BOSTON REGION METROPOLITAN PLANNING ORGANIZATION
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MEMORANDUM

DATE October 4, 2012

TO MassDOT Highway Division District 4 and the Town of Wilmington

From Chen-Yuan Wang, MPO Staff
Steven Andrews, MPO Staff

RE Safety and Operations Analyses at Selected Boston Region MPO Intersections, FFY 2012: Main Street (Route 38/129) at Church Street/Burlington Avenue (Route 62) in Wilmington

Introduction

This intersection ranked 84th on the Highway Division's 2007–2009 Statewide Top 200 Intersection Crash list. Based on the MassDOT crash database, in that three-year period, this intersection had 52 crashes, 20 of which caused personal injuries. There were three crashes that involved a pedestrian and one that involved with a cyclist.

In addition to the high number of crashes, the intersection was selected for its congested conditions during peak hours, its regional significance due to its being the intersection of two major state routes (Routes 38/129 and Route 62) , and its transit significance because of its being adjacent to a major commuter rail station.

This memorandum summarizes safety and operations analyses and proposes improvement strategies at the intersection and at its adjacent intersection on Main Street at the MBTA (Massachusetts Bay Transportation Authority) commuter rail station driveway. It contains the following sections:

- Existing Conditions
- Issues and Concerns
- Crash Data Analysis
- Intersection Capacity Analysis
- Improvement Alternatives
- Improvement Recommendations

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

Existing Conditions

The intersection is under MassDOT Highway Division District 4's jurisdiction. It is located in the central area of Wilmington, where two major state roadways meet. State Route 38/129, locally called Main Street, connects Interstate 95/Route 128 in the south

with Interstate 495 and Route 3 in the north. Route 62, locally called Burlington Avenue/Church Street, links Interstate 93 in the east and Route 3 in the west. In addition to carrying regional traffic, the two roadways function as urban major and minor arterials that serve a number of major destinations in the town. During the morning and evening peak periods, the intersection is usually congested.

The intersection is adjacent to a major railroad, and its traffic operation is affected by train preemptions at the railroad's at-grade crossing on Main Street (known as Wilmington Junction) about 1,000 feet north of the intersection. The railroad, which connects the city of Boston with locations in Maine and New Hampshire, serves both MBTA (Lowell Line and Haverhill Line) and Amtrak (Downeaster Line) trains. Near the intersection, it runs parallel and just west of Main Street from about a quarter mile south of this intersection to the Wilmington Junction, where the Lowell and Haverhill tracks split and the Haverhill Line crosses Main Street.

The intersection is signalized, and its traffic signal is coordinated with the signal at the MBTA driveway, which is located about 750 feet north of this intersection. Both signals are interconnected to the railroad crossing signal at Wilmington Junction, which is located about 250 feet north of the MBTA driveway. When a train is crossing Wilmington Junction, both signals operate under train preemption mode, which immediately clears the southbound approach and stops the northbound approach at both intersections. Then, it allows only right turns from the MBTA driveway and allows only through traffic from Burlington Avenue and Church Street and traffic turning onto Main Street Southbound at this intersection Figure 1 shows the locations of the three intersections, the connected roadways, the railroad, and the surrounding area.

Due to its proximity to the railroad junction, the intersection is elevated to allow trains to cross under Burlington Avenue. Thus, three of the approaches to the intersection, except Burlington Avenue, are on an uphill slope. Near the intersection, Burlington Avenue is relatively level, as its elevation rises gradually from a point west of the bridge over the railroad bed. The Main Street northbound approach is somewhat steeper than the other approaches and is located on a horizontal curve. Drivers on this approach cannot see the signal heads until about 200 feet from the intersection. They do not have a clear view of the entire intersection and vehicles from the opposite approach until arriving at the intersection.

In addition, the intersection layout is somewhat skewed, as the two roadways do not intersect each other perpendicularly. The skewed layout makes turning movements at the intersection difficult to maneuver, and most of the turns require larger turning radii than at a regular intersection, especially turns from Burlington Avenue and Church Street. The intersection carries a relatively high percentage of heavy trucks, including some semi-trailer trucks, which require even larger turning radii than autos for changing direction within the intersection.

All the streets connected to the intersection are two-lane roadways, except Main Street north of the intersection. It has two southbound lanes and one northbound lane.

Approaching the intersection, one of the two southbound lanes is designated as a left-turn/through lane and one as a through/right-turn lane. The other three approaches are wider—two lanes instead of one—in the sections near the intersection. The northbound and westbound approaches each have one left-turn-only lane and one through/right-turn lane. The eastbound approach has a left-turn/through lane and one right-turn-only lane.

Figure 2 shows the existing layout of the intersection and its surroundings. Based on the existing configuration, all of the approaches require only one receiving lane, except the southbound approach (Main Street). The southbound receiving lane is wide enough for two lanes of traffic in the beginning, but within about 100 feet, its width decreases to only about 12 feet. Therefore, the southbound vehicles are forced to merge immediately after they pass through the intersection. They frequently have to slow down or even stop to avoid collisions. Sometimes they back up into the intersection and prevent the vehicles behind them from passing through the intersection. In addition, because the roadway slopes downhill, the lane reduction is not entirely visible to southbound drivers before they enter the intersection. Although there is a “Lane Ends” warning sign in place just south of the intersection, drivers still have to react to it quickly due to its location within an unexpected short distance.

Sidewalks are installed on both sides of the streets at the intersection, except on Main Street south of the intersection. That segment has a sidewalk only on the east side. North of the intersection, sidewalks continue on both sides on Main Street until Wilmington Junction. Away from the intersection, sidewalks continue on only the north side of Church Street, and only on the south side of Burlington Avenue.

The surrounding areas have mixed land uses. There are various commercial developments on Main Street. Located mainly on the east side, they include a limousine company, a small strip mall with off-street parking, a gas station/garage, and a tire store to the south of the intersection, and a number of storefronts, an office building, a bank, a realtor, and a flower store to the north of the intersection. Two-hour on-street parking is allowed in front the storefronts. About 10 cars can park on a stretch of wide shoulder area with no clear marking of parking spaces. Field observations indicate that one or two vehicles frequently were parked too close to the intersection and obstructed turning vehicles from Burlington Avenue and Church Street.

On the west side of Main Street adjacent to the intersection are a sandwich shop (Big Joe’s) and a small, vacant convenience store (previously a Quick Mart store), with its own driveway and parking lot. Further north, the MBTA’s Wilmington commuter rail station and its parking lot occupy most of the area between Main Street and the railroad intersection, drivers still have to react to it quickly because it is located within an unexpectedly short distance from the lane drop.

Crosswalks are installed on all approaches of the intersection, except the westbound approach. It appears reasonable not to have a crosswalk at the approach because the approach is relatively wide, with no shops or houses on either side of the approach.

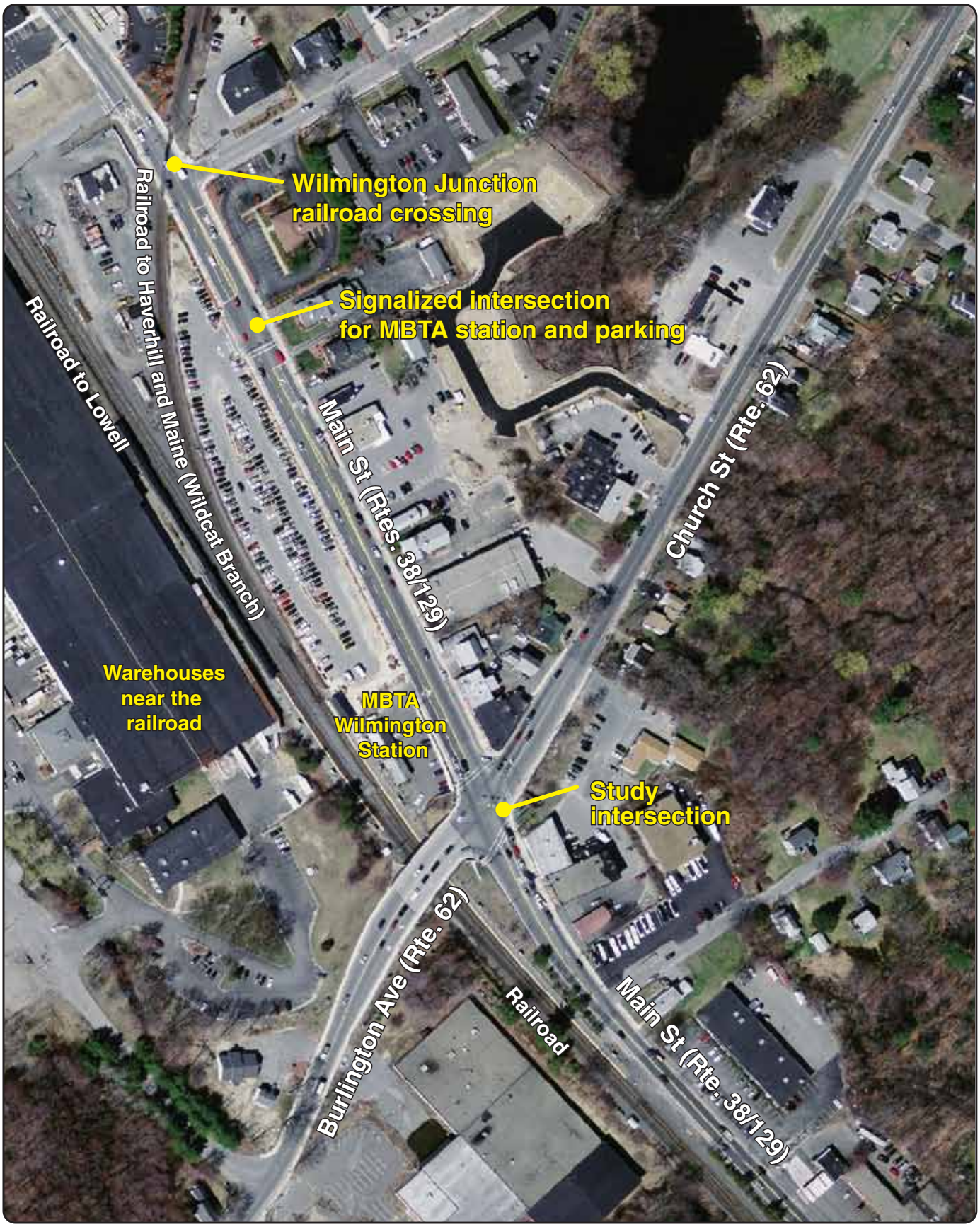

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FIGURE 1
Intersection Location and Surrounding Areas

Safety and Operations Analyses at Selected Intersections

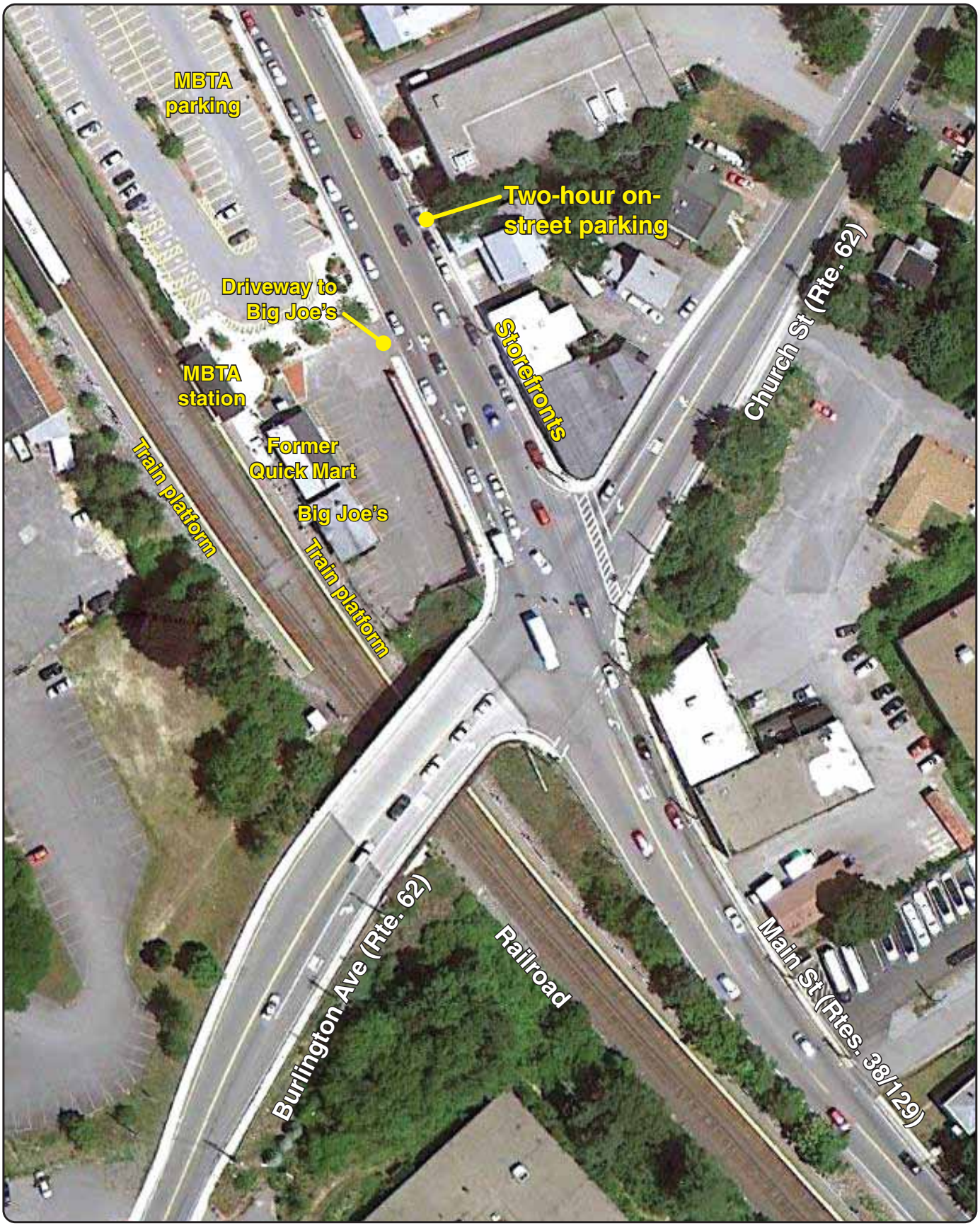

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FIGURE 2
Intersection Layout

Safety and Operations Analyses at Selected Intersections

Pedestrians are able to reach their destinations by using the existing three crosswalks. Pedestrian signals with push buttons are provided for the crosswalks. An exclusive pedestrian signal phase of 22 seconds is included in the traffic signal timing plan for pedestrian crossing calls. The pedestrian signal is not equipped with a countdown or accessible (audible) function.

North of the railroad junction, Main Street is a recently developed commercial area that has a number of major retail stores, specialty stores, restaurants, and gas stations, and a popular supermarket.

On Church Street, there are a few shops and small office buildings near the intersection. Further east on Church Street the land use is mainly residential, with a few institutional land uses. Wilmington High School is located about a mile east of the intersection. On Burlington Avenue, there are access roads leading to the warehouses, office buildings, and an industrial park that occupy the area west of the railroad. The land use farther west is mostly residential, with single-family homes in a wooded area.

Approaching the intersection, Church Street has a speed limit of 35 mile per hour (mph). Burlington Avenue, approaching in a horizontal curve and then on an elevated bridge, has a speed limit of 25 mph. Neither of the Main Street approaches has speed limit signs posted. Presumably, the speed limit is 35 mph. The crash data analyses (detailed in a later section) showed that there were a relatively high number of rear-end crashes on Main Street from both approaches. The northbound approach has several commercial driveways and is located on a horizontal curve. The southbound approach has a commercial driveway near the intersection and is relative straight. During peak traffic hours, drivers tend to change lanes when they are blocked by vehicles waiting to turn left.

Because there are industrial land uses in the area, the intersection carries a relatively high percentage of heavy-vehicle traffic. The Main Street section in the vicinity of the intersection is a state-designated truck route. CTPS traffic counts from April 2012 indicated that heavy vehicles comprise over 5% of the total entry traffic in the morning peak hour (7:30–8:30 AM) and about 2% of the total entry traffic in the evening peak hour (5:00–6:00 PM).

Currently, there are no bike lanes on any of the approaches. However, cyclists use the intersection to reach the MBTA train station and other destinations. The April traffic counts indicated that five bicycles used the intersection in the morning peak hour and two during the evening peak hour. Presumably, the number is much higher during warmer days, for example, in the summer. The MBTA station is equipped with bike racks that can accommodate about 20 bikes. A field visit on a July 2012 weekday morning indicated that over 80% of the bicycle parking spaces were occupied.

The adjacent MBTA parking lot has 161 spaces for motor vehicles, and is usually over 85% occupied during weekdays.[1] In addition to the park-and ride entries and exists, there are kiss-and-ride drop-offs and pickups at the station driveway during the morning and evening commuting hours. The April traffic counts indicated that there were about 120 entering and 70 exiting vehicles at the driveway in the morning peak hour, and about 50 entry and 140 exit vehicles in the evening peak hour. The counts include a few transit vehicles, such as buses on Route 12, which is operated hourly by the Lowell Regional Transit Authority, and passenger vans run by private companies for their employees and customers.

Issues and Concerns

During peak hours, traffic is heavy on almost all of the approaches at the intersection. In the morning peak hour, traffic is especially heavy on Main Street southbound and relatively heavy on Church Street. In the evening peak hour, traffic is especially congested on Main Street northbound and on Burlington Avenue.

Meanwhile, the intersection's traffic operation is affected by the train preemption operations at Wilmington Junction, especially during the PM peak period, when the northbound traffic is heavy. There are two train preemptions in the PM peak hour (5:00–6:00 PM). Each of the preemptions lasts about one minute to one and a quarter minutes. During this period, the northbound traffic is blocked. It usually takes two to three cycles for the northbound queue to dissipate. At times, the northbound queue extends close to the upstream intersection at Lowell Street and affects its traffic operations.

The intersection has little room for expansion or adjustment due to its proximity to the railroad and the surrounding built-up conditions. Drivers approaching the intersection have a limited sight distance from almost all the approaches. Largely due to the congested conditions, the intersection has a much higher crash rate than other signalized intersections in the area—about three times the average rate for signalized intersections in MassDOT Highway District 4 (see the next section for detailed analyses).

Based on field observations and the available crash and traffic data, the issues and concerns related to this intersection can be summarized as:

- High number of crashes and high crash rate at the intersection
- Traffic congestion at the intersection during the peak hours, especially in the PM peak hour
- Extensive traffic queues and delays on Main Street northbound during and after the train preemptions in the PM peak hour

[1] The number of parking spaces and occupancy rate are based on the counts performed in 2010 for the Boston Region MPO Congestion Management Process.

- Southbound left turns to Church Street sometimes block the through traffic due to its shared-lane operation
- Abrupt southbound departure lane reduction likely causing vehicle collisions
- Limited sight distances to the intersection for drivers from all the approaches, especially for those from the south
- No bicycle travel accommodation on Main Street for MBTA access
- No accessible pedestrian signal

Crash Data Analysis

The crash analysis was based on two sources of data: crash reports obtained from the Wilmington Police Department (WPD) and the MassDOT Registry of Motor Vehicles Division crash data, for the years 2007 to 2011. For 2007, most of the data were derived from the MassDOT crash database; for 2008 and 2009, most of the data were from both the MassDOT crash database and the crash reports; and for 2010 and 2011, the crash reports were the sole source of data. The crash diagrams were created from the WPD crash reports.

Table 1 shows that, on average, about 23 crashes occurred at the intersection of Main Street at Burlington Avenue each year. About 32% of the crashes resulted in personal injuries, and about 64% of the crashes involved property damage only. None of the crashes caused a fatality. The crash types consist of 59% rear-end collisions, 20% angle collisions, 11% single-vehicle collisions, 5% sideswipe collisions, and 2% head-on collisions. Three crashes involved pedestrians, and two crashes involved a bicyclist. About 35% of the crashes occurred during peak periods. About 22% of the crashes occurred when the roadway pavement was wet or icy. Approximately 15% of the crashes occurred in dark conditions (dawn, dusk, and nighttime).

Crash rates are another effective metric for examining the relative safety of a particular location.[2] Based on the 2007 to 2011 crash data and the recently collected traffic volume data, the crash rate for this intersection is 2.33 crashes per million entering vehicles (see Appendix A for the calculation). This crash rate is about three times the average rate for signalized intersections in MassDOT Highway Division District 4, reported by MassDOT to be 0.68 crashes per million entering vehicles.[3]

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[2] 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.

[3] The average crash rates estimated by the MassDOT Highway Division are based on a database of 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

Using the WPD crash reports, staff constructed a collision diagram for the intersections (see Figure B-1 in Appendix B). Crashes in this area stretched from the driveway of Wilmington Station to a quarter mile south of the intersection. Crashes that occurred at or near the station driveway are shown on a separate crash diagram (Figure B-2 in Appendix B).

In the five-year period 2007 through 2011, 14 rear-end crashes occurred on the stretch of road between the Wilmington Station driveway and the driveway for Big Joe's just before the intersection. Crash reports attributed most of these crashes to driver inattention. They also might have been related to the congested conditions during the peak periods, as nearly half of them occurred during a weekday peak period. Five collisions occurred at the driveway for the sandwich shop and vacant convenience store). The driveway is close to the intersection. It is difficult to exit the driveway when southbound traffic on Main Street is heavy.

Within the intersection, five crashes occurred between a vehicle traveling southbound on Main Street and a vehicle turning left onto Burlington Avenue. All of the crashes occurred during a period when the turning vehicle had a permitted green signal (rather than a dedicated left-turn signal). Two crashes occurred between vehicles traveling northbound on Main Street and a vehicle traveling eastbound on Burlington Avenue. One crash was an exceptional situation involving a towed trailer; the other was the result of a driver likely entering the intersection at the very end of a yellow phase. One crash occurred between a vehicle traveling southbound on Main Street and a vehicle traveling westbound on Church Street. The driver on Main Street did not see a red light and crashed into the westbound vehicle.

Near the intersection, the northbound, southbound, and westbound approaches each had five rear-end crashes, while the eastbound approach had only one rear-end crash. The insufficient sight distance of the intersection for drivers on the three approaches and/or congested conditions likely contributed to the rear-end crashes, while drivers on the westbound approach had a better view approaching the intersection. There were a noticeable number of out-of-control single-vehicle crashes at or near the intersection. They were also likely related to the intersection topography.

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all entries in the database, not just those entries made within the past year. The average crash rate for District 6 was calculated on July 7, 2011.

TABLE 1
Summary of Crashes at the Intersection of Main Street at Burlington Avenue/Church Street, Wilmington: January 2007–December 2011

		2007	2008	2009	2010	2011	5-Yr. Total	Annual Avg.
Total number of crashes		31	24	25	13	23	116	23.2
Severity	Property damage only	19	14	14	10	17	74	14.8
	Non-fatal injury	9	8	11	3	6	37	7.4
	Fatality	0	0	0	0	0	0	0
	Not reported/unknown	3	2	0	0	0	5	1
Collision type	Single vehicle	5	3	3	0	2	13	2.6
	Rear-end	14	17	14	11	12	68	13.6
	Angle	7	3	8	1	4	23	4.6
	Sideswipe, same direction	1	0	0	1	3	5	1
	Sideswipe, opposite direction	1	0	0	0	0	1	0.2
	Head-on	0	1	0	0	1	2	0.4
	Not reported/unknown	3	0	0	0	1	4	0.8
Involved pedestrian(s)		1	1	1	0	0	3	0.6
Involved cyclist(s)		1	0	0	0	1	2	0.4
Occurred during weekday peak periods		9	8	10	7	7	41	8.2
Wet or icy pavement conditions		5	9	6	0	6	26	5.2
Dark conditions (lit or unlit)		4	5	3	1	4	17	3.4
Source	MassDOT database	22	9	3	0	0	34	
	Wilmington Police Department	1	0	1	13	23	39	
	Both MassDOT and WPD	8	15	21	0	0	44	

Note: The Wilmington Police Department provided crash reports for the period between mid-August 2007 and December 2011. Statistics for crashes before August 2007 were obtained from the MassDOT crash database. Crashes that occurred before August 2007 are not shown on the crash diagram.

South of the intersection, a number of crashes are related to vehicles turning into and out of the driveways on Main Street. Some of the vehicles exiting these driveways caused rear-end collisions on the northbound approach. However, while many crashes were related to driveways, six rear-end crashes occurred on the southbound approach just past the intersection, where there are no driveways. The crash reports indicated that most of those crashes were due to the lane reduction of the approach.

Three crashes involved cars parked on Main Street in the allowable parking area near the sidewalk curb in front of the storefronts. The crash locations were all near the intersection. There were no clear marked parking spaces. Frequently cars were parked near the northeast corner of the intersection and obstructed the paths of vehicles turning from other approaches.

There were three crashes that involved a pedestrian or a cyclist. Two pedestrians were struck crossing the street at a location without a crosswalk. Each of them individually crossed approximately 100 feet north of the intersection, approximately where people leaving a commuter rail train might want to cross. One cyclist was sideswiped by a car turning into the Bank of America driveway.

Table 2 shows the crash data for the intersection of Main Street at the MBTA driveway. All of the data for these crashes are derived from the WPD crash reports. There were nine reported crashes at or near the driveway intersection. Most of them were property-damage-only crashes and none caused fatalities. The predominant crash type was rear-end collisions. Few crashes occurred in peak traffic periods, on wet or icy roads, or in dark conditions. No pedestrians or cyclists were involved in those crashes.

Based on the WPD crash reports, staff constructed a collision diagram for the intersections (see Figure B-2 in Appendix B). Most of the crashes occurred on Main Street north of the MBTA driveway. Five rear-end crashes occurred on Main Street southbound after the railroad crossing, and two occurred on Main Street northbound before the railroad crossing. One rear-end crash occurred on Main Street southbound before the railroad crossing because a train blowing its horn caused a driver to stop abruptly before the crossing. The train was actually headed to Lowell and did not travel over this crossing. On the southbound approach, traffic signals at the crossing and at this intersection are synchronized in order to ensure that vehicles will not back up from the intersection onto the railroad track. It is a necessary precaution to prevent vehicles from sitting on the train track when a train is coming. The operation appears to be appropriate, as the number of crashes in that section is not alarmingly high and there were no crashes on the train track there.

The crash rate at the MBTA driveway intersection was calculated as 0.29 crashes per million entering vehicles (see Appendix A for the calculation), which is significantly lower than the MassDOT District 4 average. It should be noted that there were only a few hundred vehicles going in and out of the driveway, mainly during early morning and early evening hours. Most of the time, the signal remains green on the Main Street approaches. Once there is a call from cars exiting the driveway or from a pedestrian

wanting to cross Main Street, the signal would switch to red for them to cross Main Street. However, they usually have to wait about a minute for their turn. Although there were no angle crashes reported in the study period between vehicles from the MBTA driveway and from Main Street, during a field visit in the early evening in April 2012, Staff observed two cars, at two different times, turning left from the driveway during a red light. The drivers probably were impatient about the long wait for the traffic light to change.

Intersection Capacity Analysis

Staff collected turning-movement counts at the study intersection and the intersection at the MBTA driveway for the commuter rail station on three individual midweek days in April 2012. The data were recorded in 15-minute intervals for peak traffic periods in the morning, from 7:00 to 9:00, and in the evening, from 4:00 to 6:00. Meanwhile, 24-hour automatic traffic recorder (ATR) counts at locations near the two intersections for three consecutive midweek days were collected by the MassDOT Highway Division in the week beginning March 12, 2012 (see Appendix C for the ATR counts summarized by hours of the day). Based on the 24-hour traffic counts, the turning-movement counts at the two intersections were adjusted and balanced.

Table 3 shows that the study intersection carried a total of nearly 2,500 vehicles in both the morning peak hour, from 7:30 to 8:30, and the evening peak hour, from 5:00 to 6:00. During the AM peak hour, 6 pedestrians crossed the intersection, and during the PM peak hour, 10 crossed. Table 4 shows that the MBTA driveway intersection carried nearly 1,700 vehicles in both the morning peak hour and in the evening peak hour, respectively. About five pedestrians crossed the intersection in either of the peak hours.

Five cyclists were observed crossing the study intersection in the morning peak hour, and two in the evening peak hour (not shown in the table). Two cyclists observed at the MBTA driveway in both the morning peak hour and in the evening peak hour. It should be noted that pedestrians and cyclists in April are usually fewer than in other month from May to October. At an additional site visit in July, staff observed about twice number of pedestrians and cyclists in both the morning and evening peak hours as there were during the April observations.

TABLE 2
Summary of Crashes at the Intersection of Main Street at MBTA Driveway, Wilmington: August 2007–December 2011

		2007	2008	2009	2010	2011	5-Yr. Total	Annual Avg.
Total number of crashes		0	3	2	1	3	9	1.8
Severity	Property damage only	0	3	2	1	1	7	0.8
	Non-fatal injury	0	0	0	0	2	2	0.4
	Fatality	0	0	0	0	0	0	0
	Not reported/unknown	0	0	0	0	0	0	0
Collision type	Single vehicle	0	0	0	0	0	0	0
	Rear-end	0	2	2	1	2	7	0.8
	Angle	0	0	0	0	1	1	0.2
	Sideswipe, same direction	0	0	0	0	0	0	0
	Sideswipe, opposite direction	0	1	0	0	0	1	0.2
	Head-on	0	0	0	0	0	0	0
	Not reported/unknown	0	0	0	0	0	0	0
Involved pedestrian(s)		0	0	0	0	0	0	0
Involved cyclist(s)		0	0	0	0	0	0	0
Occurred during weekday peak periods		0	0	1	0	0	1	0.2
Wet or icy pavement conditions		0	0	1	0	0	1	0.2
Dark conditions (lit or unlit)		0	1	1	0	0	2	0.4

Source: The summary is based on crash reports obtained from the Wilmington Police Department.

Based on the adjusted turning-movement counts, staff performed capacity analyses for the two intersections using Synchro software.[4] The signals at the two intersections were modeled as coordinated signals, with the signal at the MBTA driveway as the master intersection. Signal timing input data were based on the timing plans provided to staff by MassDOT Highway Division District 4 and on manual measurements at the site.

Currently, the signal at the study intersection operates in the following sequence: (1) leading northbound movements with left turns protected, (2) northbound/southbound movements with left turns permitted, (3) lagging southbound movements with left turns protected, (4) westbound split phase, (5) eastbound split phase, (6) exclusive pedestrian phase if actuated. The northbound leading phase overlaps with the eastbound right-turn movement. Field observations indicated that the signal operated at a cycle length of about 155 seconds, including the exclusive pedestrian phase of about 22 seconds.

Table 5 summarizes the capacity analyses by lane for each approach of the study intersection in the AM and PM peak hours. The coordinated Main Street approaches were estimated to experience less delay and have a better level of services (LOS) than the side street approaches, which were evaluated to operate at LOS C or D, while the eastbound left-turn/through and the westbound right-turn/through movements were evaluated as LOS F, with extensive delays.

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

Main Street at		**Main St.**						**Burlington Ave.**			**Church St.**			**Total**
		Northbound			**Southbound**			**Eastbound**			**Westbound**			
		LT	**TH**	**RT**	**LT**	**TH**	**RT**	**LT**	**TH**	**RT**	**LT**	**TH**	**RT**	
AM peak	Turning volume	118	345	68	40	968	59	53	194	214	121	224	42	2,447
	Approach volume		531			1,068			461			387		
	Ped. crossings		2			3			0			1		2
PM peak	Turning volume	80	618	59	72	625	107	65	270	170	92	247	48	2,453
	Approach volume		757			804			505			387		
	Ped. crossings		0			9			0			1		10

Note: LT = left turn; TH = through, RT = right turn.

[4] Synchro is software used for intersection capacity analysis and traffic signal coordination that is developed and distributed by Trafficware Ltd. It can be combined with SimTraffic to perform traffic simulation for an individual intersection or a series of intersections.

TABLE 4
AM and PM Peak-Hour Traffic Volumes and Pedestrian Crossings:

Main Street at the MBTA Driveway,		Main St. Northbound			Main St. Southbound			MBTA Eastbound			Private Westbound			Total
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM peak	Turning volume	15	424	1	6	1038	97	37	0	30	0	0	0	1,653
	Approach volume		440			1,146			67			0		
	Ped. crossings		4			1			0			0		5
PM peak	Turning volume	9	714	8	6	750	41	88	0	48	6	1	0	1,671
	Approach volume	731			797			136			7			
	Ped. crossings	3			0			2			0			5

Note: LT = left turn; TH = through, RT = right turn.

However, the analyses estimated that the southbound approach at the study intersection could experience a 95th-percentile queue[5] of nearly 900 feet in the AM peak hour, and the northbound approach could experience a 95th-percentile queue of the same length in the PM peak hour. It also indicated that the eastbound Burlington Avenue approach could have a 95th-percentile queue of about 675 feet in the PM peak hour. Overall, the intersection was estimated to operate at LOS D in the AM peak hour with an average delay of nearly 55 seconds per vehicle (nearly LOS E), and to operate at LOS E in the PM peak hour with an average delay of nearly 70 seconds per vehicle. Details of the capacity analysis for both the AM and PM peak hours are in Appendix D.

Table 6 summarizes the capacity analyses by lane in each approach at the MBTA driveway intersection. All of the approaches were found to operate at an acceptable LOS of C or better, with modest delays, except for the eastbound left-turn/through movements, which was estimated to have an LOS D with an average delay of about 40 to 45 seconds per vehicle in both the AM and PM peak hours. Overall, the intersection was estimated to operate at LOS B with an average delay of 11 to 12 seconds per vehicle in both the AM and PM peak hours. Details of the capacity analysis for both the AM and PM peak hours are in Appendix E.

The Synchro analyses generally coincide with the observations on the field. It should be noted that the northbound approach could experience somewhat greater delays in the PM peak hour during and after the train preemptions.

[5] The 95th-percentile queue is defined to be the queue length (25 feet per vehicle) that has only a 5 percent probability of being exceeded during the analysis time period. It is a useful parameter for determining the appropriate length of turn pockets, but it is not typical of what an average driver would experience. It can be regarded as the potential maximum queue length under the input traffic conditions.

TABLE 5
Intersection Capacity Analysis of Existing Conditions:
Main Street at Burlington Avenue/Church Street, Wilmington

		Main St.						Burlington Ave.			Church St.			Overall
		Northbound			Southbound			Eastbound			Westbound			
		LT	TH	RT	L	TH	RT	LT	TH	RT	LT	TH	RT	
AM peak	LOS	D	C		D			F		A	E	F		D
	Delay	44	27		46			102		6	72	126		55
PM peak	LOS	C	D		D			F		B	E	F		E
	Delay	25	36		52			158		11	67	141		70

Note: LT = left turn; TH = through, RT = right turn.

TABLE 6
Intersection Capacity Analysis of Existing Conditions:
Main Street at the MBTA Driveway, Wilmington

		Main Street						MBTA			Private			Overall
		Northbound			Southbound			Eastbound			Westbound			
		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM peak	LOS	A	A		B			D		B	NA			B
	Delay	4	5		12			42		17	NA			12
PM peak	LOS	A	A		A			D		B	C			B
	Delay (sec/veh)	4	9		10			44		15	27			11

Note: LT = left turn; TH = through, RT = right turn.

Improvement Alternatives

There appear to be a limited number of options for making the geometric modifications to improve traffic operations and safety at this intersection. However, traffic signal design modifications and various modifications to pavement markings may be feasible.

A major improvement project was proposed in the 1980s. It would grade-separate Route 38/129 and Route 62 by extending the elevated portion of Route 62 so that is also goes over Route 38/129. The improvement would make Route 38/129 at-grade and eliminate the vertical curves on Route 62. However, this design would require widening some sections of both roadways to connect various turning movements. The project was not favored by the Town of Wilmington. The intersection was reconstructed with no major geometric modifications when the railroad bridge on Burlington Avenue was replaced and widened in 2001.

In addition to the geometric limitations such as the lack of right-of-way for expansion, the surrounding built-up conditions, and the proximity to the railroad, signal operation improvements at this intersection are limited by the train preemption operation. The current traffic control settings of the two intersections' coordinated traffic signals are dictated by the train-crossing signal, which is necessary for ensuring the safety of roadway users during train crossings, since crashes between a crossing train and vehicles on Main Street could be fatal. The train preemption sequence, which clears the southbound queues at both intersections, stops northbound traffic and allows only right turns from the MBTA driveway and traffic from either of the side streets at the study intersection, has to be preserved.

Staff tested four improvement alternatives that do not involve major geometric modifications. They are analyzed below, progressing from simple to more involved options. The four alternatives are:

1) Retime the traffic signal under the existing intersection layout and phasing sequence.
2) Convert the southbound inside lane to a left-turn only lane, and operate northbound and southbound left turns under protected/permissive phases.
3) Convert the eastbound inside lane to a left-turn-only lane and the eastbound outside lane to a through/right-turn shared lane, and operate eastbound and westbound left turns under leading/lagging protected phases.
4) Add an exclusive left-turn lane, realign the eastbound approach within the existing bridge width, and operate the traffic signal under the existing phasing sequence.

Staff used Synchro to analyze the alternatives. Ideally, VISSIM[6] or other sophisticated multimodal transportation models that can simulate train preemption operations would have been preferable for this study. However, those programs are much more expensive and were beyond this study's budget. However, since field observations indicate that the intersection's traffic operations generally are not significantly impacted by train preemptions in the AM and PM peak periods, except the preemption at around 5:20 PM, Synchro was considered to be adequate for this study.[7]

Table 7 summarizes the intersection capacity analyses for the four alternatives. Detailed analysis results for both the AM and PM peak hours at the study intersection for the alternatives are included in Appendices F to I. The analyses show that only Alternative 4 would have a noticeable operations improvement. Alternative 1 would improve the

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[6] VISSIM is a microscopic simulation program for multimodal traffic flow modeling. With a high level of detailed input data, it proclaims to be able to accurately simulate urban and highway traffic, including pedestrians, cyclists, and transit vehicles. The software is maintained and distributed by PTV America Inc. in Corvallis, Oregon.

[7] The intersection operations are affected by three train preemptions in the morning peak period, at around 7:20, 7:50, and 8:05, and three in the evening peak period, at around 4:35, 5:20, and 6:00.

operation slightly. Alternative 2 operations would be worse than the existing operations in both the AM and PM peak hours. Alternative 3 would improve the operations moderately in the PM peak hour but could compromise the traffic safety on the side streets, making them worse than in the current split-phase operations.

The purpose of Alternative 1 was to examine the existing signal timing to determine if it could be adjusted using the most recent traffic counts. Iterations of Synchro cycle length and split optimizations indicated that the overall intersection delay could be reduced slightly, by about 5 seconds per vehicle, if the signal timing on the Main Street approaches is reduced by 10 seconds and the timing for other approaches remains the same. The adjustment would slightly reduce the average delay per vehicle and the 50th-percentile and 95th-percentile queues on almost all of the approaches. However, the analyses also estimated that in the PM peak hour, 50th-percentile and 95th-percentile queues on the northbound through/right-turn approach would increase by about one vehicle length (25 feet).

In Alternative 1, the same timing reduction was applied on the Main Street approaches at the MBTA driveway signal, as the two signals were modeled as coordinated intersections. The analyses indicated that all of the approaches of the driveway intersection would operate at a similar LOS, with comparable delays, except the eastbound left-turn approach. The adjustment would reduce the delay by about 12 seconds and 8 seconds per vehicle for the approach in the AM and PM peak hours, respectively. This potentially would reduce the red light running by vehicles turning left from the driveway. Detailed analysis results for both the AM and PM peak hours at the driveway intersection in Alternative 1 are included in Appendices J.[8]

Although Alternative 1 would moderately improve the operations for most of the approaches at the study intersection and noticeably improve the operations at the MBTA driveway, the potential increase of traffic queues on the northbound approach at the intersection is a concern. Presently, the approach endures an extensive queue during and after train preemption operations at around 5:20, during the PM peak hour.

Alternative 2 was developed with the intention of improving the traffic operations and safety on Main Street. It was expected that the LOS on Main Street would deteriorate, especially the southbound approach. The analyses showed that the southbound operations would deteriorate more than expected, especially in the AM peak hour. Meanwhile, all of the other approaches would also deteriorate significantly, as the underserved southbound demand would need the majority of the intersection's capacity. The 50th-percentile and 95th-percentile queues on the southbound approach were estimated to be about twice the estimates of the existing conditions. The tests of this

[8] The timing and phasing settings at the driveway intersection in Alternative 1 were also applied to Alternatives 2 to 4. The appendix thus represents the analysis results for the intersection in Alternatives 1 to 4.

alternative indicate that no operations appear to be feasible for the Main Street approaches except the current operations.

Alternative 3 was developed to determine if the traffic operations on Burlington Avenue and Church Street could be improved by allowing concurrent through movements from both streets. The current split-phase operation is generally safer than other operations but demands more of a share of the intersection capacity. Because the intersection's roadways do not intersect perpendicularly, the left-turn paths from the two streets tend to cross each other if they are have concurrent phases. As such, the lead/lag left-turn operation was considered for this alternative. The analyses showed that this alternative would moderately improve traffic operations on most of the approaches, but would cause traffic operations on Burlington Avenue to deteriorate, especially in the AM peak hour. Overall, the operations benefits of this alternative do not outweigh the safety benefits of the split-phase operation.

Alternative 4 was developed to utilize the relatively wide surface of the roadway section that goes over the railroad. Currently the approximately 48-foot-wide surface is divided evenly between the two In Alternative 1, the same timing reduction was applied on the Main Street approach at the MBTA driveway signal as at the signal at the study intersection, since the two signals were modeled as coordinated intersections. The analyses indicated that both of the approaches of the driveway intersection would operate at the same LOS, with comparable delays, except the eastbound left-turn approach. The adjustment would reduce the delay per vehicle by about 12 seconds in the AM peak hour, and by about 8 seconds in the PM peak hour. This would potentially reduce the frequency of red light directions. The eastbound side is further divided into two 12-foot lanes: one for right turns only and one shared by left turns and through movements. The westbound direction has a width of about 24 feet, and is designated as a single lane to receive traffic from all other streets. It appears that there is room for adding a lane on the eastbound approach by reconfiguring the lanes without widening the bridge.

Figure 3 shows the proposed lane reconfiguration for the intersection. The proposed configuration on Burlington Avenue would contain a 12-foot right-turn lane, an 11-foot through lane, and an 11-foot left-turn lane in the eastbound direction, and a 14-foot receiving lane in the westbound direction. The left-turn lane could store about three to four left-turning vehicles.

The capacity analyses indicated that Alternative 4 would improve traffic operations on all of the approaches at the intersection in both the AM and PM peak hours. Traffic queues would potentially be reduced by about 30% on the eastbound approach and by around 5% on most of the other approaches. The overall queue on the northbound approach would be slightly reduced in the AM peak hour, but would increase slightly in the PM peak hour. However, the queue in the northbound left-turn pocket would be reduced by about one vehicle length in the PM peak hour.

TABLE 7
Intersection Capacity Analyses of
Existing Conditions and Tested Alternatives:
Main Street at Burlington Avenue/Church Street, Wilmington

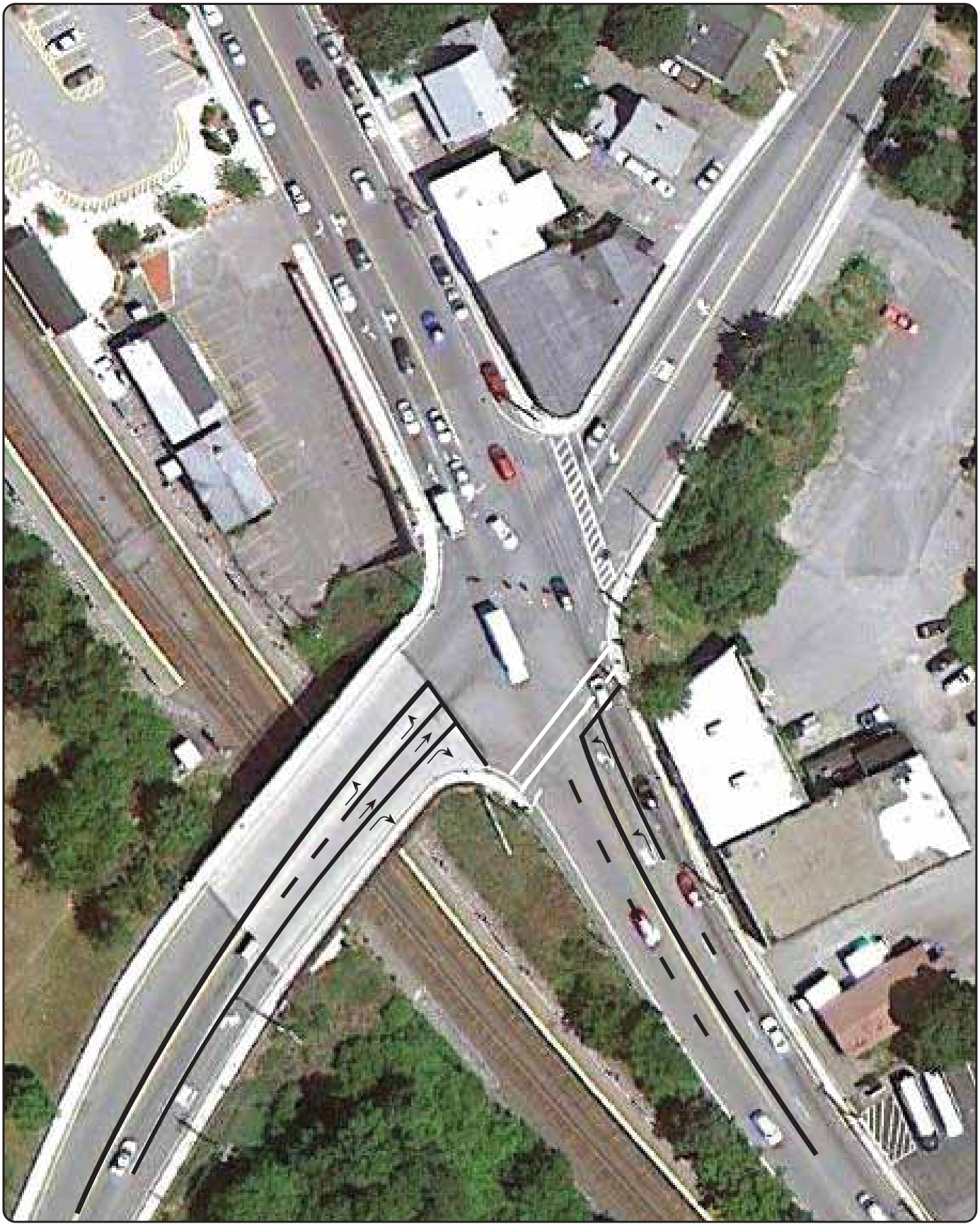
		Main Street		Burlington Avenue	Church Street	
		Northbound	Southbound	Eastbound	Westbound	Overall
AM Peak Hour	Existing	C/31	D/46	E/58	F/109	D/55
	Alternative 1	C/28	D/41	E/56	F/94	D/49
	Alternative 2	C/27	F/216	F/103	F/145	F/142
	Alternative 3	C/26	C/34	F/123	F/104	E/61
	Alternative 4	C/25	D/38	D/51	F/94	D/49
PM Peak Hour	Existing	D/35	D/54	F/108	F/124	E/70
	Alternative 1	C/30	D/44	F/99	F/125	E/64
	Alternative 2	D/44	D/52	F/99	F/125	E/71
	Alternative 3	C/26	D/41	F/114	E/76	E/57
	Alternative 4	C/30	D/44	E/69	F/106	D/54

Note: Cell Values: Level of Service (A to F)/Average Delay (seconds per vehicle).

Alt. 1: Retime the traffic signal under the existing intersection layout and phasing sequence.
Alt. 2: Convert SB inside lane to a left-turn-only lane, and operate NB and SB left turns under protected/permissive phases.
Alt. 3: Convert EB inside lane to a left-turn-only lane and EB outside lane to a through/right-turn shared lane, and operate EB/WB left turns under leading/lagging protected phases.
Alt. 4: Add an exclusive left-turn lane and realign EB approach within the existing bridge width, and operate the traffic signal under the existing phasing sequence.

Currently, the left-turn pocket has a length of about 200 feet. The analyses estimate the 95th-percentile queue as about 150 feet for the existing conditions[9] and about 130 feet for Alternative 4. Potentially, the northbound left-turn pocket could be reduced by about 50 feet, and the two-lane section of the southbound departure lane could be extended. This could be achieved by slightly adjusting the northbound center line northward (see Figure 3).

[9] Field observations of the existing conditions are generally consistent with the estimation. Usually two to three vehicles and infrequently five to six vehicles queue in the lane during the peak hours.



BOSTON
REGION
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FIGURE 3
Proposed Lane Reconfigurations

Safety and Operations
Analyses at
Selected Intersections

At this preliminary planning stage, Alternative 4 appears to have the potential to improve the intersection operations and is geometrically feasible. At the functional design stage, further engineering reviews should be performed to determine if the additional lane would allow trucks to turn left onto Main Street from Burlington Avenue and would not block the turning paths of trucks from the other approaches. If necessary, the stop line of the left-turn lane on Burlington Avenue or the stop line of the southbound Main Street left-turn lane could be set back somewhat.

Improvement Recommendations

This is a congested, high-crash intersection with a constrained geometric and operational environment. It is an intersection where two major state routes meet. It is adjacent to a major commuter railroad that has a train station and an at-grade railroad crossing. Its surrounding areas are mostly built up, with a number of stores along Main Street. Its traffic signal is coordinated with an adjacent signal at the MBTA station driveway and is interconnected with the signal at the railroad crossing. T carries multiple transportation modes and serves as a gateway to the train station.

Staff performed a series of safety and operations analyses in order to identify geometric design and operational deficiencies at the intersection. In general, the analyses found that the congestion and most of the crashes were caused by heavy peak-period traffic, significant nearby commercial and commuting activities, and roadway grade changes due to the adjacent railroad tracks. The analyses indicated that the current signal design and coordination at this intersection and at the MBTA driveway intersection are appropriate under the existing conditions of high traffic demand, right-of-way and geometric limitations, and train-crossing safety considerations.[10]

In addition, staff tested four improvement alternatives that mainly focus on signal timing and phasing adjustments under the existing intersection right-of-way. The four alternatives are:

- Alternative 1--Retime the traffic signal under the existing intersection layout and phasing sequence.
- Alternative 2--Convert the southbound inside lane to a left-turn-only lane, and operate northbound and southbound left turns under protected/permissive phases.
- Alternative 3--Convert the eastbound inside lane to a left-turn-only lane and the eastbound outside lane to a through/right-turn shared lane, and operate eastbound and westbound turns under leading/lagging protected phases.

[10] Usually, a signalized roadway train preemption control scheme's primary purpose is safety, and congestion mitigation is a secondary goal. With the advance of signal communication and traffic monitoring technologies, a number of researchers are currently seeking to find ways to achieve both objectives.

- Alternative 4--Add an exclusive left-turn lane and realign the eastbound approach within the existing roadway width, and operate the traffic signal under the existing phasing sequence.

The analyses of the alternatives indicated that only Alternative 4 would have a noticeable operations improvement over the existing conditions. Alternative 1 would moderately improve the operations on the approaches, except for the northbound approach. Alternative 2 operations would be worse than the existing operations in both the AM and PM peak hours. Alternative 3 would somewhat improve the operation in the PM peak hour but could make traffic safety on the side streets worse than with the current split-phase operations.

In the short term, staff proposes the following measures to improve operations and safety at the intersection and the adjacent roadways. All but the last two items are low-cost measures that could be implemented in a relatively short time.

- Prohibit parking on Main Street near the intersection in order to preserve the functional area for vehicles turning from Burlington Avenue and Church Street. At least 50 feet from the intersection should be clear of parking. White hatch line markings should be installed inside the wide shoulder to indicate the no-parking zone, and a "No Parking Any Time" regulatory sign (R7-1, MUTCD[11]) with an arrow pointing to the intersection should be placed at the end of the zone.
- Provide advance warning signs on the Main Street northbound approach in order to increase drivers' awareness of the potential traffic queue before the horizontal curve. A "Signal Ahead" graphic sign (W3-1, MUTCD[12]) should be placed at about 500 feet from the intersection and a "Cross Road" (W2-1) sign should be placed before the W3-1 sign about 800 feet from the intersection.
- Ensure that pavements markings such as crosswalks, stop lines, yellow center lines, and white shoulder lines are well maintained and clearly visible to delineate the travel path of vehicles at the intersection.
- Install sharrow ("Share the Road") pavement makings (see Figure 4) on Main Street between the two intersections in order to alert drivers to share the travel lane with cyclists and vice versa. At least four markings should be placed in each direction. They should be placed on the middle of the northbound single lane and the middle of the outside lane of the southbound approach.[13]

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[11] U.S. Department of Transportation, Federal Highway Administration, *Chapter* 2B, "Regulatory Signs, Barricades, and Gates," *in Manual for Uniform Traffic Control Devices,* 2009 Edition, December 2009.

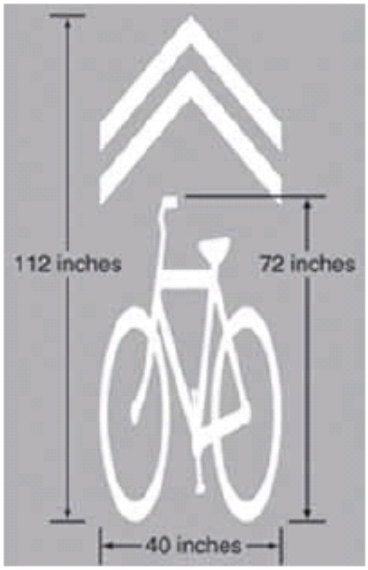
[12] MUTCD, *Chapter 2C, "*Warning Sings and Object Markers," 2009 Edition.

[13] There are a number of commuters using bikes to access the station. Currently there is no shared-lane operation for bikes in that short section of roadway due to the limitation of the existing right-of-way. Preferably, bike travels should be separated from traffic in the busy Route 38/129 corridor. The "complete street" design concept

- Install “Bicycle Warning” (W11-1) and “Share the Road” (W16-1) warning signs, as depicted in Figure 5. Share the Road signs should be installed in conjunction with shared lane markings, and the Bicycle Warning signs would alert motorists that cyclists are present.
- Install a “Cross Only at Crosswalks” (R9-3b) or a “Use Crosswalk” (R9-2) sign (see Figure 6) on Main Street at the pedestrian walkway entrance to the commuter rail station, since there were two pedestrian crashes at this location in the last few years.
- Establish a 30 mph speed limit on the Main Street northbound approach starting about 1,500 feet south of the intersection, before the curve. The speed zone is needed because of the many driveways in the section and also because of its horizontal curve.

FIGURE 4

Generic Version of a Sharrow Marking



Source: Federal Highway Administration, FHWA-HRT-10-041, *Evaluation of Shared Lane Markings*, October 2010.

should be considered for future corridor development. A possible solution would be adding a wide shoulder for bikes traveling in the corridor.

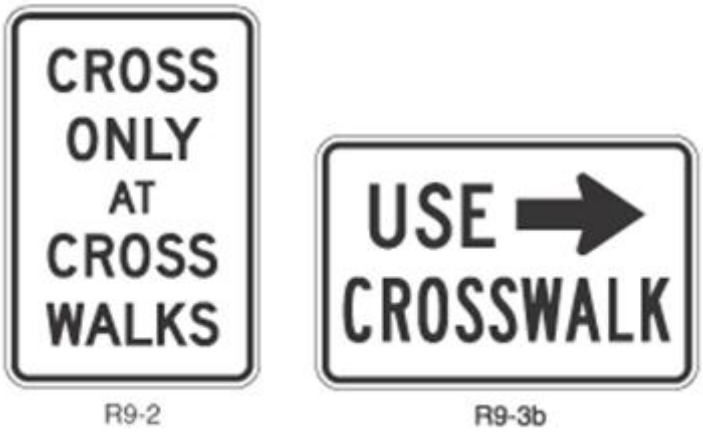
FIGURE 5

Bicycle Warning and Share the Road Warning Signs

Source: Federal Highway Administration, *Manual on Uniform Traffic Control Devices,* 2009 Edition.

FIGURE 6

Cross Only at Crosswalks and Use Crosswalk Regulatory Signs



Source: Federal Highway Administration, *Manual on Uniform Traffic Control Devices,* 2009 Edition.

For the long term, the staff proposes the following additional measures that would potentially further improve operations and safety at the intersection and the adjacent roadways:

- Implement Alternative 4: Add a left-turn pocket, realign the eastbound approach, and retime the traffic signals at this intersection and the MBTA driveway Intersection. The lane addition would require replacing the existing signal heads and detection sensors on the approach.

- Install accessible pedestrian signals at the intersection and install ADA (Americans with Disabilities Act) detectable warning pads on the curb ramps. This improvement should be included at the functional design stage of Alternative 4.
- Apply the Adaptive Signal Control technologies[14] in the Route 38/129 corridor to mitigate traffic congestion in peak periods [15]. The new signal system should include measures to mitigate traffic congestion due to train preemptions, such as dynamically extending the maximum green time on the northbound approach at this intersection and providing more green time for the congested approaches before the train preemption.
- Extend the two-lane section of the southbound roadway leaving the intersection, so that it is at least 300 feet long. This appears to be feasible, as the roadway segment has a 50-foot-wide right-of-way and there is space between the roadway and the railroad tracks for the extension.
- Explore the possibility of adding a wide shoulder of (at least four feet wide) for bike travel in the Route 38/129 corridor. It appears that the best potential for this would be to use the already-wide shoulder on the west side of Main Street from this intersection to Route 129.

One additional long-term improvement option would be to add a left-turn bay on the southbound approach. It would significantly improve the operations and safety at the intersection, but it would require the removal of about four to five on-street parking spaces from the storefronts on Main Street.[16] The parking spaces are much needed by the adjacent businesses and the Town does not favor removing them. However, this improvement option should be considered when the area of the storefronts is to be redeveloped or when the roadway north of the intersection is to be reconstructed as part of a major development in the future.

CW/cw

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[14] Traffic signal control technologies that can adapt to serve demand by adjusting the cycle lengths, splits, and/or offsets of traffic signals in a corridor based on volume or occupancy data collected in real time.

[15] The corridor is a merged section of two major state routes, Route 38 (whose whole length is on Main Street in Wilmington) and Route 129 (diverging onto Lowell Street in the south and onto Shawsheen Avenue in the north). Essentially, roadway capacity is reduced from four lanes to two to three lanes, therefore making this section of the Route 38/129 more congested than other sections of Route 38 and of Route 129

[16] The left-turn bay should have a length of at least 100 feet in order to meet the left-turn demand in peak hours.

APPENDIX A

Intersection Crash Rate

Calculation Worksheet 1
Main Street at Burlington Avenue/Church Street, Wilmington

Calculation Worksheet 2
Main Street at MBTA Wilmington Station Driveway, Wilmington

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Wilmington COUNT DATE : 4/5/2012

DISTRICT : 4 UNSIGNALIZED : SIGNALIZED : X

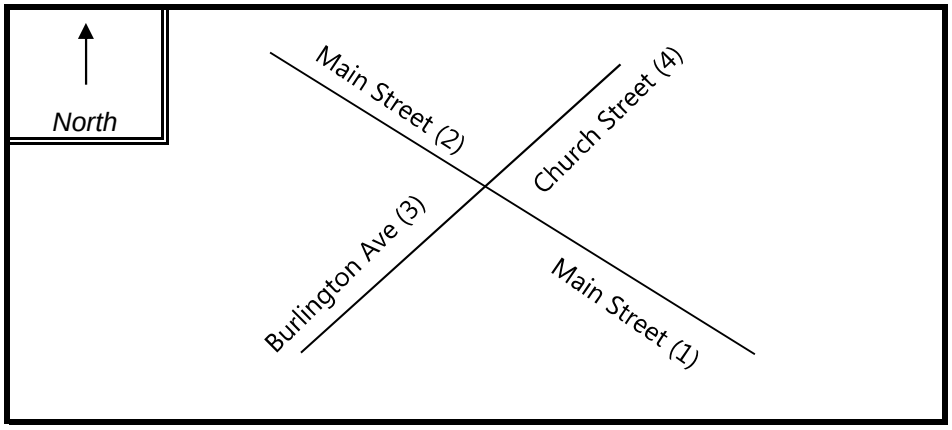
~ INTERSECTION DATA ~

MAJOR STREET : Main Street

MINOR STREET(S) : Burlington Avenue

Church 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) :	757	804	505	387		**2,453**

" K " FACTOR : **0.090** INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **27,256**

TOTAL # OF CRASHES : 116 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (**A**) : **23.20**

CRASH RATE CALCULATION : **2.332** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : MassDOT District 4 Average Rate = 0.68 (July 7, 2011)

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

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Wilmington | COUNT DATE : 4/10/2012

DISTRICT : 4 | UNSIGNALIZED : | SIGNALIZED : X

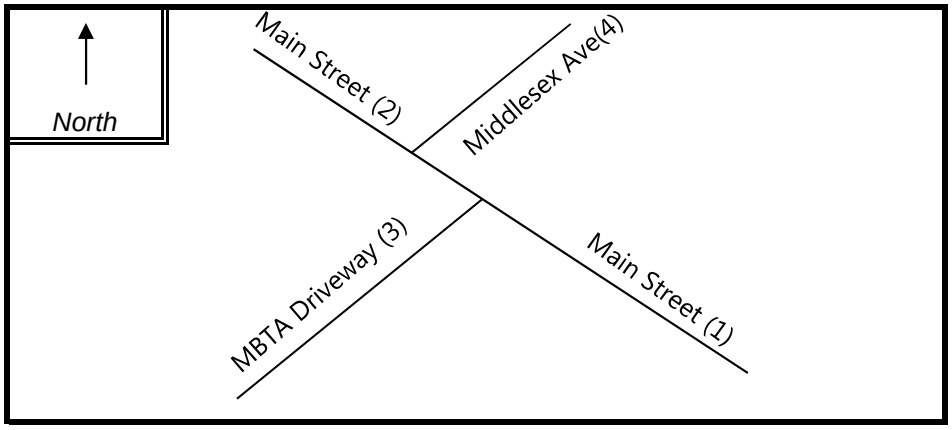
~ INTERSECTION DATA ~

MAJOR STREET : Main Street

MINOR STREET(S) : MBTA Driveway

Middlesex Avenue

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) :	659	723	136	7		**1,525**

" K " FACTOR : **0.090** | INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : **16,944**

TOTAL # OF CRASHES : 9 | # OF YEARS : 5 | AVERAGE # OF CRASHES PER YEAR (**A**) : **1.80**

CRASH RATE CALCULATION : **0.291**

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

Comments : MassDOT District 4 Average Rate = 0.68 (July 7, 2011)

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

APPENDIX B

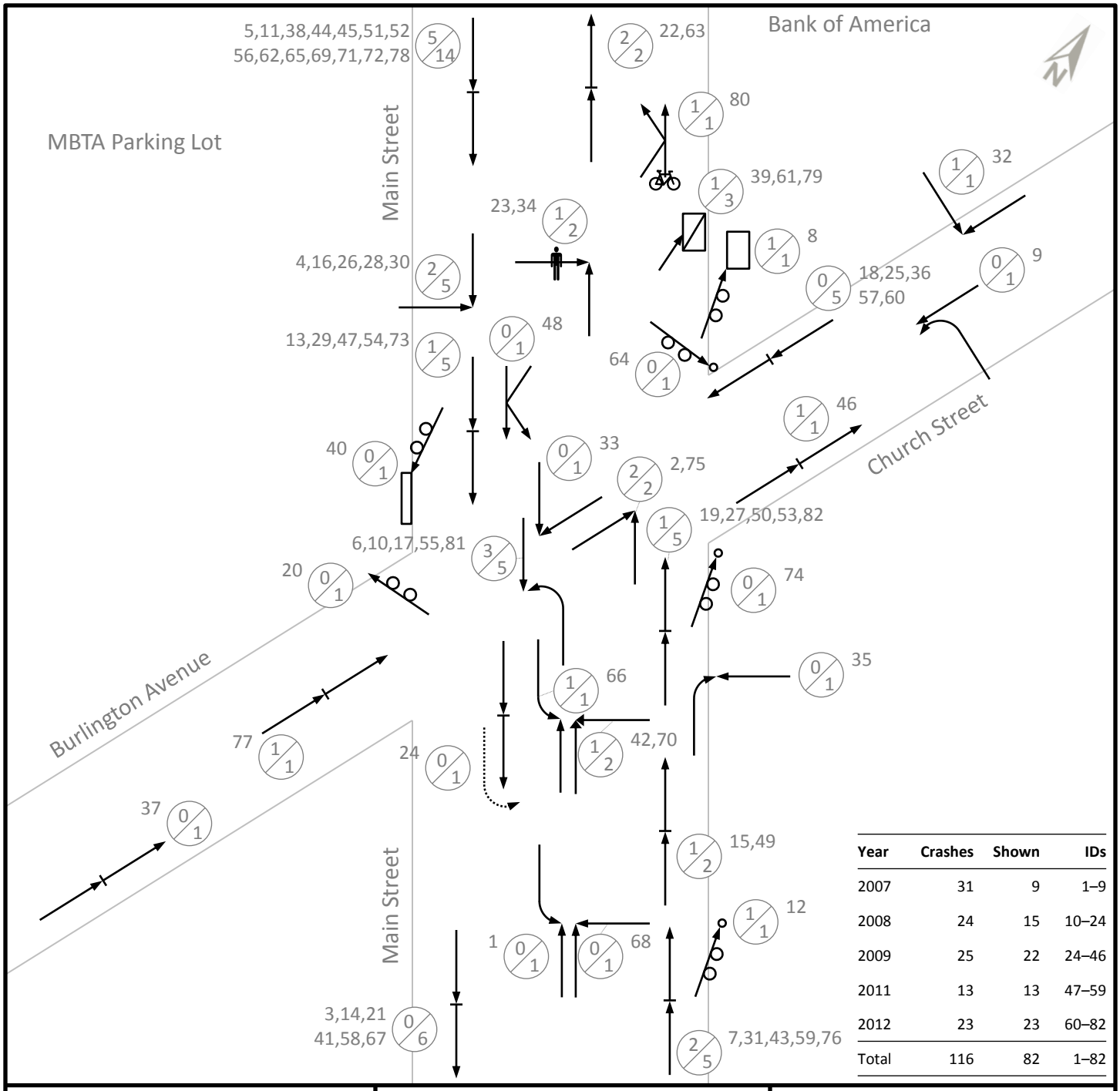
Intersection Collision Diagram

Figure B-1
Main Street at Burlington Avenue/Church Street, Wilmington

Figure B-2
Main Street at MBTA Wilmington Station Driveway, Wilmington

Table B-1
Summary of Crash Reports Used for the Collision Diagrams

Figure B-1
Collision Diagram: Main Street at Burlington Avenue/Church Street, Wilmington: August 2007– December 2011



Year	Crashes	Shown	IDs
2007	31	9	1–9
2008	24	15	10–24
2009	25	22	24–46
2011	13	13	47–59
2012	23	23	60–82
Total	116	82	1–82

SYMBOLS

- Moving Vehicle
- Backing Vehicle
- Non-Involved Vehicle
- Parked Vehicle
- Fixed Object
- Pedestrian
- Bicycle
- Animal

TYPES OF CRASH

- Head-On
- Angle
- Turning Move
- Rear-End
- Sideswipe
- Out-of-Control

SEVERITY

#1/#2 #3,4,...

#1 Injury Accident(s)

#2 Total Number of Accidents

#3,4,... Accident ID Number

Figure B-2
Collision Diagram: Main Street at MBTA Driveway, Wilmington:
August 2007– December 2011

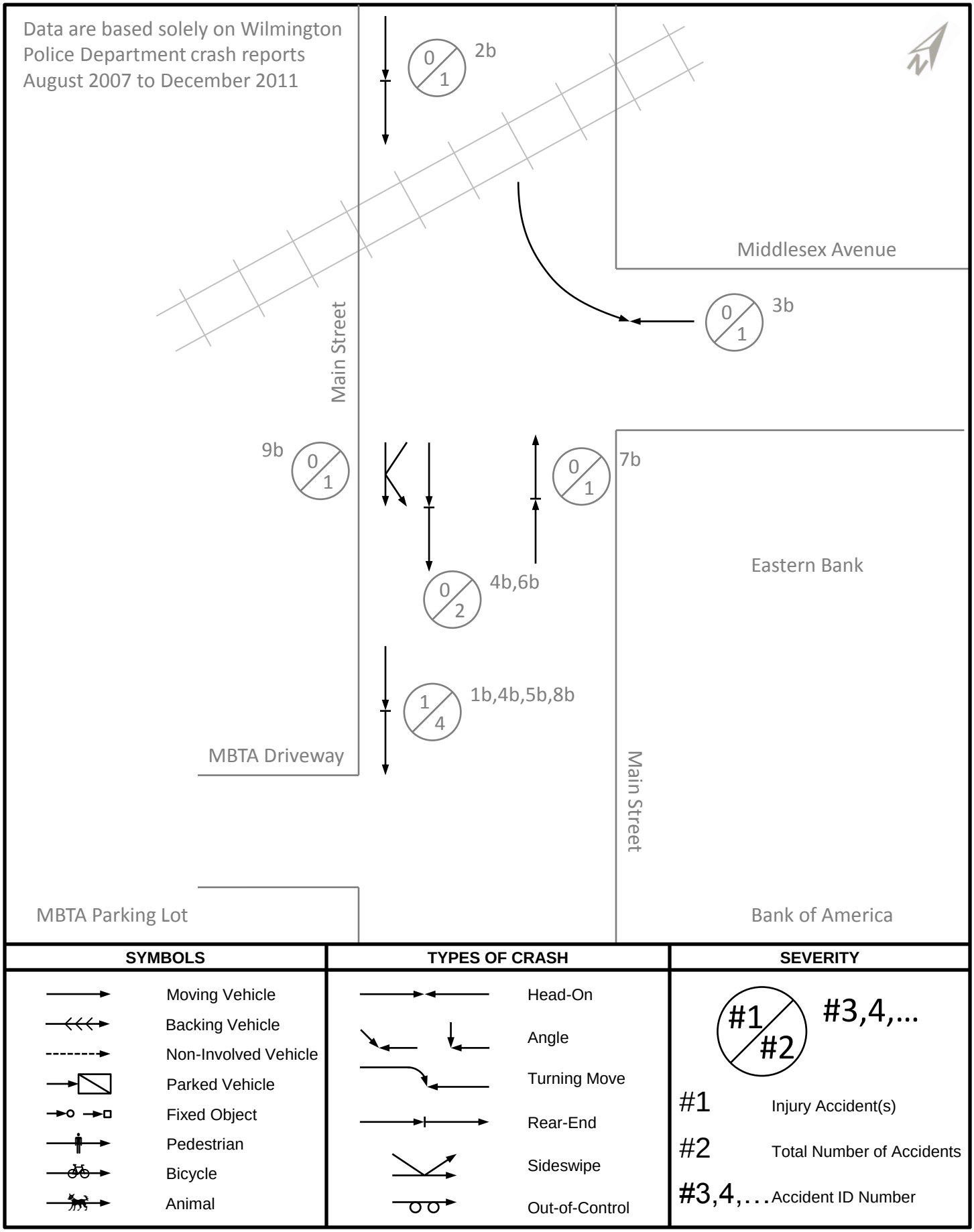


TABLE B-1

Main Street at Burlington Avenue/Church Street and Main Street at MBTA Driveway, Wilmington:
August 2007–December 2011

ID	Crash Date	Crash Day	Crash Time	Crash Severity	Number of Vehicles	Total Non-fatal Injuries	Manner of Collision	Road Surface	Light Condition	Weather Condition	Non-motorist Type	Contributing Factor(s)
Main Street at Burlington Avenue/Church Street												
1	09/11/07	Tue	06:27	Property damage only	2	0	Angle	Wet	Daylight	Cloudy		Failed to yield right-of-way
2	09/24/07	Mon	14:45	Non-fatal injury	2	1	Angle	Dry	Daylight	Clear		Disregarded traffic signs, signals, road markings
3	09/26/07	Wed	15:37	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Inattention
4	10/01/07	Mon	17:25	Property damage only	2	0	Angle	Dry	Daylight	Clear		Failed to yield right-of-way
5	10/04/07	Thu	12:25	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Operating defective equipment
6	10/27/07	Sat	19:57	Non-fatal injury	2	1	Angle	Wet	Dark - unknown	Cloudy/Other		Failed to yield right-of-way
7	11/19/07	Mon	14:36	Property damage only	2	0	Rear-end	Dry	Daylight	Cloudy		Followed too closely
8	12/03/07	Mon	12:44	Non-fatal injury	1	1	Single-vehicle crash	Wet	Daylight	Rain		Unknown
9	12/07/07	Fri	09:35	Property damage only	2	0	Angle	Dry	Daylight	Cloudy		Inattention
10	01/07/08	Mon	18:09	Property damage only	3	0	Angle	Wet	Dark - lighted roadway	Cloudy		Failed to yield right-of-way
11	02/09/08	Sat	11:51	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Inattention
12	02/21/08	Thu	02:43	Non-fatal injury	1	1	Single-vehicle crash	Dry	Dark - lighted roadway	Clear		Operating vehicle in erratic, reckless, careless, negligent, or aggressive manner
13	02/27/08	Wed	15:57	Property damage only	2	0	Rear-end	Wet	Daylight	Cloudy		Inattention
14	02/27/08	Wed	18:12	Property damage only	2	0	Rear-end	Dry	Dark - lighted roadway	Clear		No improper driving
15	03/04/08	Tue	08:53	Non-fatal injury	3	2	Rear-end	Wet	Daylight	Cloudy/Other		Exceeded authorized speed limit; other improper action
16	04/09/08	Wed	18:04	Property damage only	2	0	Angle	Dry	Daylight	Clear		Failed to yield right-of-way
17	04/21/08	Mon	19:19	Non-fatal injury	2	1	Head-on	Dry	Daylight	Clear		Exceeded authorized speed limit; failed to yield right-of-way
18	05/10/08	Sat	15:17	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Inattention
19	06/23/08	Mon	11:10	Non-fatal injury	2	1	Rear-end	Wet	Daylight	Cloudy/Rain		Inattention
20	07/14/08	Mon	16:29	Property damage only	1	0	Single-vehicle crash	Dry	Daylight	Clear/Unknown		Over-correcting/over-steering
21	09/14/08	Sun	12:55	Property damage only	3	0	Rear-end	Wet	Daylight	Cloudy		Inattention
22	10/22/08	Wed	06:49	Non-fatal injury	3	1	Rear-end	Wet	Dark - lighted roadway	Rain		Followed too closely; inattention
23	10/31/08	Fri	15:16	Property damage only	1	0	Single-vehicle crash	Dry	Daylight	Clear	Pedestrian	Hit-and-run
24	11/06/08	Thu	14:51	Property damage only	3	0	Rear-end	Wet	Daylight	Rain/Cloudy		Unknown
25	01/06/09	Tue	15:58	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Inattention; other improper action
26	01/21/09	Wed	19:15	Property damage only	2	0	Angle	Dry	Dark - lighted roadway	Clear		Failed to yield right-of-way
27	03/27/09	Fri	18:07	Property damage only	3	0	Rear-end	Dry	Daylight	Clear		Inattention
28	03/30/09	Mon	16:04	Non-fatal injury	2	1	Angle	Wet	Daylight	Cloudy/Rain		Operating vehicle in erratic, reckless, careless, negligent, or aggressive manner; visibility obstructed
29	04/15/09	Wed	13:01	Property damage only	3	0	Rear-end	Dry	Daylight	Clear		Inattention
30	04/22/09	Wed	18:34	Non-fatal injury	2	1	Angle	Wet	Daylight	Rain		Failed to yield right-of-way
31	04/29/09	Wed	16:06	Non-fatal injury	3	1	Rear-end	Dry	Daylight	Clear		Unknown
32	05/01/09	Fri	14:57	Non-fatal injury	2	1	Angle	Dry	Daylight	Cloudy		Failure to keep in proper lane or running off road
33	05/01/09	Fri	15:28	Property damage only	2	0	Angle	Dry	Daylight	Clear		Disregarded traffic signs, signals, road markings
34	05/19/09	Tue	23:12	Non-fatal injury	1	1	Single-vehicle crash	Dry	Dark - lighted roadway	Clear	Pedestrian	Unknown
35	06/03/09	Wed	11:39	Property damage only	2	0	Angle	Dry	Daylight	Clear		Made an improper turn
36	06/09/09	Tue	17:10	Property damage only	3	0	Rear-end	Wet	Dawn	Cloudy		Inattention
37	08/03/09	Mon	15:01	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Inattention
38	09/10/09	Thu	15:22	Non-fatal injury	3	1	Rear-end	Dry	Daylight	Clear		Inattention
39	09/12/09	Sat	14:21	Non-fatal injury	3	1	Angle	Wet	Daylight	Rain		Driving too fast for conditions; exceeded authorized speed limit
40	09/24/09	Thu	12:01	Property damage only	1	0	Single-vehicle crash	Dry	Daylight	Clear		Operating defective equipment
41	09/24/09	Thu	16:51	Property damage only	3	0	Rear-end	Dry	Daylight	Clear		Inattention
42	11/27/09	Fri	11:31	Non-fatal injury	2	1	Angle	Wet	Daylight	Rain		Failed to yield right-of-way
43	12/09/09	Wed	14:21	Property damage only	2	0	Rear-end	Wet	Daylight	Rain/Snow		Inattention
44	12/12/09	Sat	17:59	Non-fatal injury	3	2	Rear-end	Dry	Daylight	Clear		Inattention
45	12/14/09	Mon	18:15	Non-fatal injury	2	1	Rear-end	Dry	Dark - lighted roadway	Cloudy		No improper driving
46	12/18/09	Fri	08:05	Non-fatal injury	2	1	Rear-end	Dry	Daylight	Clear		Inattention; followed too closely
47	03/01/10	Mon	15:45	Non-fatal injury	3	7	Rear-end	Dry	Daylight	Clear		Inattention
48	03/03/10	Wed	15:55	Property damage only	2	0	Sideswipe, same dir.	Dry	Daylight	Cloudy		Inattention; failure to keep in proper lane or running off road
49	03/03/10	Wed	16:28	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Followed too closely; inattention
50	03/12/10	Fri	13:20	Property damage only	2	0	Rear-end	Dry	Daylight	Cloudy		Inattention
51	03/16/10	Tue	17:44	Non-fatal injury	4	1	Rear-end	Dry	Daylight	Clear		Followed too closely; inattention
52	03/28/10	Sun	10:58	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Inattention
53	04/13/10	Tue	16:48	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Operating defective equipment
54	04/22/10	Thu	15:06	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Inattention
55	05/05/10	Wed	12:04	Non-fatal injury	2	3	Angle	Dry	Daylight	Clear		Made an improper turn
56	07/09/10	Fri	08:30	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Distracted
57	09/23/10	Thu	08:06	Property damage only	3	0	Rear-end	Dry	Daylight	Clear		Inattention
58	11/06/10	Sat	13:41	Property damage only	2	0	Rear-end	Dry	Daylight	Cloudy		Inattention
59	12/21/10	Tue	18:43	Property damage only	2	0	Rear-end	Dry	Dark - lighted roadway	Cloudy		Inattention

(continued on next page)

TABLE B-1 (continued)

ID	Crash Date	Crash Day	Crash Time	Crash Severity	Number of Vehicles	Total Non-fatal Injuries	Manner of Collision	Road Surface	Light Condition	Weather Condition	Non-motorist Type	Contributing Factor(s)
60	02/05/11	Sat	11:58	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Followed too closely
61	03/04/11	Fri	18:36	Property damage only	2	0	Sideswipe, same dir.	Wet	Daylight	Cloudy, Rain		Failure to keep in proper lane or running off road
62	03/05/11	Sat	11:56	Property damage only	3	0	Rear-end	Dry	Daylight	Clear		Inattention
63	03/18/11	Fri	20:57	Non-fatal injury	2	1	Rear-end	Dry	Dark - lighted roadway	Clear		Followed too closely; inattention
64	03/20/11	Sun	04:11	Property damage only	1	0	Single-vehicle crash	Dry	Dark - lighted roadway	Clear		Fatigued/asleep
65	04/23/11	Sat	14:22	Non-fatal injury	2	1	Rear-end	Wet	Daylight	Rain		Followed too closely; inattention
66	05/09/11	Mon	14:54	Non-fatal injury	2	2	Angle	Dry	Daylight	Clear		Failed to yield right-of-way
67	05/12/11	Thu	13:28	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Followed too closely
68	07/06/11	Wed	10:17	Property damage only	2	0	Angle	Dry	Daylight	Clear		Failed to yield right-of-way; inattention
69	07/08/11	Fri	08:30	Property damage only	2	0	Unknown	Dry	Daylight	Cloudy		Hit-and-run; unknown
70	08/01/11	Mon	16:38	Property damage only	2	0	Angle	Dry	Daylight	Clear, Cloudy		Failed to yield right-of-way
71	08/02/11	Tue	18:23	Property damage only	3	0	Rear-end	Wet	Daylight	Cloudy, Rain		Other improper action;
72	08/16/11	Tue	07:22	Property damage only	3	0	Rear-end	Wet	Daylight	Rain		Inattention; followed too closely
73	09/19/11	Mon	08:39	Property damage only	3	0	Rear-end	Dry	Daylight	Clear		Inattention
74	10/17/11	Mon	00:06	Property damage only	1	0	Single-vehicle crash	Dry	Dark - lighted roadway	Cloudy		Distracted
75	10/17/11	Mon	08:37	Non-fatal injury	2	2	Angle	Dry	Daylight	Clear		Driving too fast for conditions; inattention
76	10/19/11	Wed	13:35	Non-fatal injury	3	1	Rear-end	Wet	Daylight	Cloudy, Rain		Followed too closely; other improper action
77	10/30/11	Sun	15:50	Non-fatal injury	4	2	Rear-end	Dry	Daylight	Clear		Followed too closely; other improper action
78	11/05/11	Sat	13:13	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Inattention
79	12/05/11	Mon	01:33	Property damage only	3	0	Sideswipe, same dir.	Wet	Dark - lighted roadway	Clear		Inattention; cellular phone
80	12/10/11	Sat	10:23	Property damage only	1	1	Sideswipe, same dir.	Dry	Daylight	Clear	Cyclist	Driving too fast for conditions
81	12/16/11	Fri	16:20	Property damage only	2	0	Head-on	Dry	Daylight	Cloudy		Unknown
82	12/16/11	Fri	20:56	Property damage only	2	0	Rear-end	Dry	Dusk	Clear		Physical impairment
N/A	01/02/07	Tue	16:33	Non-fatal injury	1	2	Single-vehicle crash	Dry	Dusk	Clear		N/A - No police report
N/A	01/28/07	Sun	15:05	Not Reported	2	0	Rear-end	Dry	Daylight	Clear		N/A - No police report
N/A	02/22/07	Thu	11:40	Not Reported	3	0	Rear-end	Dry	Daylight	Cloudy		N/A - No police report
N/A	02/27/07	Tue	08:35	Not Reported	2	0	Sideswipe, opposite dir.	Dry	Daylight	Clear		N/A - No police report
N/A	03/02/07	Fri	06:50	Property damage only	2	0	Not reported	Wet	Daylight	Sleet, hail		N/A - No police report
N/A	03/28/07	Wed	18:15	Non-fatal injury	2	2	Rear-end	Wet	Daylight	Clear		N/A - No police report
N/A	04/28/07	Sat	10:00	Property damage only	2	0	Sideswipe, same dir.	Dry	Not reported	Clear		N/A - No police report
N/A	05/06/07	Sun	00:00	Non-fatal injury	1	1	Single-vehicle crash	Dry	Dark - lighted roadway	Clear	Skater	N/A - No police report
N/A	05/08/07	Tue	17:18	Non-fatal injury	1	1	Single-vehicle crash	Dry	Daylight	Clear		N/A - No police report
N/A	06/01/07	Fri	13:35	Property damage only	2	0	Angle	Dry	Daylight	Cloudy		N/A - No police report
N/A	06/06/07	Wed	06:50	Property damage only	1	0	Single-vehicle crash	Dry	Daylight	Clear		N/A - No police report
N/A	06/07/07	Thu	11:00	Property damage only	2	0	Not reported	Not reported	Not reported	Not Reported		N/A - No police report
N/A	06/07/07	Thu	15:07	Non-fatal injury	2	1	Angle	Dry	Daylight	Clear/Clear		N/A - No police report
N/A	06/12/07	Tue	14:37	Property damage only	2	0	Rear-end	Dry	Daylight	Cloudy		N/A - No police report
N/A	06/27/07	Wed	12:05	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		N/A - No police report
N/A	06/28/07	Thu	12:40	Non-fatal injury	2	1	Rear-end	Dry	Daylight	Clear		N/A - No police report
N/A	07/11/07	Wed	15:48	Property damage only	3	0	Rear-end	Dry	Daylight	Clear		N/A - No police report
N/A	07/26/07	Thu	03:10	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		N/A - No police report
N/A	08/23/07	Thu	09:38	Property damage only	4	0	Rear-end	Dry	Daylight	Cloudy		N/A - No police report
N/A	08/30/07	Thu	15:09	Property damage only	3	0	Rear-end	Dry	Daylight	Clear/Other		N/A - No police report
N/A	09/16/07	Sun	19:35	Property damage only	2	0	Not reported	Dry	Dark - lighted roadway	Clear		N/A - No police report
N/A	11/09/07	Fri	18:36	Property damage only	2	0	Rear-end	Dry	Dark - lighted roadway	Clear		N/A - No police report
N/A	02/22/08	Fri	19:53	Property damage only	2	0	Rear-end	Snow	Dark - lighted roadway	Snow		N/A - No police report
N/A	03/06/08	Thu	06:56	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		N/A - No police report
N/A	03/29/08	Sat	06:00	Not Reported	2	0	Rear-end	Dry	Daylight	Clear		N/A - No police report
N/A	04/03/08	Thu	07:08	Non-fatal injury	2	1	Rear-end	Dry	Daylight	Clear		N/A - No police report
N/A	06/23/08	Mon	11:20	Non-fatal injury	2	1	Rear-end	Wet	Other	Cloudy		N/A - No police report
N/A	09/06/08	Sat	12:09	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		N/A - No police report
N/A	10/08/08	Wed	15:09	Property damage only	3	0	Rear-end	Dry	Daylight	Clear		N/A - No police report
N/A	10/24/08	Fri	16:30	Non-fatal injury	2	1	Rear-end	Dry	Daylight	Clear		N/A - No police report
N/A	11/26/08	Wed	03:22	Unknown	2	0	Angle	Not reported	Daylight	Clear		N/A - No police report
N/A	04/04/09	Sat	14:27	Property damage only	1	0	Rear-end	Dry	Daylight	Cloudy		N/A - No police report
N/A	04/22/09	Wed	07:26	Property damage only	1	0	Single-vehicle crash	Dry	Daylight	Clear		N/A - No police report
N/A	07/22/09	Wed	17:15	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		N/A - No police report
Main Street at MBTA Driveway												
1b	05/15/08	Thu	12:48	Property damage only	3	0	Rear-end	Dry	Daylight	Clear		Inattention
2b	07/28/08	Mon	11:42	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Followed too closely; other improper action
3b	11/20/08	Thu	20:06	Property damage only	2	0	Sideswipe, opposite dir.	Dry	Dark - lighted roadway	Clear		Made an improper turn; failure to keep in proper lane or running off road
4b	02/05/09	Thu	18:38	Property damage only	2	0	Rear-end	Dry	Dark - lighted roadway	Clear		Operating defective equipment
5b	12/15/09	Tue	09:00	Property damage only	2	0	Rear-end	Wet	Daylight	Cloudy		Followed too closely
6b	01/23/10	Sat	14:43	Property damage only	2	0	Rear-end	Dry	Daylight	Clear		Inattention
7b	07/18/11	Mon	18:58	Property damage only	4	0	Rear-end	Dry	Daylight	Cloudy		Operating vehicle in erratic, reckless, careless, negligent, or aggressive manner; inattention
8b	11/19/11	Sat	11:52	Non-fatal injury	3	1	Rear-end	Dry	Daylight	Clear		Followed too closely; driving too fast for conditions
9b	12/12/11	Mon	12:56	Non-fatal injury	2	0	Angle	Dry	Daylight	Clear		Inattention

APPENDIX C

Average Daily Traffic (ADT) Summary
March 12-15, 2012

bing Maps

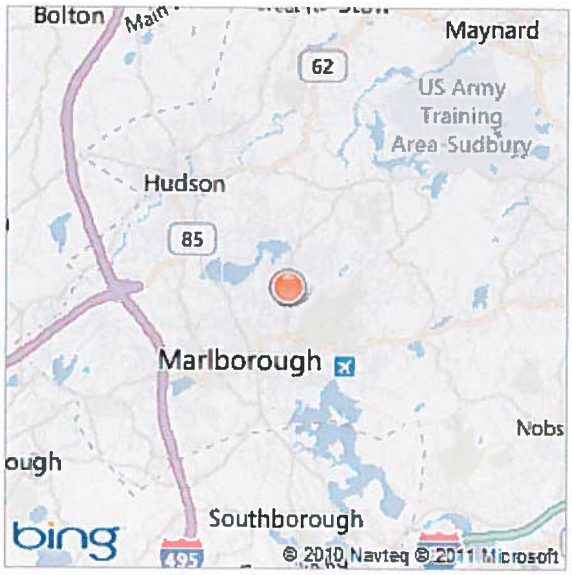
Massachusetts

My Notes

TDC PROJECT #
S12-018

WILMINGTON

On the go? Use **m.bing.com** to find maps, directions, businesses, and more



STA. 1 NB

Site Reference: 120180010201 File: 10201.prn
Site ID: 000000000417 City: WILMINGTON
Location: RTES. 38/129, NORTH MIDDLESEX AVE. County: DIR VOL
Direction: NORTH

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		84	76	93		84			84	253
02:00		40	36	39		38			38	115
03:00		23	24	22		23			23	69
04:00		35	34	26		31			31	95
05:00		28	32	43		34			34	103
06:00		103	96	103		100			100	302
07:00		251	264	282		265			265	797
08:00		405	401	442		416			416	1248
09:00		519	559	517		531			531	1595
10:00		505	585	497		529			529	1587
11:00		610	561			585			585	1171
12:00		684	755			719			719	1439
13:00	839	804	812			818			818	2455
14:00	788	704	740			744			744	2232
15:00	824	832	808			821			821	2464
16:00	852	827	877			852			852	2556
17:00	977	905	934			938			938	2816
18:00	955	940	932			942			942	2827
19:00	863	826	831			840			840	2520
20:00	648	608	637			631			631	1893
21:00	466	507	519			497			497	1492
22:00	313	364	327			334			334	1004
23:00	189	230	206			208			208	625
24:00	182	189	192			187			187	563
TOTALS	7896	11023	11238	2064	0	11167	0	0	11167	32221
% AVG WKDY	70.7	98.7	100.6	18.4						
% AVG WEEK	70.7	98.7	100.6	18.4						
AM Times		12:00	12:00	09:00		12:00			12:00	
AM Peaks		684	755	517		719			719	
PM Times	17:00	18:00	17:00			18:00			18:00	
PM Peaks	977	940	934			942			942	

u3

NB 11167
SB 12866
COMB AWD 24033
FAC .96(.98)
COMB ADT 22,600

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 3/12/2012

STA. 1 SB

Site Reference: 120180010201
Site ID: 000000000417
Location: RTES. 38/129, NORTH MIDDLESEX AVE.
Direction: SOUTH

File: 10201.prn
City: WILMINGTON
County: DIR VOL

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		32	71	48		50			50	151
02:00		35	33	35		34			34	103
03:00		25	27	20		24			24	72
04:00		42	38	50		43			43	130
05:00		114	125	116		118			118	355
06:00		467	445	474		462			462	1386
07:00		988	990	996		991			991	2974
08:00		1159	1157	1117		1144			1144	3433
09:00		989	943	976		969			969	2908
10:00		695	730	758		727			727	2183
11:00		657	677			667			667	1334
12:00		699	737			718			718	1436
13:00	834	805	787			808			808	2426
14:00	777	777	773			775			775	2327
15:00	866	812	784			820			820	2462
16:00	787	733	809			776			776	2329
17:00	722	726	717			721			721	2165
18:00	787	772	795			784			784	2354
19:00	688	709	641			679			679	2038
20:00	522	518	516			518			518	1556
21:00	425	403	417			415			415	1245
22:00	311	313	299			307			307	923
23:00	227	224	201			217			217	652
24:00	103	87	108			99			99	298
TOTALS	7049	12781	12820	4590	0	12866	0	0	12866	37240
% AVG WKDY	54.7	99.3	99.6	35.6						
% AVG WEEK	54.7	99.3	99.6	35.6						
AM Times		08:00	08:00	08:00		08:00			08:00	
AM Peaks		1159	1157	1117		1144			1144	
PM Times	15:00	15:00	16:00			15:00			15:00	
PM Peaks	866	812	809			820			820	

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 4/23/2012

STA. 2 NB

Site Reference: 000000020102
Site ID: 120180000706
Location: RTE 138/129 BTWN MIDDLESEX&T PARKING LOT
Direction: EAST

File: V-20102.prn
City: WILMINGTON
County: DIR VOL N&S

TIME	MON 23	TUE 24	WED 25	THU 26	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		73	84	98		85			85	255
02:00		26	31	35		30			30	92
03:00		20	25	30		25			25	75
04:00		27	40	38		35			35	105
05:00		38	38	41		39			39	117
06:00		96	108	87		97			97	291
07:00		288	274	285		282			282	847
08:00		447	477	404		442			442	1328
09:00		474	493	520		495			495	1487
10:00		563	553			558			558	1116
11:00		566	559			562			562	1125
12:00	653	620	606			626			626	1879
13:00	666	746	681			697			697	2093
14:00	641	638	693			657			657	1972
15:00	748	696	718			720			720	2162
16:00	694	809	816			773			773	2319
17:00	803	755	785			781			781	2343
18:00	857	828	853			846			846	2538
19:00	728	786	809			774			774	2323
20:00	527	580	547			551			551	1654
21:00	420	433	395			416			416	1248
22:00	275	281	246			267			267	802
23:00	175	224	206			201			201	605
24:00	156	188	232			192			192	576
TOTALS	7343	10202	10269	1538	0	10151	0	0	10151	29352
% AVG WKDY	72.3	100.5	101.1	15.1						
% AVG WEEK	72.3	100.5	101.1	15.1						
AM Times	12:00	12:00	12:00	09:00		12:00			12:00	
AM Peaks	653	620	606	520		626			626	
PM Times	18:00	18:00	18:00			18:00			18:00	
PM Peaks	857	828	853			846			846	

U3

NB 10151
SB 12015
COMB AWD 22166
FAC .92(.98)
COMB ADT 20,000

STA. 2 SB

Site Reference: 000000020102 File: V-20102.prn
Site ID: 120180000706 City: WILMINGTON
Location: RTE 138/129 BTWN MIDDLESEX&T PARKING LOT County: DIR VOL N&S
Direction: SOUTH

TIME	MON 23	TUE 24	WED 25	THU 26	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		26	31	45		34			34	102
02:00		21	22	25		22			22	68
03:00		31	23	22		25			25	76
04:00		35	36	39		36			36	110
05:00		127	130	127		128			128	384
06:00		483	472	496		483			483	1451
07:00		1073	1082	1048		1067			1067	3203
08:00		1100	1192	1092		1128			1128	3384
09:00		953	979	1024		985			985	2956
10:00		653	797			725			725	1450
11:00		655	653			654			654	1308
12:00	582	605	664			617			617	1851
13:00	725	695	719			713			713	2139
14:00	672	681	693			682			682	2046
15:00	678	746	741			721			721	2165
16:00	656	722	689			689			689	2067
17:00	596	662	653			637			637	1911
18:00	690	729	802			740			740	2221
19:00	554	617	657			609			609	1828
20:00	437	495	454			462			462	1386
21:00	293	375	321			329			329	989
22:00	208	248	203			219			219	659
23:00	190	201	205			198			198	596
24:00	108	111	118			112			112	337
TOTALS	6389	12044	12336	3918	0	12015	0	0	12015	34687
% AVG WKDY	53.1	100.2	102.6	32.6						
% AVG WEEK	53.1	100.2	102.6	32.6						
AM Times	12:00	08:00	08:00	08:00		08:00			08:00	
AM Peaks	582	1100	1192	1092		1128			1128	
PM Times	13:00	15:00	18:00			18:00			18:00	
PM Peaks	725	746	802			740			740	

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 3/12/2012

STA. 3 NB

Site Reference: 120180030102
Site ID: 000000000611
Location: RTES 38/129 BTWN T PARKING LOT & RTE. 62
Direction: NORTH

File: 30102.prn
City: WILMINGTON
County: DIR VOL

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		78	73	91		80			80	242
02:00		37	32	32		33			33	101
03:00		21	24	18		21			21	63
04:00		33	33	24		30			30	90
05:00		29	31	43		34			34	103
06:00		103	94	101		99			99	298
07:00		227	259	245		243			243	731
08:00		371	373	372		372			372	1116
09:00		458	496	441		465			465	1395
10:00		473	506	451		476			476	1430
11:00		553	531			542			542	1084
12:00	578	608	659			615			615	1845
13:00	758	708	733			733			733	2199
14:00	673	649	649			657			657	1971
15:00	724	733	705			720			720	2162
16:00	781	742	776			766			766	2299
17:00	846	744	813			801			801	2403
18:00	730	755	736			740			740	2221
19:00	736	722	741			733			733	2199
20:00	577	512	558			549			549	1647
21:00	389	449	450			429			429	1288
22:00	280	330	286			298			298	896
23:00	176	226	184			195			195	586
24:00	179	169	182			176			176	530
TOTALS	7427	9730	9924	1818	0	9807	0	0	9807	28899
% AVG WKDY	75.7	99.2	101.1	18.5						
% AVG WEEK	75.7	99.2	101.1	18.5						
AM Times	12:00	12:00	12:00	10:00		12:00			12:00	
AM Peaks	578	608	659	451		615			615	
PM Times	17:00	18:00	17:00			17:00			17:00	
PM Peaks	846	755	813			801			801	

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NB 9807
SB 11646
COMB AWD 21453

FAC .96 (.98)
COMB ADT 20,200

STA. 35B

Site Reference: 120180030102
Site ID: 000000000611
Location: RTES 38/129 BTWN T PARKING LOT & RTE. 62
Direction: SOUTH

File: 30102.prn
City: WILMINGTON
County: DIR VOL

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		37	67	48		50			50	152
02:00		33	34	32		33			33	99
03:00		27	25	20		24			24	72
04:00		41	37	50		42			42	128
05:00		111	122	116		116			116	349
06:00		436	423	452		437			437	1311
07:00		867	873	890		876			876	2630
08:00		1005	1012	982		999			999	2999
09:00		924	885	897		902			902	2706
10:00		649	673	692		671			671	2014
11:00		591	616			603			603	1207
12:00	588	613	670			623			623	1871
13:00	766	714	693			724			724	2173
14:00	661	721	688			690			690	2070
15:00	770	708	714			730			730	2192
16:00	689	655	713			685			685	2057
17:00	679	638	638			651			651	1955
18:00	714	696	707			705			705	2117
19:00	615	640	610			621			621	1865
20:00	457	468	493			472			472	1418
21:00	398	411	389			399			399	1198
22:00	285	287	277			283			283	849
23:00	213	226	198			212			212	637
24:00	101	88	105			98			98	294
TOTALS	6936	11586	11662	4179	0	11646	0	0	11646	34363
% AVG WKDY	59.5	99.4	100.1	35.8						
% AVG WEEK	59.5	99.4	100.1	35.8						
AM Times	12:00	08:00	08:00	08:00		08:00			08:00	
AM Peaks	588	1005	1012	982		999			999	
PM Times	15:00	14:00	15:00			15:00			15:00	
PM Peaks	770	721	714			730			730	

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 3/12/2012

STA. 4 NB

Site Reference: 120180040102
Site ID: 000000000753
Location: RTES 38/129, SOUTH OF KIRK ST.
Direction: NORTH

File: 40102.prn
City: WILMINGTON
County: DIR VOL

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		87	91	108		95			95	286
02:00		49	39	43		43			43	131
03:00		25	29	23		25			25	77
04:00		42	37	30		36			36	109
05:00		37	36	52		41			41	125
06:00		112	116	115		114			114	343
07:00		282	310	274		288			288	866
08:00		450	485	490		475			475	1425
09:00		513	558	509		526			526	1580
10:00		519	543	458		506			506	1520
11:00		533	506			519			519	1039
12:00		653	695			674			674	1348
13:00	788	723	748			753			753	2259
14:00	733	696	681			703			703	2110
15:00	767	790	776			777			777	2333
16:00	816	828	848			830			830	2492
17:00	910	814	838			854			854	2562
18:00	776	778	800			784			784	2354
19:00	796	806	773			791			791	2375
20:00	612	573	630			605			605	1815
21:00	434	472	475			460			460	1381
22:00	323	376	346			348			348	1045
23:00	210	240	222			224			224	672
24:00	203	184	187			191			191	574
TOTALS	7368	10582	10769	2102	0	10662	0	0	10662	30821
% AVG WKDY	69.1	99.2	101	19.7						
% AVG WEEK	69.1	99.2	101	19.7						
AM Times		12:00	12:00	09:00		12:00			12:00	
AM Peaks		653	695	509		674			674	
PM Times	17:00	16:00	16:00			17:00			17:00	
PM Peaks	910	828	848			854			854	

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NB 10662
SB 13076
COMB AWD 23738
FAC .96 (.98)
COMB ADT 22,300

STA. 4 SB

Site Reference: 120180040102
Site ID: 000000000753
Location: RTES 38/129, SOUTH OF KIRK ST.
Direction: SOUTH

File: 40102.prn
City: WILMINGTON
County: DIR VOL

TIME	MON	TUE	WED	THU	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
	12	13	14	15						
01:00		34	63	42		46			46	139
02:00		31	29	33		31			31	93
03:00		34	26	26		28			28	86
04:00		48	44	54		48			48	146
05:00		136	138	134		136			136	408
06:00		548	522	554		541			541	1624
07:00		1102	1104	1127		1111			1111	3333
08:00		1239	1256	1184		1226			1226	3679
09:00		1121	1033	1063		1072			1072	3217
10:00		775	761	835		790			790	2371
11:00		659	700			679			679	1359
12:00		681	692			686			686	1373
13:00	809	751	798			786			786	2358
14:00	772	759	753			761			761	2284
15:00	916	812	797			841			841	2525
16:00	807	731	874			804			804	2412
17:00	755	755	728			746			746	2238
18:00	729	725	732			728			728	2186
19:00	625	656	620			633			633	1901
20:00	436	470	466			457			457	1372
21:00	360	374	367			367			367	1101
22:00	277	254	253			261			261	784
23:00	208	209	194			203			203	611
24:00	95	87	104			95			95	286
TOTALS	6789	12991	13054	5052	0	13076	0	0	13076	37886
% AVG WKDY	51.9	99.3	99.8	38.6						
% AVG WEEK	51.9	99.3	99.8	38.6						
AM Times		08:00	08:00	08:00		08:00			08:00	
AM Peaks		1239	1256	1184		1226			1226	
PM Times	15:00	15:00	16:00			15:00			15:00	
PM Peaks	916	812	874			841			841	

STA. 5 EB

Site Reference: 120180050403
Site ID: 000000000740
Location: MIDDLESEX AVE., EAST OF RTES. 38/129
Direction: EAST

File: 50403.prn
City: WILMINGTON
County: DIR VOL

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		3	6	7		5			5	16
02:00		2	2	1		1			1	5
03:00		1	3	1		1			1	5
04:00		0	0	2		0			0	2
05:00		5	5	4		4			4	14
06:00		16	15	13		14			14	44
07:00		45	42	44		43			43	131
08:00		116	117	90		107			107	323
09:00		91	82	113		95			95	286
10:00		75	93	104		90			90	272
11:00		87	113			100			100	200
12:00		111	124			117			117	235
13:00	119	126	154			133			133	399
14:00	120	95	129			114			114	344
15:00	159	161	128			149			149	448
16:00	137	136	137			136			136	410
17:00	124	136	129			129			129	389
18:00	137	143	153			144			144	433
19:00	115	119	102			112			112	336
20:00	80	94	80			84			84	254
21:00	46	47	39			44			44	132
22:00	40	41	35			38			38	116
23:00	25	22	14			20			20	61
24:00	10	10	12			10			10	32
TOTALS	1112	1682	1714	379	0	1690	0	0	1690	4887
% AVG WKDY	65.7	99.5	101.4	22.4						
% AVG WEEK	65.7	99.5	101.4	22.4						
AM Times		08:00	12:00	09:00		12:00			12:00	
AM Peaks		116	124	113		117			117	
PM Times	15:00	15:00	13:00			15:00			15:00	
PM Peaks	159	161	154			149			149	

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EB 1690
WB 1662
COMB AWD 3352
FAC .96(.99)
COMB ADT 3,200

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1 Page: 1
Starting: 3/12/2012

STA. 5 WB

Site Reference: 120180050403 File: 50403.prn
Site ID: 000000000740 City: WILMINGTON
Location: MIDDLESEX AVE., EAST OF RTES. 38/129 County: DIR VOL
Direction: WEST

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		6	3	6		5			5	15
02:00		3	5	5		4			4	13
03:00		4	1	5		3			3	10
04:00		2	2	2		2			2	6
05:00		5	4	3		4			4	12
06:00		18	11	18		15			15	47
07:00		49	60	65		58			58	174
08:00		115	96	108		106			106	319
09:00		108	96	101		101			101	305
10:00		69	103	85		85			85	257
11:00		86	91			88			88	177
12:00		102	118			110			110	220
13:00	146	135	144			141			141	425
14:00	130	95	115			113			113	340
15:00	133	130	132			131			131	395
16:00	145	138	120			134			134	403
17:00	140	160	122			140			140	422
18:00	141	120	133			131			131	394
19:00	94	80	91			88			88	265
20:00	58	80	74			70			70	212
21:00	50	98	56			68			68	204
22:00	33	35	33			33			33	101
23:00	12	24	21			19			19	57
24:00	10	21	8			13			13	39
TOTALS	1092	1683	1639	398	0	1662	0	0	1662	4812
% AVG WKDY	65.7	101.2	98.6	23.9						
% AVG WEEK	65.7	101.2	98.6	23.9						
AM Times		08:00	12:00	08:00		12:00			12:00	
AM Peaks		115	118	108		110			110	
PM Times	13:00	17:00	13:00			13:00			13:00	
PM Peaks	146	160	144			141			141	

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 3/12/2012

STA. 6 EB

Site Reference: 120180060304
Site ID: 000000000707
Location: RTE. 62, EAST OF RTES. 38/129
Direction: EAST

File: 60304.prn
City: WILMINGTON
County: DIR VOL

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		14	11	15		13			13	40
02:00		12	13	10		11			11	35
03:00		11	11	10		10			10	32
04:00		23	13	20		18			18	56
05:00		35	46	47		42			42	128
06:00		140	120	129		129			129	389
07:00		287	311	272		290			290	870
08:00		324	343	343		336			336	1010
09:00		323	283	282		296			296	888
10:00		271	257			264			264	528
11:00		267	292			279			279	559
12:00	296	303	294			297			297	893
13:00	327	327	266			306			306	920
14:00	377	320	334			343			343	1031
15:00	351	349	341			347			347	1041
16:00	402	395	360			385			385	1157
17:00	398	399	392			396			396	1189
18:00	391	406	409			402			402	1206
19:00	259	269	284			270			270	812
20:00	145	185	179			169			169	509
21:00	123	106	134			121			121	363
22:00	67	94	96			85			85	257
23:00	39	48	33			40			40	120
24:00	25	31	24			26			26	80
TOTALS	3200	4939	4846	1128	0	4875	0	0	4875	14113
% AVG WKDY	65.6	101.3	99.4	23.1						
% AVG WEEK	65.6	101.3	99.4	23.1						
AM Times	12:00	08:00	08:00	08:00		08:00			08:00	
AM Peaks	296	324	343	343		336			336	
PM Times	16:00	18:00	18:00			18:00			18:00	
PM Peaks	402	406	409			402			402	

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EB 4875
WB 4563
COMB AWD 9438
FAC .96 (.98)
COMB ADT 8,900

STA. 6 WB

Site Reference: 120180060304
Site ID: 000000000707
Location: RTE. 62, EAST OF RTES. 38/129
Direction: WEST

File: 60304.prn
City: WILMINGTON
County: DIR VOL

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		8	9	7		8			8	24
02:00		6	7	3		5			5	16
03:00		4	4	6		4			4	14
04:00		8	8	9		8			8	25
05:00		31	26	39		32			32	96
06:00		145	128	123		132			132	396
07:00		325	322	307		318			318	954
08:00		394	380	320		364			364	1094
09:00		305	282	262		283			283	849
10:00		271	232			251			251	503
11:00		255	255			255			255	510
12:00	325	343	295			321			321	963
13:00	313	305	302			306			306	920
14:00	308	308	300			305			305	916
15:00	350	347	332			343			343	1029
16:00	413	392	383			396			396	1188
17:00	378	421	345			381			381	1144
18:00	299	306	275			293			293	880
19:00	211	197	197			201			201	605
20:00	130	181	153			154			154	464
21:00	98	108	101			102			102	307
22:00	47	54	65			55			55	166
23:00	19	43	26			29			29	88
24:00	17	19	15			17			17	51
TOTALS	2908	4776	4442	1076	0	4563	0	0	4563	13202
% AVG WKDY	63.7	104.6	97.3	23.5						
% AVG WEEK	63.7	104.6	97.3	23.5						
AM Times	12:00	08:00	08:00	08:00		08:00			08:00	
AM Peaks	325	394	380	320		364			364	
PM Times	16:00	17:00	16:00			16:00			16:00	
PM Peaks	413	421	383			396			396	

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 3/12/2012

STA. 7 EB

Site Reference: 120180070304
Site ID: 000000000460
Location: RTES. 62, WEST OF RTES. 38/129
Direction: EAST

File: 70304.prn
City: WILMINGTON
County: DIR VOL

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		21	20	11		17			17	52
02:00		6	9	14		9			9	29
03:00		8	5	8		7			7	21
04:00		11	17	14		14			14	42
05:00		39	26	39		34			34	104
06:00		152	159	151		154			154	462
07:00		349	354	356		353			353	1059
08:00		495	494	474		487			487	1463
09:00		451	448	429		442			442	1328
10:00		353	332	360		348			348	1045
11:00		330	341			335			335	671
12:00		297	329			313			313	626
13:00	309	325	351			328			328	985
14:00	397	361	353			370			370	1111
15:00	463	437	434			444			444	1334
16:00	460	426	438			441			441	1324
17:00	462	482	445			463			463	1389
18:00	467	460	495			474			474	1422
19:00	378	414	404			398			398	1196
20:00	267	282	287			278			278	836
21:00	160	174	191			175			175	525
22:00	101	127	116			114			114	344
23:00	56	66	61			61			61	183
24:00	33	42	40			38			38	115
TOTALS	3553	6108	6149	1856	0	6097	0	0	6097	17666
% AVG WKDY	58.2	100.1	100.8	30.4						
% AVG WEEK	58.2	100.1	100.8	30.4						
AM Times		08:00	08:00	08:00		08:00			08:00	
AM Peaks		495	494	474		487			487	
PM Times	18:00	17:00	18:00			18:00			18:00	
PM Peaks	467	482	495			474			474	

US

EB 6097
WB 5677
COMB AWD 11774
FAC .96 (.98)
COMB ADT 11,100

STA. 7 WB

Site Reference: 120180070304
Site ID: 000000000460
Location: RTES. 62, WEST OF RTES. 38/129
Direction: WEST

File: 70304.prn
City: WILMINGTON
County: DIR VOL

TIME	MON 12	TUE 13	WED 14	THU 15	FRI	WKDAY AVG	SAT	SUN	WEEK AVG	TOTAL
01:00		29	43	36		36			36	108
02:00		13	15	14		14			14	42
03:00		7	7	7		7			7	21
04:00		8	4	4		5			5	16
05:00		11	9	16		12			12	36
06:00		70	59	65		64			64	194
07:00		230	228	218		225			225	676
08:00		464	441	416		440			440	1321
09:00		411	410	361		394			394	1182
10:00		307	285	250		280			280	842
11:00		253	221			237			237	474
12:00		281	306			293			293	587
13:00	315	309	315			313			313	939
14:00	318	345	315			326			326	978
15:00	363	390	384			379			379	1137
16:00	430	440	402			424			424	1272
17:00	469	463	416			449			449	1348
18:00	476	519	472			489			489	1467
19:00	384	405	379			389			389	1168
20:00	335	316	310			320			320	961
21:00	235	291	226			250			250	752
22:00	156	181	192			176			176	529
23:00	88	94	117			99			99	299
24:00	65	58	45			56			56	168
TOTALS	3634	5895	5601	1387	0	5677	0	0	5677	16517
% AVG WKDY	64	103.8	98.6	24.4						
% AVG WEEK	64	103.8	98.6	24.4						
AM Times		08:00	08:00	08:00		08:00			08:00	
AM Peaks		464	441	416		440			440	
PM Times	18:00	18:00	18:00			18:00			18:00	
PM Peaks	476	519	472			489			489	

APPENDIX D

AM/PM Peak-Hour Intersection Capacity Analysis
Existing Conditions

Main Street at Burlington Avenue/Church Street, Wilmington

Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	118	345	68	40	968	59	53	194	214	121	224	42
Confl. Peds. (#/hr)	1		6	6		1	5		2			
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	8%	8%	8%	4%	4%	4%	2%	2%	2%	7%	7%	7%
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 (%)												
Lane Group Flow (vph)	128	449	0	0	1159	0	0	269	233	132	289	0
Turn Type	pm+pt	NA		pm+pt	NA		Split	NA	pt+ov	Split	NA	
Protected Phases	5	2		1	6		4	4	4 5	3	3	
Permitted Phases	2			6								
Detector Phase	5	2		1	6		4	4	4 5	3	3	
Switch Phase												
Minimum Initial (s)	5.0	6.0		5.0	6.0		6.0	6.0		5.0	5.0	
Minimum Split (s)	10.0	20.0		10.0	20.0		20.0	20.0		20.0	20.0	
Total Split (s)	22.0	58.0		22.0	58.0		32.0	32.0		31.0	31.0	
Total Split (%)	13.3%	35.2%		13.3%	35.2%		19.4%	19.4%		18.8%	18.8%	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0	
Lost Time Adjust (s)	0.0	0.0			0.0			0.0		0.0	0.0	
Total Lost Time (s)	5.0	5.0			5.0			5.0		5.0	5.0	
Lead/Lag	Lead	Lead		Lag	Lag		Lag	Lag		Lead	Lead	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Recall Mode	None	C-Min		None	C-Min		None	None		None	None	
Act Effct Green (s)	89.7	89.7			73.3			25.5	39.9	26.0	26.0	
Actuated g/C Ratio	0.54	0.54			0.44			0.15	0.24	0.16	0.16	
v/c Ratio	0.69	0.47			0.80			0.91	0.41	0.51	1.02	
Control Delay	43.8	27.1			45.9			102.5	5.6	71.6	126.1	
Queue Delay	0.0	0.0			0.0			0.0	0.0	0.0	0.0	
Total Delay	43.8	27.1			45.9			102.5	5.6	71.6	126.1	
LOS	D	C			D			F	A	E	F	
Approach Delay		30.8			45.9			57.5			109.0	
Approach LOS		C			D			E			F	
Queue Length 50th (ft)	60	256			510			287	0	133	~331	
Queue Length 95th (ft)	147	462			#893			#448	53	208	#530	
Internal Link Dist (ft)		226			699			634			791	
Turn Bay Length (ft)	200								225	150		
Base Capacity (vph)	235	962			1441			312	613	257	282	
Starvation Cap Reductn	0	0			0			0	0	0	0	
Spillback Cap Reductn	0	0			0			0	0	0	0	
Storage Cap Reductn	0	0			0			0	0	0	0	
Reduced v/c Ratio	0.54	0.47			0.80			0.86	0.38	0.51	1.02	

Intersection Summary

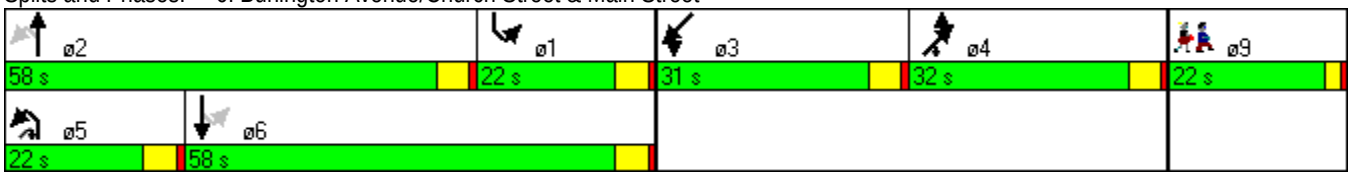
Cycle Length: 165

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 (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	7.0
Minimum Split (s)	22.0
Total Split (s)	22.0
Total Split (%)	13%
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	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 165
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Natural Cycle: 135
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.02
Intersection Signal Delay: 54.8 Intersection LOS: D
Intersection Capacity Utilization 96.3% ICU Level of Service F
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Burlington Avenue/Church Street & Main Street



Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	80	618	59	72	625	107	65	270	170	92	247	48
Confl. Peds. (#/hr)			1	1		9	9					
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	3%	3%	3%
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 (%)												
Lane Group Flow (vph)	87	736	0	0	873	0	0	364	185	100	320	0
Turn Type	pm+pt	NA		pm+pt	NA		Split	NA	pt+ov	Split	NA	
Protected Phases	5	2		1	6		4	4	4 5	3	3	
Permitted Phases	2			6								
Detector Phase	5	2		1	6		4	4	4 5	3	3	
Switch Phase												
Minimum Initial (s)	5.0	6.0		5.0	6.0		6.0	6.0		5.0	5.0	
Minimum Split (s)	22.0	20.0		10.0	20.0		20.0	20.0		20.0	20.0	
Total Split (s)	22.0	58.0		22.0	58.0		32.0	32.0		31.0	31.0	
Total Split (%)	13.3%	35.2%		13.3%	35.2%		19.4%	19.4%		18.8%	18.8%	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0	
Lost Time Adjust (s)	0.0	0.0			0.0			0.0		0.0	0.0	
Total Lost Time (s)	5.0	5.0			5.0			5.0		5.0	5.0	
Lead/Lag	Lead	Lead		Lag	Lag		Lag	Lag		Lead	Lead	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Recall Mode	None	C-Min		None	C-Min		None	None		None	None	
Act Effct Green (s)	88.2	88.2			74.4			27.0	38.8	26.0	26.0	
Actuated g/C Ratio	0.53	0.53			0.45			0.16	0.24	0.16	0.16	
v/c Ratio	0.34	0.73			0.88			1.16	0.37	0.37	1.09	
Control Delay	25.1	36.4			52.4			157.9	10.6	66.9	141.3	
Queue Delay	0.0	0.0			0.0			0.0	0.0	0.0	0.0	
Total Delay	25.1	36.4			52.4			157.9	10.6	66.9	141.3	
LOS	C	D			D			F	B	E	F	
Approach Delay		35.2			52.4			108.2			123.6	
Approach LOS		D			D			F			F	
Queue Length 50th (ft)	40	516			396			~462	29	98	~388	
Queue Length 95th (ft)	91	896			#713			#677	76	162	#592	
Internal Link Dist (ft)		226			699			634			791	
Turn Bay Length (ft)	200								225	150		
Base Capacity (vph)	326	1015			995			315	579	267	293	
Starvation Cap Reductn	0	0			0			0	0	0	0	
Spillback Cap Reductn	0	0			0			0	0	0	0	
Storage Cap Reductn	0	0			0			0	0	0	0	
Reduced v/c Ratio	0.27	0.73			0.88			1.16	0.32	0.37	1.09	

Intersection Summary

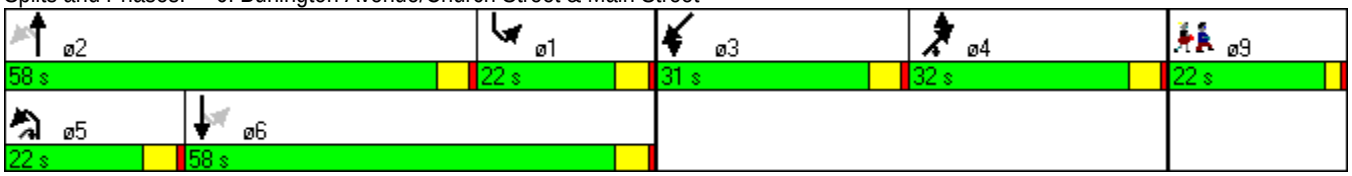
Cycle Length: 165

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 (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	7.0
Minimum Split (s)	22.0
Total Split (s)	22.0
Total Split (%)	13%
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	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 165
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Natural Cycle: 145
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.16
Intersection Signal Delay: 69.8 Intersection LOS: E
Intersection Capacity Utilization 109.4% ICU Level of Service H
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

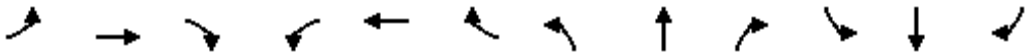
Splits and Phases: 6: Burlington Avenue/Church Street & Main Street



APPENDIX E

AM/PM Peak-Hour Intersection Capacity Analysis
Existing Conditions

Main Street at the MBTA Wilmington Station Driveway, Wilmington

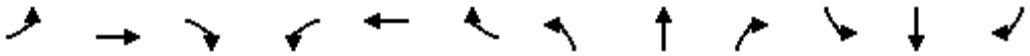


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	37	0	30	0	0	0	15	424	1	1	1038	97
Confl. Peds. (#/hr)			3	3			2					2
Confl. Bikes (#/hr)												
Peak Hour Factor	0.50	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	8%	8%	8%	0%	0%	0%	7%	7%	7%	3%	3%	3%
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 (%)												
Lane Group Flow (vph)	74	0	35	0	0	0	18	500	0	0	1336	0
Turn Type	custom		Over	Perm			pm+pt	NA		Perm	NA	
Protected Phases			5		8		5	2			6	
Permitted Phases	4			8			2			6		
Detector Phase	4		5	8	8		5	2		6	6	
Switch Phase												
Minimum Initial (s)	4.0		5.0	4.0	4.0		5.0	4.0		4.0	4.0	
Minimum Split (s)	22.0		10.0	20.0	20.0		10.0	20.0		22.0	22.0	
Total Split (s)	22.0		16.0	22.0	22.0		16.0	58.0		42.0	42.0	
Total Split (%)	27.5%		20.0%	27.5%	27.5%		20.0%	72.5%		52.5%	52.5%	
Yellow Time (s)	4.0		4.0	4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0		1.0	1.0	1.0		1.0	1.0		1.0	1.0	
Lost Time Adjust (s)	0.0		0.0		0.0		0.0	0.0			0.0	
Total Lost Time (s)	5.0		5.0		5.0		5.0	5.0			5.0	
Lead/Lag			Lead				Lead			Lag	Lag	
Lead-Lag Optimize?			Yes				Yes			Yes	Yes	
Recall Mode	None		None	None	None		None	C-Min		C-Min	C-Min	
Act Effct Green (s)	9.8		6.3				62.1	63.1			56.0	
Actuated g/C Ratio	0.12		0.08				0.78	0.79			0.70	
v/c Ratio	0.49		0.24				0.06	0.38			0.62	
Control Delay	41.9		16.7				4.1	5.1			12.1	
Queue Delay	0.0		0.0				0.0	0.0			0.0	
Total Delay	41.9		16.7				4.1	5.1			12.1	
LOS	D		B				A	A			B	
Approach Delay								5.0			12.1	
Approach LOS								A			B	
Queue Length 50th (ft)	35		0				2	65			202	
Queue Length 95th (ft)	36		24				8	150			352	
Internal Link Dist (ft)		1			57			699			142	
Turn Bay Length (ft)							100					
Base Capacity (vph)	264		222				365	1308			2160	
Starvation Cap Reductn	0		0				0	0			0	
Spillback Cap Reductn	0		0				0	0			0	
Storage Cap Reductn	0		0				0	0			0	
Reduced v/c Ratio	0.28		0.16				0.05	0.38			0.62	

Intersection Summary
Cycle Length: 80

Actuated Cycle Length: 80	
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green, Master Intersection	
Natural Cycle: 65	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.62	
Intersection Signal Delay: 11.5	Intersection LOS: B
Intersection Capacity Utilization 44.3%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 7: Main Street & MBTA Driveway



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	88	0	48	6	1	0	9	714	8	6	750	41
Confl. Peds. (#/hr)			3	3			2					2
Confl. Bikes (#/hr)												
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	1%	1%	1%	0%	0%	0%	1%	1%	1%	1%	1%	1%
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 (%)												
Lane Group Flow (vph)	104	0	56	0	8	0	11	849	0	0	937	0
Turn Type	custom		Over	Perm	NA		pm+pt	NA		Perm	NA	
Protected Phases			5		8		5	2			6	
Permitted Phases	4			8			2			6		
Detector Phase	4		5	8	8		5	2		6	6	
Switch Phase												
Minimum Initial (s)	4.0		5.0	4.0	4.0		5.0	4.0		4.0	4.0	
Minimum Split (s)	22.0		10.0	20.0	20.0		10.0	20.0		22.0	22.0	
Total Split (s)	22.0		16.0	22.0	22.0		16.0	58.0		42.0	42.0	
Total Split (%)	27.5%		20.0%	27.5%	27.5%		20.0%	72.5%		52.5%	52.5%	
Yellow Time (s)	4.0		4.0	4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0		1.0	1.0	1.0		1.0	1.0		1.0	1.0	
Lost Time Adjust (s)	0.0		0.0		0.0		0.0	0.0			0.0	
Total Lost Time (s)	5.0		5.0		5.0		5.0	5.0			5.0	
Lead/Lag			Lead				Lead			Lag	Lag	
Lead-Lag Optimize?			Yes				Yes			Yes	Yes	
Recall Mode	None		None	None	None		None	C-Min		C-Min	C-Min	
Act Effct Green (s)	10.9		6.5		10.7		61.2	62.2			55.0	
Actuated g/C Ratio	0.14		0.08		0.13		0.76	0.78			0.69	
v/c Ratio	0.58		0.33		0.04		0.03	0.62			0.43	
Control Delay	44.2		15.4		27.3		4.0	8.6			9.6	
Queue Delay	0.0		0.0		0.0		0.0	0.0			0.0	
Total Delay	44.2		15.4		27.3		4.0	8.6			9.6	
LOS	D		B		C		A	A			A	
Approach Delay					27.3			8.5			9.6	
Approach LOS					C			A			A	
Queue Length 50th (ft)	50		0		4		1	167			121	
Queue Length 95th (ft)	85		29		13		6	336			209	
Internal Link Dist (ft)		1			57			699			142	
Turn Bay Length (ft)							100					
Base Capacity (vph)	281		253		360		499	1363			2160	
Starvation Cap Reductn	0		0		0		0	0			0	
Spillback Cap Reductn	0		0		0		0	0			0	
Storage Cap Reductn	0		0		0		0	0			0	
Reduced v/c Ratio	0.37		0.22		0.02		0.02	0.62			0.43	

Intersection Summary
Cycle Length: 80

Actuated Cycle Length: 80	
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green, Master Intersection	
Natural Cycle: 60	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.62	
Intersection Signal Delay: 11.2	Intersection LOS: B
Intersection Capacity Utilization 51.6%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 7: Main Street & MBTA Driveway

APPENDIX F

AM/PM Peak-Hour Intersection Capacity Analysis
Alternative 1

Main Street at Burlington Avenue/Church Street, Wilmington

Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	118	345	68	40	968	59	53	194	214	121	224	42
Confl. Peds. (#/hr)	1		6	6		1	5		2	2		5
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	8%	8%	8%	4%	4%	4%	2%	2%	2%	7%	7%	7%
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 (%)												
Lane Group Flow (vph)	128	449	0	0	1159	0	0	269	233	132	289	0
Turn Type	pm+pt	NA		pm+pt	NA		Split	NA	pt+ov	Split	NA	
Protected Phases	5	2		1	6		4	4	4 5	3	3	
Permitted Phases	2			6								
Detector Phase	5	2		1	6		4	4	4 5	3	3	
Switch Phase												
Minimum Initial (s)	5.0	6.0		5.0	6.0		6.0	6.0		5.0	5.0	
Minimum Split (s)	10.0	20.0		10.0	20.0		20.0	20.0		20.0	20.0	
Total Split (s)	20.0	52.0		20.0	52.0		30.0	30.0		31.0	31.0	
Total Split (%)	12.9%	33.5%		12.9%	33.5%		19.4%	19.4%		20.0%	20.0%	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0	
Lost Time Adjust (s)	0.0	0.0			0.0			0.0		0.0	0.0	
Total Lost Time (s)	5.0	5.0			5.0			5.0		5.0	5.0	
Lead/Lag	Lead	Lead		Lag	Lag		Lag	Lag		Lead	Lead	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Recall Mode	None	C-Min		None	C-Min		None	None		None	None	
Act Effct Green (s)	85.7	85.7			70.3			23.9	38.3	26.0	26.0	
Actuated g/C Ratio	0.55	0.55			0.45			0.15	0.25	0.17	0.17	
v/c Ratio	0.68	0.46			0.79			0.92	0.40	0.48	0.97	
Control Delay	39.8	24.1			41.3			99.0	5.9	65.1	107.4	
Queue Delay	0.0	0.0			0.0			0.0	0.0	0.0	0.0	
Total Delay	39.8	24.1			41.3			99.0	5.9	65.1	107.4	
LOS	D	C			D			F	A	E	F	
Approach Delay		27.6			41.3			55.8			94.1	
Approach LOS		C			D			E			F	
Queue Length 50th (ft)	58	247			494			270	0	123	295	
Queue Length 95th (ft)	141	455			#876			#431	52	196	#488	
Internal Link Dist (ft)		226			699			634			791	
Turn Bay Length (ft)	200								225	150		
Base Capacity (vph)	230	979			1472			307	613	274	299	
Starvation Cap Reductn	0	0			0			0	0	0	0	
Spillback Cap Reductn	0	0			0			0	0	0	0	
Storage Cap Reductn	0	0			0			0	0	0	0	
Reduced v/c Ratio	0.56	0.46			0.79			0.88	0.38	0.48	0.97	

Intersection Summary

Cycle Length: 155

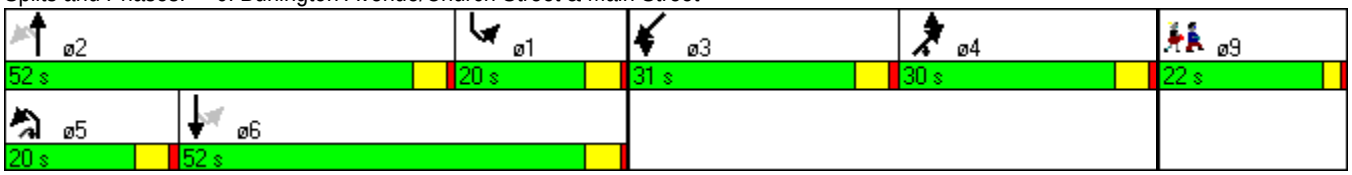
Lane Group	ø9
Lane Configurations	
Volume (vph)	
Confl. Peds. (#/hr)	
Confl. Bikes (#/hr)	
Peak Hour Factor	
Growth Factor	
Heavy Vehicles (%)	
Bus Blockages (#/hr)	
Parking (#/hr)	
Mid-Block Traffic (%)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	7.0
Minimum Split (s)	22.0
Total Split (s)	22.0
Total Split (%)	14%
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	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 155	
Offset: 80 (52%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green	
Natural Cycle: 135	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.97	
Intersection Signal Delay: 49.4	Intersection LOS: D
Intersection Capacity Utilization 96.4%	ICU Level of Service F
Analysis Period (min) 15	

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Burlington Avenue/Church Street & Main Street



Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	80	618	59	72	625	107	65	270	170	92	247	48
Confl. Peds. (#/hr)			1	1		9	9					
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	3%	3%	3%
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 (%)												
Lane Group Flow (vph)	87	736	0	0	873	0	0	364	185	100	320	0
Turn Type	pm+pt	NA		pm+pt	NA		Split	NA	pt+ov	Split	NA	
Protected Phases	5	2		1	6		4	4	4 5	3	3	
Permitted Phases	2			6								
Detector Phase	5	2		1	6		4	4	4 5	3	3	
Switch Phase												
Minimum Initial (s)	5.0	6.0		5.0	6.0		6.0	6.0		5.0	5.0	
Minimum Split (s)	10.0	20.0		10.0	20.0		20.0	20.0		20.0	20.0	
Total Split (s)	22.0	63.0		10.0	51.0		31.0	31.0		29.0	29.0	
Total Split (%)	14.2%	40.6%		6.5%	32.9%		20.0%	20.0%		18.7%	18.7%	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0	
Lost Time Adjust (s)	0.0	0.0			0.0			0.0		0.0	0.0	
Total Lost Time (s)	5.0	5.0			5.0			5.0		5.0	5.0	
Lead/Lag	Lead	Lead		Lag	Lag		Lag	Lag		Lead	Lead	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Recall Mode	None	C-Min		None	C-Min		None	None		None	None	
Act Effct Green (s)	85.6	85.6			72.2			26.0	38.4	24.0	24.0	
Actuated g/C Ratio	0.55	0.55			0.47			0.17	0.25	0.15	0.15	
v/c Ratio	0.32	0.70			0.82			1.13	0.35	0.38	1.11	
Control Delay	21.6	31.2			43.7			145.1	9.0	63.7	143.9	
Queue Delay	0.0	0.0			0.0			0.0	0.0	0.0	0.0	
Total Delay	21.6	31.2			43.7			145.1	9.0	63.7	143.9	
LOS	C	C			D			F	A	E	F	
Approach Delay		30.2			43.7			99.2			124.8	
Approach LOS		C			D			F			F	
Queue Length 50th (ft)	38	490			371			~425	17	92	~369	
Queue Length 95th (ft)	89	#919			#688			#635	62	154	#571	
Internal Link Dist (ft)		226			699			634			791	
Turn Bay Length (ft)	200								225	150		
Base Capacity (vph)	346	1049			1064			323	614	262	288	
Starvation Cap Reductn	0	0			0			0	0	0	0	
Spillback Cap Reductn	0	0			0			0	0	0	0	
Storage Cap Reductn	0	0			0			0	0	0	0	
Reduced v/c Ratio	0.25	0.70			0.82			1.13	0.30	0.38	1.11	

Intersection Summary

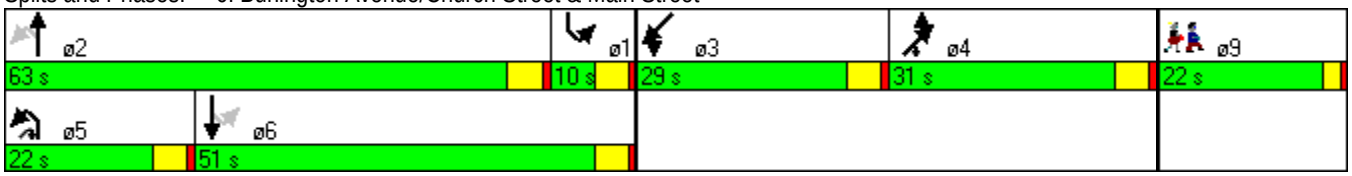
Cycle Length: 155

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 (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	7.0
Minimum Split (s)	22.0
Total Split (s)	22.0
Total Split (%)	14%
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	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 155
Offset: 22 (14%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Natural Cycle: 145
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.13
Intersection Signal Delay: 63.7 Intersection LOS: E
Intersection Capacity Utilization 109.4% ICU Level of Service H
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Burlington Avenue/Church Street & Main Street



APPENDIX G

AM/PM Peak-Hour Intersection Capacity Analysis
Alternative 2

Main Street at Burlington Avenue/Church Street, Wilmington

Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	118	345	68	40	968	59	53	194	214	121	224	42
Confl. Peds. (#/hr)	1		6	6		1	5		2	2		5
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	8%	8%	8%	4%	4%	4%	2%	2%	2%	7%	7%	7%
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 (%)												
Lane Group Flow (vph)	128	449	0	43	1116	0	0	269	233	132	289	0
Turn Type	pm+pt	NA		pm+pt	NA		Split	NA	pt+ov	Split	NA	
Protected Phases	5	2		1	6		4	4	4 5	3	3	
Permitted Phases	2			6								
Detector Phase	5	2		1	6		4	4	4 5	3	3	
Switch Phase												
Minimum Initial (s)	5.0	6.0		5.0	6.0		6.0	6.0		5.0	5.0	
Minimum Split (s)	10.0	20.0		10.0	20.0		20.0	20.0		20.0	20.0	
Total Split (s)	10.0	74.0		10.0	74.0		23.0	23.0		26.0	26.0	
Total Split (%)	6.5%	47.7%		6.5%	47.7%		14.8%	14.8%		16.8%	16.8%	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0		0.0	0.0	
Total Lost Time (s)	5.0	5.0		5.0	5.0			5.0		5.0	5.0	
Lead/Lag	Lead	Lag		Lead	Lag		Lag	Lag		Lead	Lead	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Recall Mode	None	C-Min		None	C-Min		None	None		None	None	
Act Effct Green (s)	95.6	88.1		80.8	75.2			18.0	38.4	21.0	21.0	
Actuated g/C Ratio	0.62	0.57		0.52	0.49			0.12	0.25	0.14	0.14	
v/c Ratio	0.60	0.45		0.10	1.23			1.22	0.40	0.60	1.20	
Control Delay	43.3	22.8		14.5	148.5			186.1	6.8	75.2	176.9	
Queue Delay	0.0	0.0		0.0	74.9			0.0	0.0	0.0	0.0	
Total Delay	43.3	22.8		14.5	223.4			186.1	6.8	75.2	176.9	
LOS	D	C		B	F			F	A	E	F	
Approach Delay		27.3			215.7			102.9			145.0	
Approach LOS		C			F			F			F	
Queue Length 50th (ft)	73	242		15	~1334			~332	0	128	~353	
Queue Length 95th (ft)	#277	443		44	#1735			#521	62	204	#548	
Internal Link Dist (ft)		226			699			634			791	
Turn Bay Length (ft)	200								225	150		
Base Capacity (vph)	215	1006		452	907			221	580	221	241	
Starvation Cap Reductn	0	0		0	109			0	0	0	0	
Spillback Cap Reductn	0	0		0	0			0	0	0	0	
Storage Cap Reductn	0	0		0	0			0	0	0	0	
Reduced v/c Ratio	0.60	0.45		0.10	1.40			1.22	0.40	0.60	1.20	

Intersection Summary

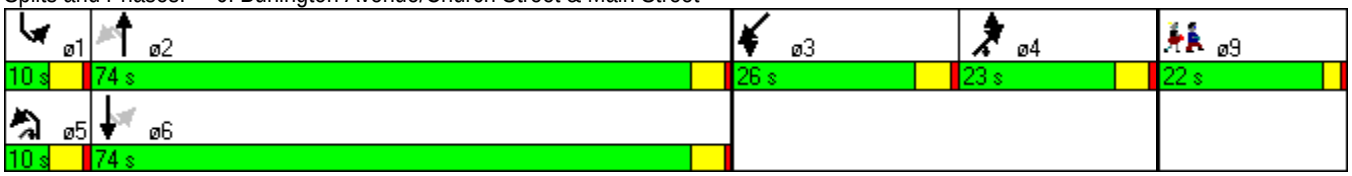
Cycle Length: 155

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 (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	7.0
Minimum Split (s)	22.0
Total Split (s)	22.0
Total Split (%)	14%
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	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 155
Offset: 80 (52%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Natural Cycle: 145
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.23
Intersection Signal Delay: 142.3 Intersection LOS: F
Intersection Capacity Utilization 105.3% ICU Level of Service G
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Burlington Avenue/Church Street & Main Street



Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	80	618	59	72	625	107	65	270	170	92	247	48
Confl. Peds. (#/hr)			1	1		9	9					
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	3%	3%	3%
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 (%)												
Lane Group Flow (vph)	87	736	0	78	795	0	0	364	185	100	320	0
Turn Type	pm+pt	NA		pm+pt	NA		Split	NA	pt+ov	Split	NA	
Protected Phases	5	2		1	6		4	4	4 5	3	3	
Permitted Phases	2			6								
Detector Phase	5	2		1	6		4	4	4 5	3	3	
Switch Phase												
Minimum Initial (s)	5.0	6.0		5.0	6.0		6.0	6.0		5.0	5.0	
Minimum Split (s)	10.0	20.0		10.0	20.0		20.0	20.0		20.0	20.0	
Total Split (s)	20.0	63.0		10.0	53.0		31.0	31.0		29.0	29.0	
Total Split (%)	12.9%	40.6%		6.5%	34.2%		20.0%	20.0%		18.7%	18.7%	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0	
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0		0.0	0.0	
Total Lost Time (s)	5.0	5.0		5.0	5.0			5.0		5.0	5.0	
Lead/Lag	Lead	Lag		Lead	Lag		Lag	Lag		Lead	Lead	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Recall Mode	None	C-Min		None	C-Min		None	None		None	None	
Act Effct Green (s)	81.0	73.1		79.6	72.1			26.0	38.5	24.0	24.0	
Actuated g/C Ratio	0.52	0.47		0.51	0.47			0.17	0.25	0.15	0.15	
v/c Ratio	0.61	0.82		0.48	0.91			1.13	0.35	0.38	1.11	
Control Delay	43.6	44.5		31.8	53.8			145.1	9.4	63.7	143.9	
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0	0.0	0.0	
Total Delay	43.6	44.5		31.8	53.8			145.1	9.4	63.7	143.9	
LOS	D	D		C	D			F	A	E	F	
Approach Delay		44.4			51.9			99.4			124.8	
Approach LOS		D			D			F			F	
Queue Length 50th (ft)	38	602		34	690			~425	19	92	~369	
Queue Length 95th (ft)	107	#1050		#105	#1289			#635	64	154	#571	
Internal Link Dist (ft)		226			699			634			791	
Turn Bay Length (ft)	200								225	150		
Base Capacity (vph)	212	897		163	872			323	593	262	288	
Starvation Cap Reductn	0	0		0	0			0	0	0	0	
Spillback Cap Reductn	0	0		0	0			0	0	0	0	
Storage Cap Reductn	0	0		0	0			0	0	0	0	
Reduced v/c Ratio	0.41	0.82		0.48	0.91			1.13	0.31	0.38	1.11	

Intersection Summary

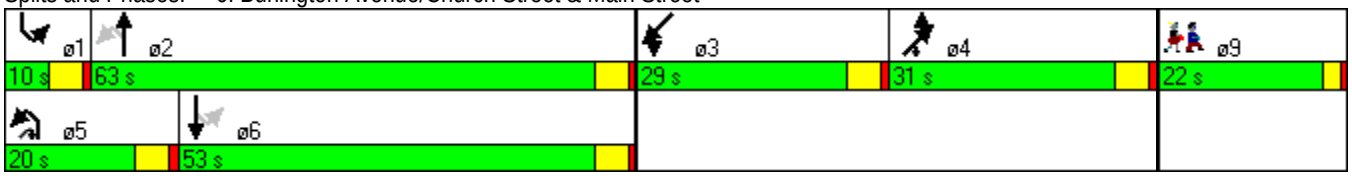
Cycle Length: 155

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 (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	7.0
Minimum Split (s)	22.0
Total Split (s)	22.0
Total Split (%)	14%
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	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 155
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Natural Cycle: 145
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.13
Intersection Signal Delay: 70.8 Intersection LOS: E
Intersection Capacity Utilization 94.3% ICU Level of Service F
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Burlington Avenue/Church Street & Main Street



APPENDIX H

AM/PM Peak-Hour Intersection Capacity Analysis
Alternative 3

Main Street at Burlington Avenue/Church Street, Wilmington

Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	118	345	68	40	968	59	53	194	214	121	224	42
Confl. Peds. (#/hr)	1		6	6		1	5		2	2		5
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	8%	8%	8%	4%	4%	4%	2%	2%	2%	7%	7%	7%
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 (%)												
Lane Group Flow (vph)	128	449	0	0	1159	0	58	444	0	132	289	0
Turn Type	pm+pt	NA		pm+pt	NA		Prot	NA		Prot	NA	
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases	2			6								
Detector Phase	5	2		1	6		7	4		3	8	
Switch Phase												
Minimum Initial (s)	5.0	6.0		5.0	6.0		6.0	6.0		5.0	5.0	
Minimum Split (s)	10.0	20.0		10.0	20.0		20.0	20.0		20.0	20.0	
Total Split (s)	14.0	64.0		10.0	60.0		20.0	39.0		20.0	39.0	
Total Split (%)	9.0%	41.3%		6.5%	38.7%		12.9%	25.2%		12.9%	25.2%	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0	
Lost Time Adjust (s)	0.0	0.0			0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Lead/Lag	Lead	Lead		Lag	Lag		Lead	Lead		Lag	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Recall Mode	None	C-Min		None	C-Min		None	None		None	None	
Act Effct Green (s)	87.3	87.3			70.7		9.6	34.0		14.3	41.0	
Actuated g/C Ratio	0.56	0.56			0.46		0.06	0.22		0.09	0.26	
v/c Ratio	0.65	0.45			0.78		0.53	1.08		0.87	0.61	
Control Delay	35.8	23.0			41.0		87.0	118.0		114.3	58.0	
Queue Delay	0.0	0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay	35.8	23.0			41.0		87.0	118.0		114.3	58.0	
LOS	D	C			D		F	F		F	E	
Approach Delay		25.8			41.0			114.4			75.6	
Approach LOS		C			D			F			E	
Queue Length 50th (ft)	56	239			499		58	~473		134	262	
Queue Length 95th (ft)	#186	444			#784		106	#698		#256	383	
Internal Link Dist (ft)		226			699			634			791	
Turn Bay Length (ft)	200									150		
Base Capacity (vph)	197	996			1479		171	412		158	471	
Starvation Cap Reductn	0	0			0		0	0		0	0	
Spillback Cap Reductn	0	0			0		0	0		0	0	
Storage Cap Reductn	0	0			0		0	0		0	0	
Reduced v/c Ratio	0.65	0.45			0.78		0.34	1.08		0.84	0.61	

Intersection Summary

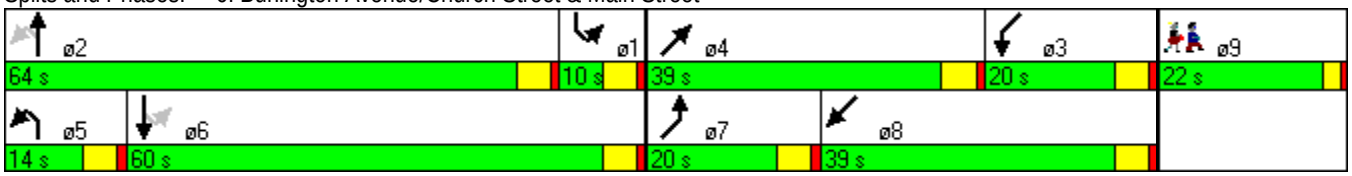
Cycle Length: 155

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 (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	7.0
Minimum Split (s)	22.0
Total Split (s)	22.0
Total Split (%)	14%
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	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 155
Offset: 80 (52%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Natural Cycle: 145
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.08
Intersection Signal Delay: 57.1 Intersection LOS: E
Intersection Capacity Utilization 99.0% ICU Level of Service F
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Burlington Avenue/Church Street & Main Street



Intersection Capacity Analysis
Main St @ Burlington Ave/Church St

8/6/2012

Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	80	618	59	72	625	107	65	270	170	92	247	48
Confl. Peds. (#/hr)			1	1		9	9					
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	3%	3%	3%
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 (%)												
Lane Group Flow (vph)	87	736	0	0	873	0	71	478	0	100	320	0
Turn Type	pm+pt	NA		pm+pt	NA		Prot	NA		Prot	NA	
Protected Phases	5	2		1	6		7	4		3	8	
Permitted Phases	2			6								
Detector Phase	5	2		1	6		7	4		3	8	
Switch Phase												
Minimum Initial (s)	5.0	6.0		5.0	6.0		4.0	6.0		3.0	5.0	
Minimum Split (s)	10.0	20.0		10.0	20.0		8.0	20.0		8.0	20.0	
Total Split (s)	10.0	69.0		10.0	69.0		12.0	40.0		14.0	42.0	
Total Split (%)	6.5%	44.5%		6.5%	44.5%		7.7%	25.8%		9.0%	27.1%	
Yellow Time (s)	4.0	4.0		4.0	4.0		3.5	4.0		4.0	4.0	
All-Red Time (s)	1.0	1.0		1.0	1.0		0.5	1.0		1.0	1.0	
Lost Time Adjust (s)	0.0	0.0			0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)	5.0	5.0			5.0		4.0	5.0		5.0	5.0	
Lead/Lag	Lead	Lead		Lag	Lag		Lag	Lag		Lead	Lead	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Recall Mode	None	C-Min		None	C-Min		None	None		None	None	
Act Effct Green (s)	91.6	91.6			79.9		14.6	35.0		9.0	30.4	
Actuated g/C Ratio	0.59	0.59			0.52		0.09	0.23		0.06	0.20	
v/c Ratio	0.30	0.66			0.71		0.42	1.12		1.02	0.88	
Control Delay	18.6	26.3			33.9		75.5	130.4		165.3	84.5	
Queue Delay	0.0	0.0			0.0		0.0	0.0		0.0	0.0	
Total Delay	18.6	26.3			33.9		75.5	130.4		165.3	84.5	
LOS	B	C			C		E	F		F	F	
Approach Delay		25.5			33.9			123.3			103.7	
Approach LOS		C			C			F			F	
Queue Length 50th (ft)	34	440			330		69	~539		~105	317	
Queue Length 95th (ft)	83	809			#538		#163	#769		#235	417	
Internal Link Dist (ft)		226			699			634			791	
Turn Bay Length (ft)	200									150		
Base Capacity (vph)	290	1122			1233		168	428		98	444	
Starvation Cap Reductn	0	0			0		0	0		0	0	
Spillback Cap Reductn	0	0			0		0	0		0	0	
Storage Cap Reductn	0	0			0		0	0		0	0	
Reduced v/c Ratio	0.30	0.66			0.71		0.42	1.12		1.02	0.72	

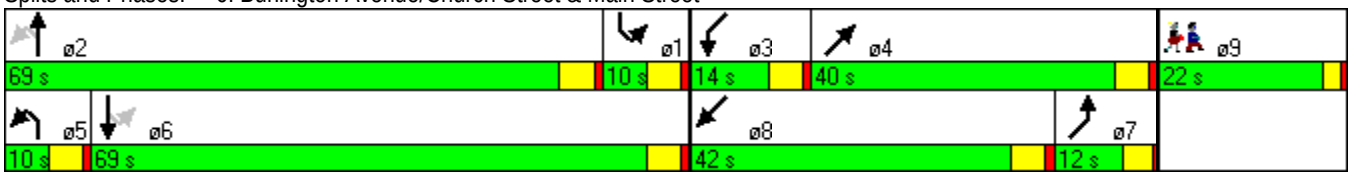
Intersection Summary
Cycle Length: 155

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 (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	7.0
Minimum Split (s)	22.0
Total Split (s)	22.0
Total Split (%)	14%
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	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 155
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Natural Cycle: 150
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.12
Intersection Signal Delay: 60.7 Intersection LOS: E
Intersection Capacity Utilization 105.4% ICU Level of Service G
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Burlington Avenue/Church Street & Main Street



APPENDIX I

AM/PM Peak-Hour Intersection Capacity Analysis
Alternative 4

Main Street at Burlington Avenue/Church Street, Wilmington

Intersection Capacity Analysis
Main St @ Burlington Ave/Church St

8/6/2012

Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	118	345	68	40	968	59	53	194	214	121	224	42
Confl. Peds. (#/hr)	1		6	6		1	5		2	2		5
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	8%	8%	8%	4%	4%	4%	2%	2%	2%	7%	7%	7%
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 (%)												
Lane Group Flow (vph)	128	449	0	0	1159	0	58	211	233	132	289	0
Turn Type	pm+pt	NA		pm+pt	NA		Split	NA	pt+ov	Split	NA	
Protected Phases	5	2		1	6		4	4	4 5	3	3	
Permitted Phases	2			6								
Detector Phase	5	2		1	6		4	4	4 5	3	3	
Switch Phase												
Minimum Initial (s)	5.0	6.0		5.0	6.0		6.0	6.0		5.0	5.0	
Minimum Split (s)	10.0	20.0		10.0	20.0		20.0	20.0		20.0	20.0	
Total Split (s)	20.0	54.0		20.0	54.0		28.0	28.0		31.0	31.0	
Total Split (%)	12.9%	34.8%		12.9%	34.8%		18.1%	18.1%		20.0%	20.0%	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0	
Lost Time Adjust (s)	0.0	0.0			0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Lead/Lag	Lead	Lead		Lag	Lag		Lag	Lag		Lead	Lead	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Recall Mode	None	C-Min		None	C-Min		None	None		None	None	
Act Effct Green (s)	88.7	88.7			73.5		20.9	20.9	35.1	26.0	26.0	
Actuated g/C Ratio	0.57	0.57			0.47		0.13	0.13	0.23	0.17	0.17	
v/c Ratio	0.65	0.44			0.75		0.25	0.87	0.43	0.48	0.97	
Control Delay	34.3	22.4			38.3		62.0	97.2	6.5	65.1	107.4	
Queue Delay	0.0	0.0			0.0		0.0	0.0	0.0	0.0	0.0	
Total Delay	34.3	22.4			38.3		62.0	97.2	6.5	65.1	107.4	
LOS	C	C			D		E	F	A	E	F	
Approach Delay		25.0			38.3			51.0			94.1	
Approach LOS		C			D			D			F	
Queue Length 50th (ft)	56	239			481		53	209	0	123	295	
Queue Length 95th (ft)	131	444			#853		99	#334	53	196	#488	
Internal Link Dist (ft)		226			699			634			791	
Turn Bay Length (ft)	200						75		225	150		
Base Capacity (vph)	242	1013			1538		254	267	577	274	299	
Starvation Cap Reductn	0	0			0		0	0	0	0	0	
Spillback Cap Reductn	0	0			0		0	0	0	0	0	
Storage Cap Reductn	0	0			0		0	0	0	0	0	
Reduced v/c Ratio	0.53	0.44			0.75		0.23	0.79	0.40	0.48	0.97	

Intersection Summary
Cycle Length: 155

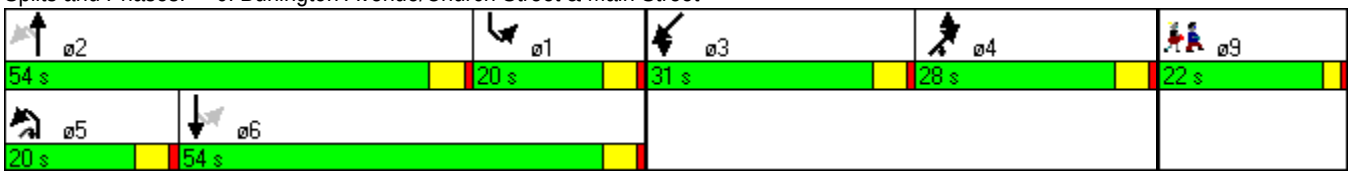
Lane Group	ø9
Lane Configurations	
Volume (vph)	
Confl. Peds. (#/hr)	
Confl. Bikes (#/hr)	
Peak Hour Factor	
Growth Factor	
Heavy Vehicles (%)	
Bus Blockages (#/hr)	
Parking (#/hr)	
Mid-Block Traffic (%)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	7.0
Minimum Split (s)	22.0
Total Split (s)	22.0
Total Split (%)	14%
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	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 155	
Offset: 80 (52%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green	
Natural Cycle: 125	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.97	
Intersection Signal Delay: 46.7	Intersection LOS: D
Intersection Capacity Utilization 88.3%	ICU Level of Service E
Analysis Period (min) 15	

\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 6: Burlington Avenue/Church Street & Main Street



Intersection Capacity Analysis
Main St @ Burlington Ave/Church St

8/6/2012

Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations												
Volume (vph)	80	618	59	72	625	107	65	270	170	92	247	48
Confl. Peds. (#/hr)			1	1		9	9					
Confl. Bikes (#/hr)												
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	3%	3%	3%
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 (%)												
Lane Group Flow (vph)	87	736	0	0	873	0	71	293	185	100	320	0
Turn Type	pm+pt	NA		pm+pt	NA		Split	NA	pt+ov	Split	NA	
Protected Phases	5	2		1	6		4	4	4 5	3	3	
Permitted Phases	2			6								
Detector Phase	5	2		1	6		4	4	4 5	3	3	
Switch Phase												
Minimum Initial (s)	5.0	6.0		5.0	6.0		6.0	6.0		5.0	5.0	
Minimum Split (s)	10.0	20.0		10.0	20.0		20.0	20.0		20.0	20.0	
Total Split (s)	22.0	63.0		10.0	51.0		29.0	29.0		31.0	31.0	
Total Split (%)	14.2%	40.6%		6.5%	32.9%		18.7%	18.7%		20.0%	20.0%	
Yellow Time (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0		1.0	1.0	
Lost Time Adjust (s)	0.0	0.0			0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Lead/Lag	Lead	Lead		Lag	Lag		Lag	Lag		Lead	Lead	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes	Yes	
Recall Mode	None	C-Min		None	C-Min		None	None		None	None	
Act Effct Green (s)	85.6	85.6			72.2		24.0	24.0	36.4	26.0	26.0	
Actuated g/C Ratio	0.55	0.55			0.47		0.15	0.15	0.23	0.17	0.17	
v/c Ratio	0.32	0.70			0.82		0.26	0.97	0.36	0.35	1.03	
Control Delay	21.6	31.2			43.7		60.5	109.6	6.4	61.1	119.3	
Queue Delay	0.0	0.0			0.0		0.0	0.0	0.0	0.0	0.0	
Total Delay	21.6	31.2			43.7		60.5	109.6	6.4	61.1	119.3	
LOS	C	C			D		E	F	A	E	F	
Approach Delay		30.2			43.7			68.5			105.5	
Approach LOS		C			D			E			F	
Queue Length 50th (ft)	38	490			371		64	299	0	91	~344	
Queue Length 95th (ft)	89	#919			#688		116	#494	49	152	#545	
Internal Link Dist (ft)		226			699			634			791	
Turn Bay Length (ft)	200								225	150		
Base Capacity (vph)	346	1049			1064		277	301	596	284	312	
Starvation Cap Reductn	0	0			0		0	0	0	0	0	
Spillback Cap Reductn	0	0			0		0	0	0	0	0	
Storage Cap Reductn	0	0			0		0	0	0	0	0	
Reduced v/c Ratio	0.25	0.70			0.82		0.26	0.97	0.31	0.35	1.03	

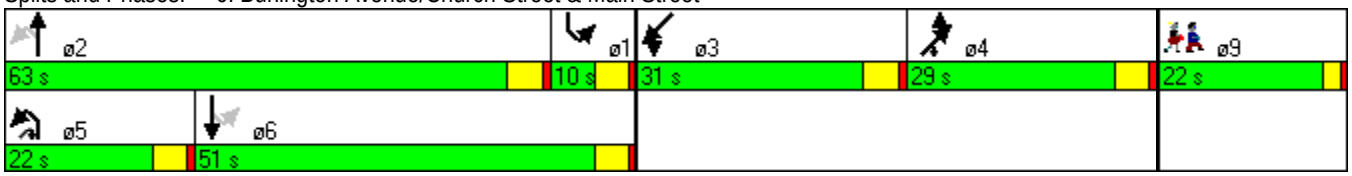
Intersection Summary
Cycle Length: 155

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 (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	7.0
Minimum Split (s)	22.0
Total Split (s)	22.0
Total Split (%)	14%
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	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary

Actuated Cycle Length: 155
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
Natural Cycle: 145
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.03
Intersection Signal Delay: 54.3 Intersection LOS: D
Intersection Capacity Utilization 96.6% ICU Level of Service F
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

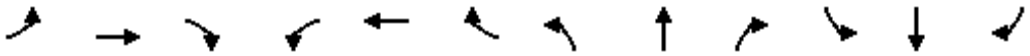
Splits and Phases: 6: Burlington Avenue/Church Street & Main Street



APPENDIX J

AM/PM Peak-Hour Intersection Capacity Analysis
Alternative 1

Main Street at the MBTA Wilmington Station Driveway, Wilmington

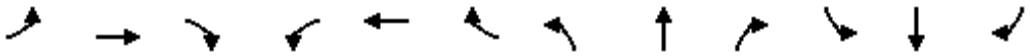


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	37	0	30	0	0	0	15	424	1	1	1038	97
Confl. Peds. (#/hr)			3	3			2					2
Confl. Bikes (#/hr)												
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	1%	1%	1%	0%	0%	0%	1%	1%	1%	1%	1%	1%
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 (%)												
Lane Group Flow (vph)	44	0	35	0	0	0	18	500	0	0	1336	0
Turn Type	custom		Over	Perm			pm+pt	NA		Perm	NA	
Protected Phases			5		8		5	2			6	
Permitted Phases	4			8			2			6		
Detector Phase	4		5	8	8		5	2		6	6	
Switch Phase												
Minimum Initial (s)	4.0		5.0	4.0	4.0		5.0	4.0		4.0	4.0	
Minimum Split (s)	22.0		10.0	20.0	20.0		10.0	20.0		22.0	22.0	
Total Split (s)	22.0		10.0	22.0	22.0		10.0	48.0		38.0	38.0	
Total Split (%)	31.4%		14.3%	31.4%	31.4%		14.3%	68.6%		54.3%	54.3%	
Yellow Time (s)	4.0		4.0	4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0		1.0	1.0	1.0		1.0	1.0		1.0	1.0	
Lost Time Adjust (s)	0.0		0.0		0.0		0.0	0.0			0.0	
Total Lost Time (s)	5.0		5.0		5.0		5.0	5.0			5.0	
Lead/Lag			Lead				Lead			Lag	Lag	
Lead-Lag Optimize?			Yes				Yes			Yes	Yes	
Recall Mode	None		None	None	None		None	C-Min		C-Min	C-Min	
Act Effct Green (s)	8.3		5.6				55.7	57.7			51.2	
Actuated g/C Ratio	0.12		0.08				0.80	0.82			0.73	
v/c Ratio	0.28		0.23				0.06	0.35			0.58	
Control Delay	30.3		15.6				4.2	4.5			11.1	
Queue Delay	0.0		0.0				0.0	0.0			0.0	
Total Delay	30.3		15.6				4.2	4.5			11.1	
LOS	C		B				A	A			B	
Approach Delay								4.5			11.1	
Approach LOS								A			B	
Queue Length 50th (ft)	18		0				1	52			177	
Queue Length 95th (ft)	37		23				9	150			#328	
Internal Link Dist (ft)		1			57			699			142	
Turn Bay Length (ft)							100					
Base Capacity (vph)	323		152				310	1446			2302	
Starvation Cap Reductn	0		0				0	0			0	
Spillback Cap Reductn	0		0				0	0			0	
Storage Cap Reductn	0		0				0	0			0	
Reduced v/c Ratio	0.14		0.23				0.06	0.35			0.58	

Intersection Summary
Cycle Length: 70

Actuated Cycle Length: 70
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green, Master Intersection
Natural Cycle: 65
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.58
Intersection Signal Delay: 9.9 Intersection LOS: A
Intersection Capacity Utilization 44.3% ICU Level of Service A
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 7: Main Street & MBTA Driveway



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	88	0	48	6	1	0	9	714	8	6	750	41
Confl. Peds. (#/hr)			3	3			2					2
Confl. Bikes (#/hr)												
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	1%	1%	1%	0%	0%	0%	1%	1%	1%	1%	1%	1%
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 (%)												
Lane Group Flow (vph)	104	0	56	0	8	0	11	849	0	0	937	0
Turn Type	custom		Over	Perm	NA		pm+pt	NA		Perm	NA	
Protected Phases			5		8		5	2			6	
Permitted Phases	4			8			2			6		
Detector Phase	4		5	8	8		5	2		6	6	
Switch Phase												
Minimum Initial (s)	4.0		5.0	4.0	4.0		5.0	4.0		4.0	4.0	
Minimum Split (s)	22.0		10.0	20.0	20.0		10.0	20.0		22.0	22.0	
Total Split (s)	22.0		10.0	22.0	22.0		10.0	48.0		38.0	38.0	
Total Split (%)	31.4%		14.3%	31.4%	31.4%		14.3%	68.6%		54.3%	54.3%	
Yellow Time (s)	4.0		4.0	4.0	4.0		4.0	4.0		4.0	4.0	
All-Red Time (s)	1.0		1.0	1.0	1.0		1.0	1.0		1.0	1.0	
Lost Time Adjust (s)	0.0		0.0		0.0		0.0	0.0			0.0	
Total Lost Time (s)	5.0		5.0		5.0		5.0	5.0			5.0	
Lead/Lag			Lead				Lead			Lag	Lag	
Lead-Lag Optimize?			Yes				Yes			Yes	Yes	
Recall Mode	None		None	None	None		None	C-Min		C-Min	C-Min	
Act Effct Green (s)	10.3		5.7		10.2		51.7	52.7			46.2	
Actuated g/C Ratio	0.15		0.08		0.15		0.74	0.75			0.66	
v/c Ratio	0.53		0.32		0.03		0.03	0.64			0.45	
Control Delay	36.3		15.2		22.6		4.6	9.9			9.9	
Queue Delay	0.0		0.0		0.0		0.0	0.0			0.0	
Total Delay	36.3		15.2		22.6		4.6	9.9			9.9	
LOS	D		B		C		A	A			A	
Approach Delay					22.6			9.8			9.9	
Approach LOS					C			A			A	
Queue Length 50th (ft)	42		0		3		1	159			118	
Queue Length 95th (ft)	73		28		12		6	352			190	
Internal Link Dist (ft)		1			57			699			142	
Turn Bay Length (ft)							100					
Base Capacity (vph)	321		173		411		409	1318			2075	
Starvation Cap Reductn	0		0		0		0	0			0	
Spillback Cap Reductn	0		0		0		0	0			0	
Storage Cap Reductn	0		0		0		0	0			0	
Reduced v/c Ratio	0.32		0.32		0.02		0.03	0.64			0.45	

Intersection Summary
Cycle Length: 70

Actuated Cycle Length: 70	
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green, Master Intersection	
Natural Cycle: 60	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.64	
Intersection Signal Delay: 11.5	Intersection LOS: B
Intersection Capacity Utilization 51.6%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 7: Main Street & MBTA Driveway