and public participation. First the PRC reviews and evaluates the proposed project based on the Executive Office of Transportation and Public Works's statewide priorities and criteria. If the result is positive, MassDOT Highway Division moves the project forward to the design phase, and to programming review by the MPO. The PRC may provide a Project Management Plan to define roles and responsibilities for subsequent steps. The MPO review includes project evaluation based on the MPO's regional priorities and criteria. The MPO may assign project evaluation criteria score, a Transportation Improvement Program (TIP) year, a tentative project category, and a tentative funding category.

4 ENVIRONMENTAL, DESIGN, AND RIGHT-OF-WAY PROCESS

This step has four distinct but closely integrated elements: public outreach, environmental documentation and permitting (if required), design, and right-of-way acquisition (if required). The outcome of this step is a fully designed and permitted project ready for construction. However, a project does not have to be fully designed in order for the MPO to program it in the TIP.

5 PROGRAMMING

Programming, which typically begins during the design phase, can actually occur at any time during the process, from planning to design. In this step, which is distinct from project initiation, where the MPO receives preliminary information on the proposed project, the proponent requests that the MPO place the project in the region's TIP. The MPO considers the project in terms of regional needs, evaluation criteria, and compliance with the regional Transportation Plan and decides whether to place it in the draft TIP for public review and then in the final TIP.

6 PROCUREMENT

Following project design and programming, MassDOT Highway Division publishes a request for proposals. It then reviews the bids and awards the contract to the qualified bidder with the lowest bid.

7 CONSTRUCTION

After a construction contract is awarded, MassDOT Highway Division and the contractor develop a public participation plan and a management plan for the construction process.

8 PROJECT ASSESSMENT

The purpose of this step is to receive constituents' comments on the project development process and the project's design elements. MassDOT Highway Division can apply what is learned in this process to future projects.