



TOWN OF BROOKLINE

Department of Public Works
333 Washington Street
Brookline, MA 02445-6863

Right Turn On Red Restriction

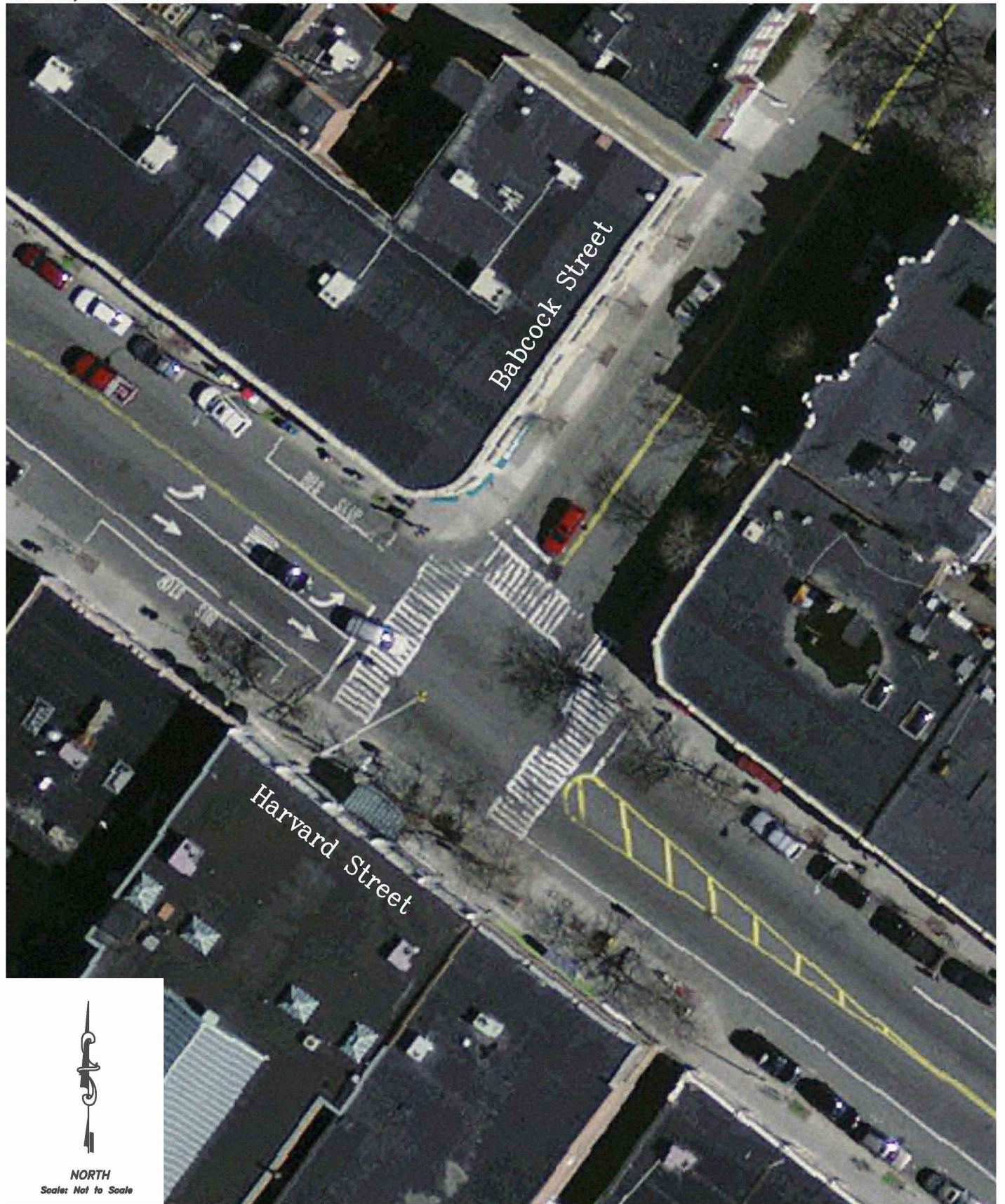
For

Harvard Street at Babcock Street

The purpose of this study is to determine if the existing NO TURN ON RED restriction at the intersection of Harvard Street and Babcock Street is warranted. Currently the restriction is in place for both the right turning movement from Harvard Street northbound onto Babcock Street and Babcock Street westbound onto Harvard Street. The study location can be seen in **Figure 1**. Recommendations will be based on the guidelines found in the latest version of the Manual of Uniform Traffic Control Devices (MUTCD). The MUTCD suggests the following factors should be considered for the implementation of a NO TURN ON RED restriction:

1. Sight distance of vehicles approaching from the Left;
2. Geometric or operational characteristics of the intersection that might result in unexpected conflicts;
3. An exclusive (“Barn Dance”) pedestrian phase;
4. An unacceptable number of pedestrian conflicts with right-turn-on-red maneuvers, especially involving children, older pedestrians, or persons with disabilities;
5. More than three (3) right-turn-on-red accidents reported in a 12 month period for the particular approach.

According to our files the Transportation Board, or its predecessor the Traffic Council, implemented the NO TURN ON RED restriction based on the fact that there was an exclusive “barn dance” pedestrian phase.



BROOKLINE ENGINEERING/TRANSPORTATION DIVISION
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Figure 1

Study Location

SIGHT DISTANCE

The American Association of State and Transportation Officials (AASHTO) standards reference two types of sight distances which are relevant for the intersection at Babcock Street and Harvard Street: stopping sight distance (SSD) and intersection sight distance (ISD). Stopping sight distance pertains to roadway segments (i.e., Harvard Street) and intersection sight distance, as the name implies, relates specifically to intersections. Sight lines for right turning vehicle movements from Babcock Street onto Harvard Street are compared to minimum safe stopping sight distance (SSD) and intersection sight distance (ISD) guidelines for the regulatory speed limit below in **Table 1**. Sight line calculations are provided in the **Appendix**.

Table 1
Sight Distance

<u>Approach /Travel Direction</u>	<u>Available Sight Distance</u>	<u>AASHTO Recommended</u> ¹ <u>Posted Speed</u> <u>(30 mph)</u>
Stopping Sight Distance		
Harvard Street - Northbound	>500'	200'
Intersection Sight Distance - Stop Control		
Babcock Street Looking South	160'	290'

¹Recommended sight distance based on A Policy on Geometric Design of Highways and Streets, AASHTO, 4th edition 2001. Based on driver height of eye of 3.5 feet to object height of 2.0 feet for SSD or 3.5 feet for ISD and adjustments for roadway grade.

The existing stopping sight distance is adequate. However intersection sight distance is deficient for a right turn on red movement. Looking south from Babcock Street Intersection sight triangles are obstructed by parked cars and buildings. The MUTCD recommends no turn on red when there are restricted sight lines.

There are no sight distance requirements for vehicles to take a right on red from Harvard Street on Babcock Street.

INTERSECTION GEOMETRY AND SKEW

Babcock Street meets Harvard Street at 90 degrees to form a T signalized intersection. Currently The Babcock Street approach provides one general purpose travel lane. The Harvard Street Southbound approach provides one through lane and one left turn lane. The Harvard Street Northbound approach provides one general purpose travel lane. The Babcock Street approach provides one wide general purpose lane. In the near future the intersection will be upgraded so that the Harvard Street Northbound approach will provide a through lane and a right turn lane and the Babcock Street westbound approach will provide a left turn lane and right turn a lane. Land use at the intersection is primarily commercial. No Geometric Characteristics would restrict a right turn on red.

PEDESTRIAN CONFLICTS AND SIGNAL OPERATION

Pedestrian activity at the Babcock Street at Harvard Street intersection is very high with a significant portion of children, elderly and disabled. The signal operates with a leading pedestrian interval, in which the pedestrian phase gets a four second advance before vehicles. It is desired to have all cars stopped during that interval. Pedestrian and vehicle counts can be found in the appendix. Using the MUTCD guidelines for right turn on red restrictions, removal of the no right turn on red restriction would not be recommended.

CRASH ANALYSIS

In order to identify accident trends and safety characteristics for the study intersection accident reports were obtained from MassDOT Highway Crash Database for a three-year period covering 2006 through 2008. This data can be found in the **Appendix**. A summary of the crash data for the study intersection is detailed in **Table 2**.

<u>Data Category</u>	<u>Harvard Street at Babcock Street</u>
Year:	
2006	4
2007	5
2008	<u>2</u>
Total	11
Type:	
Angle	0
Rear-End	4
Sidewipe	1
Right-Turn	0
Head-On	1
Pedestrian	5
Unknown/Other	0
Severity:	
P. Damage Only	4
Personal Injury	5
Fatality	0
Unknown/Other	2
Conditions:	
Dry	8
Wet	2
Snow/Ice	0
Other/Unreported	1
Time:	
7:00 AM to 9 AM	1
4:00 AM to 6 PM	2
Rest of Day	8

As summarized in **Table 2**, a total of eleven crashes occurred at the intersection of Babcock Street at Harvard Street for the three-year period studied from 2006 to 2008. None of the reported crashes involved right turning vehicles. However right turn on red maneuvers are currently restricted. The MUTCD warrants a right-turn-on-red restriction if three (3) or more accidents were caused by right turn on red maneuvers within 12 months.

CONCLUSION

The Harvard Street northbound approach to Babcock Street is an area with a very high pedestrian volume, including children and elderly pedestrians from the nearby Devotion School and Senior Housing. The concurrent pedestrian phase includes a 4 second Leading Pedestrian Interval (LPI) allowing pedestrians an opportunity to establish themselves in the crosswalk before vehicles receive a green light during this time it is desired to have all vehicles stopped. Using the MUTCD guidelines 2 & 4 from above the removal of the NO TURN ON RED restriction would not be recommended.

The Babcock Street westbound approach to Harvard Street has restricted sightlines, high pedestrian volume, including children and elderly pedestrians from the nearby Devotion School and Senior Housing. The concurrent pedestrian phase includes a 4 second Leading Pedestrian Interval (LPI) allowing pedestrians an opportunity to establish themselves in the crosswalk before vehicles receive a green light during this time it is desired to have all vehicles stopped. Using the MUTCD guidelines 1, 2, & 4 from above the removal of the NO TURN ON RED restriction would not be recommended.

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Table 2
Accident Summary

<u>Data Category</u>	<u>Harvard Street at Babcock Street</u>
Year:	
2006	4
2007	5
2008	<u>2</u>
Total	11
Type:	
Angle	0
Rear-End	4
Sidewipe	1
Right-Turn	0
Head-On	1
Pedestrian	5
Unknown/Other	0
Severity:	
P. Damage Only	4
Personal Injury	5
Fatality	0
Unknown/Other	2
Conditions:	
Dry	8
Wet	2
Snow/Ice	0
Other/Unreported	1
Time:	
7:00 AM to 9 AM	1
4:00 AM to 6 PM	2
Rest of Day	8

As summarized in **Table 2**, a total of eight crashes occurred at the intersection of Babcock Street at Harvard Street for the three-year period studied from 2006 to 2008. None of the reported crashes involved right turning vehicles. However right turn on red maneuvers are currently restricted. The MUTCD warrants a right-turn-on-red restriction if three (3) or more accidents were caused by right turn on red maneuvers within 12 months.

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Appendix

- Sight Line Calculations
- Traffic & Pedestrian Counts
- Accident Data

- Sight Distance Calculations

Sight Line Calculations

Intersection Sight Distance		Speed		
	<u>Posted</u>	<u>Average</u>	<u>85th</u>	
Stop Control Left Turning	331			
Stop Control Right Turning/Crossing	287			
Yield Control Left Turning	353			
Yield Control Right Turning/Crossing	309			
Stopping Sight Distance		Speed		
	<u>Posted</u>	<u>Average</u>	<u>85th</u>	
Northeast bound Stopping Sight Distance	197			
Southwest bound Stopping Sight Distance	197			

<u>Inputs</u>	North Bound			South Bound		
	Posted	Average	85th	Posted	Average	85th
Speed:	30			30		
Grade:	0			0		

Sight Distance Formulas - Source: AASHTO

$$\text{Intersection Sight Distance} = 1.47 \times V \times t$$

$$\text{Stopping Sight Distance} = (1.47 \times V \times s) + \frac{V^2}{(30 \times ((a/32.2) + (G/100)))}$$

Where:

s = Reaction Time (sec) = 2.5 s

V = Travel Speed (mph)

G = Roadway Grade

a = Deceleration Rate (ft/sec²) = 11.2 ft/s²

- t = Time Gap (sec) =
- Stop Control Left Turning = 7.5 s
 - Stop Control Right Turning = 6.5 s
 - Yield Control Left Turning = 8 s
 - Yield Control Right Turning = 7 s

- Traffic & Pedestrian Counts

N/S: Harvard Street
W: Babcock
Brookline, MA

Brookline Engineering Division
Department of Public Works
333 Washington St, Brookline, MA
617-730-2319

File Name : Harvard-Babcock
Site Code : 00201009
Start Date : 09/01/2009
Page : 1

Groups Printed: Passenger Vehicles - Heavy Vehicles

Start Time	Harvard Street Southbound				Babcock Street Westbound					Harvard Street Northbound				Int. Total
	Left	Throug h	Peds	App. Total	Left	Throug h	Right	Peds	App. Total	Throug h	Right	Peds	App. Total	
Factor	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0		
07:00 AM	15	72	3	90	18	0	13	21	52	88	14	3	105	247
07:15 AM	9	80	5	94	16	0	16	17	49	92	13	5	110	253
07:30 AM	12	83	2	97	18	0	15	34	67	93	10	1	104	268
07:45 AM	13	94	6	113	16	0	11	39	66	112	10	9	131	310
Total	49	329	16	394	68	0	55	111	234	385	47	18	450	1078
08:00 AM	16	91	5	112	16	0	11	35	62	124	19	3	146	320
08:15 AM	30	93	10	133	22	0	20	30	72	97	17	5	119	324
08:30 AM	23	104	14	141	22	0	12	48	82	124	11	12	147	370
08:45 AM	28	91	24	143	32	0	16	56	104	121	19	18	158	405
Total	97	379	53	529	92	0	59	169	320	466	66	38	570	1419
09:00 AM	20	107	21	148	28	0	16	41	85	127	12	8	147	380
09:15 AM	21	79	12	112	25	0	12	39	76	107	20	9	136	324
09:30 AM	15	83	12	110	15	0	15	63	93	135	19	17	171	374
09:45 AM	21	91	21	133	33	0	14	63	110	122	14	11	147	390
Total	77	360	66	503	101	0	57	206	364	491	65	45	601	1468
10:00 AM	21	78	19	118	22	1	21	63	107	120	20	31	171	396
10:15 AM	26	83	16	125	19	0	14	90	123	111	12	18	141	389
10:30 AM	23	127	25	175	26	0	25	91	142	119	21	26	166	483
10:45 AM	19	92	48	159	29	0	22	68	119	103	10	21	134	412
Total	89	380	108	577	96	1	82	312	491	453	63	96	612	1680
11:00 AM	21	111	33	165	33	0	23	86	142	113	21	13	147	454
11:15 AM	29	96	32	157	25	0	15	93	133	117	16	30	163	453
11:30 AM	21	92	28	141	25	0	33	98	156	88	15	41	144	441
11:45 AM	36	115	31	182	28	0	30	125	183	111	9	28	148	513
Total	107	414	124	645	111	0	101	402	614	429	61	112	602	1861
12:00 PM	12	104	25	141	26	0	42	117	185	84	20	69	173	499
12:15 PM	43	118	28	189	36	0	43	130	209	112	14	64	190	588
12:30 PM	31	115	51	197	30	0	34	152	216	132	7	65	204	617
12:45 PM	36	101	53	190	39	0	32	130	201	92	20	52	164	555
Total	122	438	157	717	131	0	151	529	811	420	61	250	731	2259
01:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:00 PM	26	123	32	181	29	0	33	0	62	89	13	55	157	400
03:15 PM	25	108	20	153	34	0	34	0	68	98	14	41	153	374
03:30 PM	25	109	29	163	27	0	36	0	63	106	16	31	153	379
03:45 PM	22	110	41	173	21	0	25	0	46	104	20	45	169	388
Total	98	450	122	670	111	0	128	0	239	397	63	172	632	1541
04:00 PM	25	99	22	146	35	0	32	0	67	132	11	32	175	388
04:15 PM	29	113	23	165	28	0	31	0	59	141	12	44	197	421
04:30 PM	19	99	29	147	31	0	40	0	71	123	8	51	182	400
04:45 PM	29	111	19	159	40	0	39	0	79	117	10	48	175	413
Total	102	422	93	617	134	0	142	0	276	513	41	175	729	1622

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File Name : Harvard-Babcock
 Site Code : 00201009
 Start Date : 09/01/2009
 Page : 2

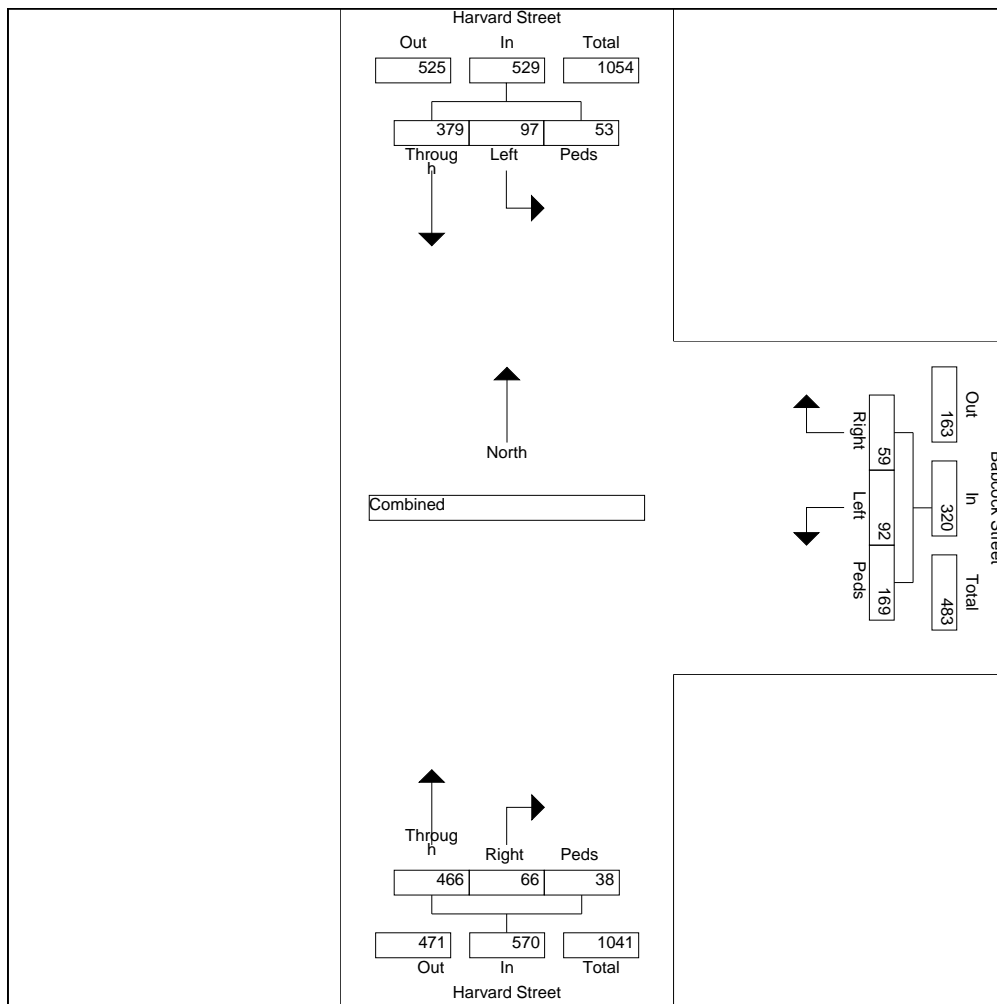
Groups Printed: Passenger Vehicles - Heavy Vehicles

Start Time	Harvard Street Southbound				Babcock Street Westbound					Harvard Street Northbound				Int. Total
	Left	Throug h	Peds	App. Total	Left	Throug h	Right	Peds	App. Total	Throug h	Right	Peds	App. Total	
Factor	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0		
05:00 PM	20	94	22	136	39	0	37	0	76	134	12	41	187	399
05:15 PM	28	88	18	134	46	0	63	0	109	120	14	40	174	417
05:30 PM	15	94	11	120	38	0	34	0	72	131	21	44	196	388
05:45 PM	20	101	30	151	38	0	42	0	80	125	12	52	189	420
Total	83	377	81	541	161	0	176	0	337	510	59	177	746	1624
06:00 PM	25	115	18	158	41	0	43	0	84	138	18	34	190	432
06:15 PM	25	123	22	170	33	0	50	0	83	125	14	42	181	434
06:30 PM	20	99	30	149	28	0	32	0	60	149	12	41	202	411
06:45 PM	32	106	28	166	41	0	41	0	82	137	16	40	193	441
Total	102	443	98	643	143	0	166	0	309	549	60	157	766	1718
07:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grand Total	926	3992	918	5836	1148	1	1117	1729	3995	4613	586	1240	6439	16270
Apprch %	15.9	68.4	15.7		28.7	0.0	28.0	43.3		71.6	9.1	19.3		
Total %	5.7	24.5	5.6	35.9	7.1	0.0	6.9	10.6	24.6	28.4	3.6	7.6	39.6	

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File Name : Harvard-Babcock
 Site Code : 00201009
 Start Date : 09/01/2009
 Page : 3

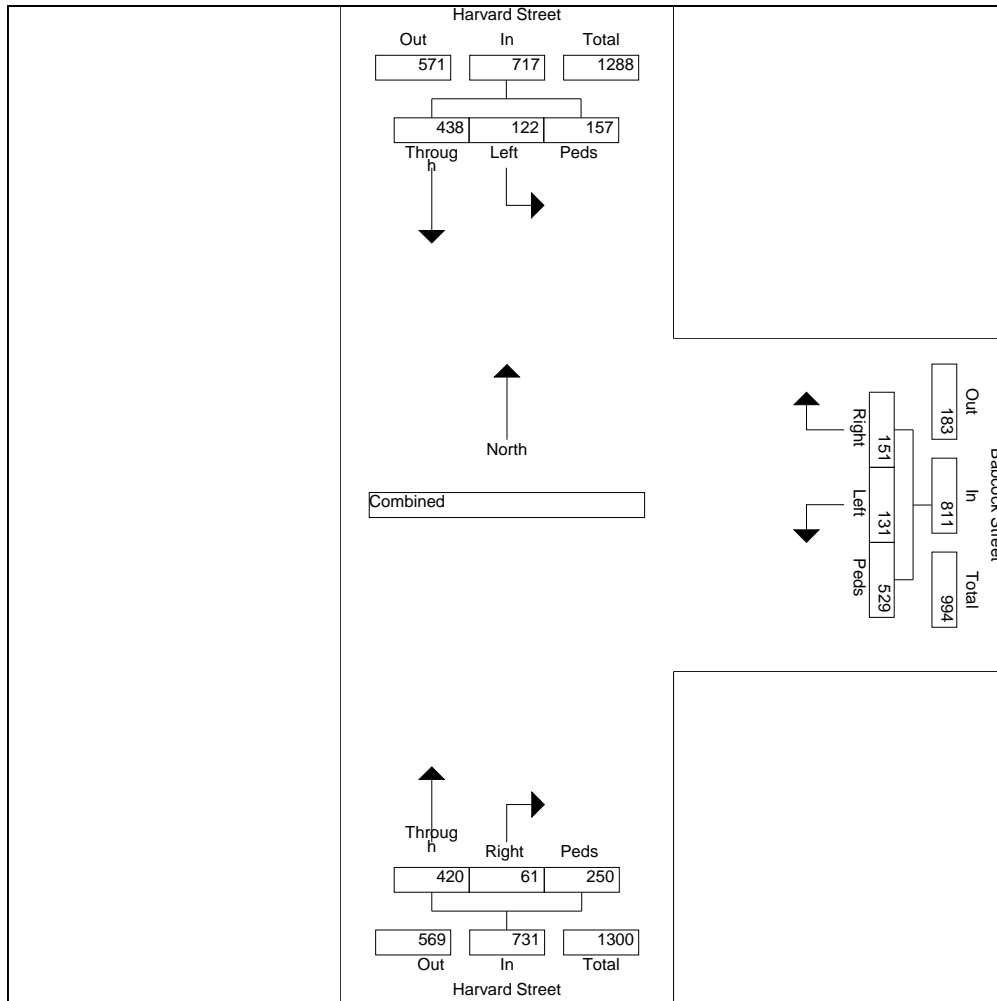
Start Time	Harvard Street Southbound				Babcock Street Westbound					Harvard Street Northbound				Int. Total
	Left	Throug h	Peds	App. Total	Left	Throug h	Right	Peds	App. Total	Throug h	Right	Peds	App. Total	
Peak Hour From 07:00 AM to 08:45 AM - Peak 1 of 1														
Intersection 08:00 AM	97	379	53	529	92	0	59	169	320	466	66	38	570	1419
Volume	18.3	71.6	10.0		28.8	0.0	18.4	52.8		81.8	11.6	6.7		
Percent														
High Int. 08:45 AM	30	104	24	143	32	0	20	56	104	124	19	18	158	405
Volume														
Peak Factor	0.925				0.769					0.902				0.876



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File Name : Harvard-Babcock
 Site Code : 00201009
 Start Date : 09/01/2009
 Page : 4

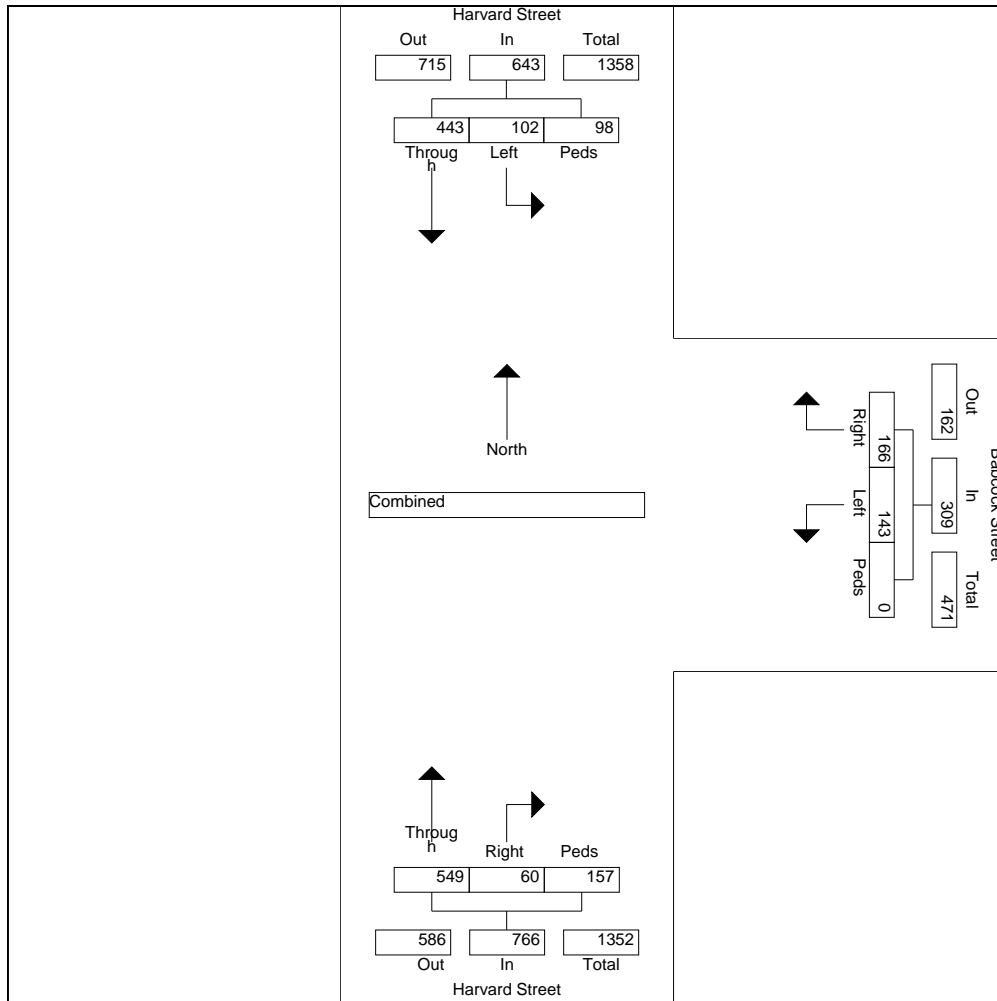
Start Time	Harvard Street Southbound				Babcock Street Westbound					Harvard Street Northbound				Int. Total
	Left	Throug h	Peds	App. Total	Left	Throug h	Right	Peds	App. Total	Throug h	Right	Peds	App. Total	
Peak Hour From 11:00 AM to 12:45 PM - Peak 1 of 1														
Intersection 12:00 PM														
Volume	122	438	157	717	131	0	151	529	811	420	61	250	731	2259
Percent	17.0	61.1	21.9		16.2	0.0	18.6	65.2		57.5	8.3	34.2		
High Int. 12:30 PM														12:30
Volume	43	118	53	197	39	0	43	152	216	132	20	69	204	617
Peak Factor				0.910					0.939				0.896	0.915



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 333 Washington St, Brookline, MA
 617-730-2319

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 Site Code : 00201009
 Start Date : 09/01/2009
 Page : 5

Start Time	Harvard Street Southbound				Babcock Street Westbound					Harvard Street Northbound				Int. Total
	Left	Throug h	Peds	App. Total	Left	Throug h	Right	Peds	App. Total	Throug h	Right	Peds	App. Total	
Peak Hour From 04:00 PM to 06:45 PM - Peak 1 of 1														
Intersection 06:00 PM														
Volume	102	443	98	643	143	0	166	0	309	549	60	157	766	1718
Percent	15.9	68.9	15.2		46.3	0.0	53.7	0.0		71.7	7.8	20.5		
High Int. 06:15 PM														
Volume	32	123	30	170	41	0	50	0	84	149	18	42	202	441
Peak Factor				0.946				0.920				0.948	0.974	



- Accident Data

**MassHighway Crash Report for Brookline in the year 2006**

Crash Number	City/Town Name	Crash Date	Crash Time	Crash Severity	Number of Vehicles	Total Nonfatal Injuries	Total Fatal Injuries	Manner of Collision	Vehicles Travel Directions	Most Harmful Events	Road Surface Condition	Ambient Light	Weather Condition	At Roadway Intersection	Distance from Nearest Roadway Intersection	Distance from Nearest Milemarker	Distance from Nearest Exit	Distance from Nearest Landmark	Non Motorist Type
2055070	BROOKLINE	23-Feb-2006	11:20 AM	Non-fatal injury Property damage only (none injured)	2	1	0	Rear-end	V1:Southbound / V2:Southbound	V1: Not reported / V2: Not reported	Dry	Daylight	Cloudy	HARVARD STREET / BABCOCK STREET					
2022424	BROOKLINE	05-Apr-2006	00:00 AM	Not Reported	1	0	0	Rear-to-rear	V1:Southbound	V1: Collision with highway traffic sign post	Dry	Dark - unknown roadway lighting	Clear/Clear	BABCOCK STREET / HARVARD STREET					
2101931	BROOKLINE	20-Oct-2006	11:20 AM	Not Reported	1	0	0	Not reported	V1:Southbound	V1: Collision with motor vehicle in traffic	Not reported	Not reported	Not Reported	HARVARD STREET / BABCOCK STREET					P2:Pedestrian
2113361	BROOKLINE	16-Nov-2006	9:50 AM	Non-fatal injury	2	2	0	Head-on	V1:Northbound / V2:Southbound	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic	Wet	Daylight	Rain/Rain	HARVARD STREET / BABCOCK STREET	318 HARVARD STREET				

**MassHighway Crash Report for Brookline in the year 2007**

Crash Number	City/Town Name	Crash Date	Crash Time	Crash Severity	Number of Vehicles	Total Nonfatal Injuries	Total Fatal Injuries	Manner of Collision	Vehicle Action Prior to Crash	Vehicle Travel Directions	Most Harmful Events	Vehicle Configuration	Road Surface Condition	Ambient Light	Weather Condition	At Roadway Intersection	Distance from Nearest Roadway Intersection	Distance from Nearest Milemarker	Distance from Nearest Exit	Distance from Nearest Landmark	Non Motorist Type
2307515	BROOKLINE	13-Apr-2007	1:35 AM	Property damage only (none injured)	2	0	0	Sideswipe, same direction	V1: Slowing or stopped in traffic / V2: Overtaking/passing	V1: Southbound / V2: Southbound	V1: Not reported / V2: Not reported	V1: Light truck/van, mini-van, panel, pickup, sport utility with only four tires / V2: Passenger car	Dry	Daylight	Clear	HARVARD STREET / BABCOCK STREET					
2190275	BROOKLINE	21-May-2007	7:10 AM	Non-fatal injury	1	1	0	Single vehicle crash	V1: Turning left	V1: Southbound	V1: Collision with pedestrian	V1: Passenger car	Dry	Daylight	Clear/Clear	HARVARD STREET / BABCOCK STREET					P2: Pedestrian
2197574	BROOKLINE	10-Jun-2007	6:50 PM	Property damage only (none injured)	1	0	0	Angle	V1: Entering traffic lane	V1: Northbound	V1: Not reported	V1: Passenger car	Dry	Daylight	Clear/Clear		305 HARVARD STREET / BABCOCK STREET				P2: Pedalcyclist (bicycle, tricycle, unicycle, pedal car)
2253909	BROOKLINE	12-Nov-2007	9:15 PM	Non-fatal injury	1	2	0	Single vehicle crash	V1: Travelling straight ahead	V1: Northbound	V1: Collision with pedestrian	V1: Passenger car	Dry	Dark - lighted roadway	Cloudy	HARVARD STREET / BABCOCK STREET					P4: Pedestrian
2386017	BROOKLINE	28-Dec-2007	5:25 PM	Not Reported	2	0	0	Rear-end	V1: Slowing or stopped in traffic / V2: Slowing or stopped in traffic	V1: Southbound / V2: Southbound	V1: Not reported / V2: Not reported	V1: Light truck/van, mini-van, panel, pickup, sport utility with only four tires / V2: Passenger car	Dry	Dusk	Clear		299 HARVARD STREET / BABCOCK STREET				

**MassHighway Crash Report for Brookline in the year 2008**

Crash Number	City/Town Name	Crash Date	Crash Time	Crash Severity	Number of Vehicles	Total Nonfatal Injuries	Total Fatal Injuries	Manner of Collision	Vehicle Action Prior to Crash	Vehicle Travel Directions	Most Harmful Events	Vehicle Configuration	Road Surface Condition	Ambient Light	Weather Condition	At Roadway Intersection	Distance from Nearest Roadway Intersection	Distance from Nearest Milemarker	Distance from Nearest Exit	Distance from Nearest Landmark	Non Motorist Type
2291648	BROOKLINE	24-Feb-2008	4:00 PM	Property damage only (none injured)	1	0	0	Single vehicle crash	V1: Turning right	V1: Northbound	V1: Collision with pedestrian	V1: Passenger car	Dry	Daylight	Clear	BABCOCK STREET / HARVARD STREET					P3:Pedestrian
2372638	BROOKLINE	06-Sep-2008	10:45 PM	Non-fatal injury	2	1	0	Rear-end	V1: Travelling straight ahead / V2:Slowing or stopped in traffic	V1:Southbound / V2:Southbound	V1: Collision with motor vehicle in traffic / V2: Collision with motor vehicle in traffic	V1: Passenger car / V2:Passenger car	Wet	Dark - lighted roadway	Rain	HARVARD STREET / BABCOCK STREET					