

Old Colony Planning Council



Robert G. Moran, Jr.
President

70 School Street
Brockton, MA 02301-4097

Pasquale Ciaramella
Executive Director

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June 7, 2011

Mr. Sid Kaski, P.E., MPS
Plymouth Department of Public Works – Engineering Division
11 Lincoln Street
Plymouth, MA 02360

Re: Plympton Road (Route 80) at Carver Road

Dear Mr. Kashi,,

Per a request received from Mr. James Downey in your office, the Old Colony Planning Council has conducted alternatives analysis for the intersection of Plympton Road (Route 80) at Carver Road, as a follow-up to a 2009 Local Highway Planning Technical Assistance Study completed for this intersection. Alternatives tested for this intersection included changing the Carver Road eastbound lane configuration from the existing two shared lanes to one shared through and right turn lane (right turn for a private driveway on the south side of the intersection) and one exclusive left turn lane. The proposed change in lane configuration was tested with left turn on protected arrow only phasing, and a lead/lag phase allowing split protected and permitted left turns from the eastbound direction.

Table 1 summarizes the results of the analysis conducted for these alternatives. The analysis indicates that reconfiguration of the eastbound approach lanes and signal phasing without adding capacity to the intersection could result in significant impacts on level of service for the forecast year of 2016.

Table 1: Existing and Forecast LOS

	2011 Existing Conditions		Forecast 2016 - No Changes		Forecast 2016 - Eastbound LT Lane With LT Lead Phase		Forecast 2016 - Eastbound LT Lane With Protected LT (Left On Arrow Only)	
	Avg. Delay Per Vehicle	LOS	Avg. Delay Per Vehicle	LOS	Avg. Delay Per Vehicle	LOS	Avg. Delay Per Vehicle	LOS
Carver Road AM Peak LOS	7.9 seconds	A	11.9 seconds	B	7.8 seconds	A	5.4 seconds	A
Eastbound PM Peak LOS	21.2 seconds	C	24.2 seconds	C	14.5 seconds	B	13.6 seconds	B
Carver Road AM Peak LOS	N/A		N/A		16.7 seconds	B	32.6 seconds	C
Eastbound - LT Lane PM Peak LOS	N/A		N/A		31.2 seconds	C	83.3 seconds	F
Carver Road AM Peak LOS	5.4 seconds	A	7.0 seconds	A	12.5 seconds	B	12.9 seconds	B
Westbound PM Peak LOS	16.1 seconds	B	17.7 seconds	B	31.9 seconds	C	40.8 seconds	D
Plympton Road AM Peak LOS	19.1 seconds	B	16.1 seconds	B	13.4 seconds	B	31.1 seconds	C
Southbound PM Peak LOS	21.3 seconds	C	24.7 seconds	C	32.0 seconds	C	40.5 seconds	D
<i>Intersection AM Peak LOS</i>	<i>9.1 seconds</i>	<i>A</i>	<i>10.6 seconds</i>	<i>B</i>	<i>12.2 seconds</i>	<i>B</i>	<i>17.5 seconds</i>	<i>B</i>
<i>Total PM Peak LOS</i>	<i>19.0 seconds</i>	<i>B</i>	<i>21.5 seconds</i>	<i>C</i>	<i>28.5 seconds</i>	<i>C</i>	<i>38.1 seconds</i>	<i>D</i>

Additionally, we reviewed the crash data for the intersection, as reported in the MassDOT Registry of Motor Vehicles Database for the years 2007 through 2009. There are 13 records of reported crashes in that time period. Based on this data, the calculated crash rate for the intersection is 0.45 crashes per million entering vehicles (MEV), which is below the MassDOT District 5 regional average of 0.77 crashes for signalized intersections. Five of the crashes (38.46%) involved personal injury. There were no reported fatalities during the time period.

Table 2 summarizes the 2007-2009 crash data. The data indicates that each of the three angled collisions and one head-on collision may have been the result of a left turning vehicle from the eastbound direction colliding with a vehicle arriving from the westbound direction.

Table 2: Crashes at Plympton Road (Route 80) and Carver Road, 2007-2009

Analysis of Three Year Crash History (2007-2009)						
Total # Crashes:	13			Average Per Year:	4.33	
Type of Collision	3-Year Total	% of Total	Time Of Crash	3-Year Total	% of Total	
Rear-End Collisions	5	38.46%	12:00-6:00 AM	3	23.08%	
Single Vehicle	4	30.77%	6:00 AM-12:00 PM	2	15.38%	
Angled Collisions	3	23.08%	12:00-6:00 PM	6	46.15%	
Head-On Collisions	1	7.69%	6:00 PM-12:00 AM	2	15.38%	
			Morning Peak (7:00-9:00)	1	7.69%	
			Afternoon Peak (4:00-6:00)	3	23.08%	
Crashes With Injury:	5		Crash Rate (2007-2009):	0.45		
% With Injury:	38.46%		2010 MassHighway District 5 Average:	0.77		

Old Colony Planning Council recommends continued monitoring of this facility, particularly as development of the Sysco facility on Spring Street in Plympton and any future development on Commerce Way progress. As Plympton Road (Route 80) is a State owned and maintained facility, the Town of Plymouth should work closely with

MassDOT Highway Division – District Five regarding planning reconfiguration of this intersection.

Should you have any questions regarding this analysis or require further assistance, please contact Bill McNulty at wmcnulty@ocpcrpa.org or at (508) 583-1833 x207.

Sincerely,



Charles Kilmer
Transportation Program Manager

Cc:

Mr. William Hallisey, Jr., Chairman Plymouth Board of Selectmen
Mr. Jonathan Beder, Director, Plymouth Department of Public Works
Chief Michael Botieri, Plymouth Police Department
Mr. James Downey, Plymouth Department of Public Works – Engineering Division
Mr. Lee Hartmann, AICP, Plymouth Director of Planning and Development
Ms. Pamela Haznar, P.E., Project Development Engineer, MassDOT District 5
Mr. Paul Maloney, P.E., Transportation Planning Engineer, FHWA
Mr. Andrew Lehmann, MPO Liaison, MassDOT Office of Transportation Planning

Enclosures:

2009 AM and PM Turning Movement Counts
2011 Existing Conditions AM and PM Peak Hour LOS
2016 Forecast AM and PM LOS – No Changes
2016 Forecast AM and PM LOS – Eastbound LT Lane with Lead/Lag Phasing
2016 Forecast AM and PM LOS – Eastbound LT Lane with Protected Left Turn
Crash Rate – Plympton Road (Route 80) at Carver Road

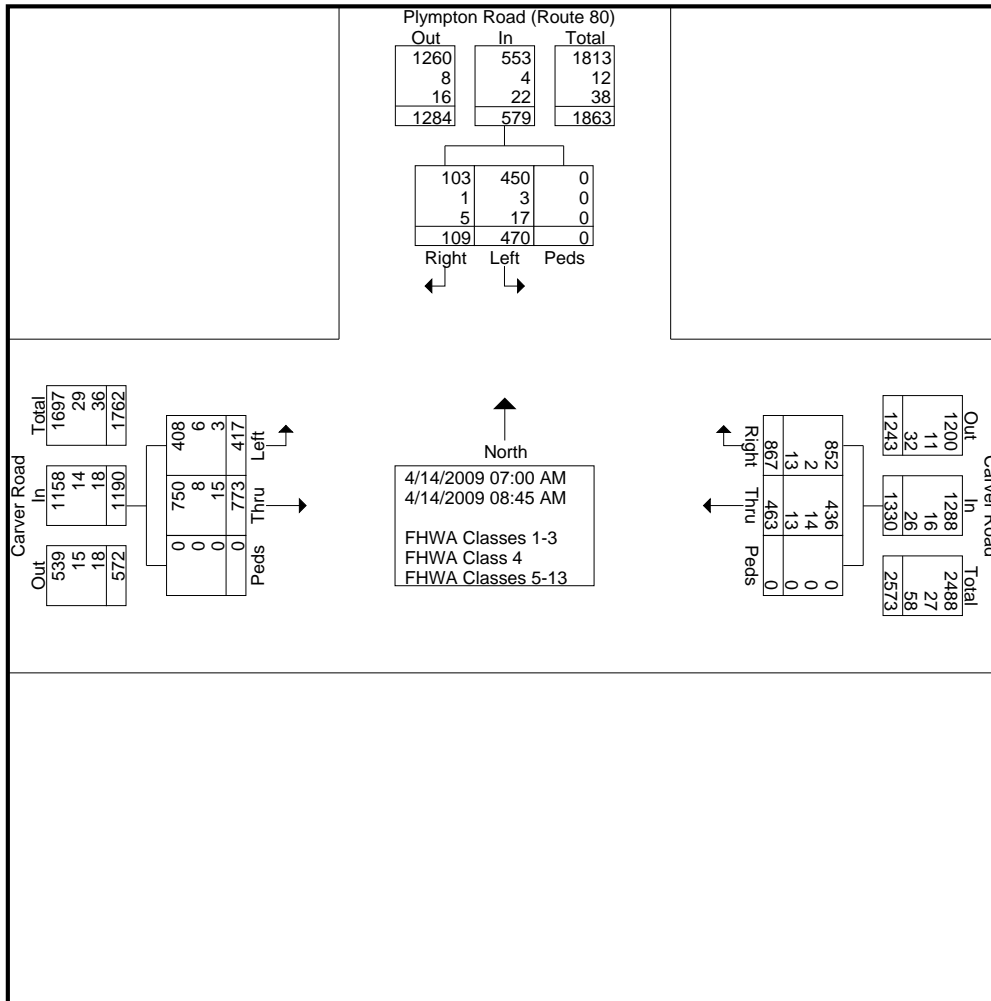
**Old Colony Planning Council
70 School Street
Brockton, MA 02301
508-583-1833**

Community: Plymouth
Weather: Clear
Board #: DB-400 (6)
Staff: BH

File Name : 239_Plympton(80)&Carver_AM
Site Code : 239
Start Date : 4/14/2009
Page No : 1

Groups Printed- 3 - FHWA Class 4 - 13

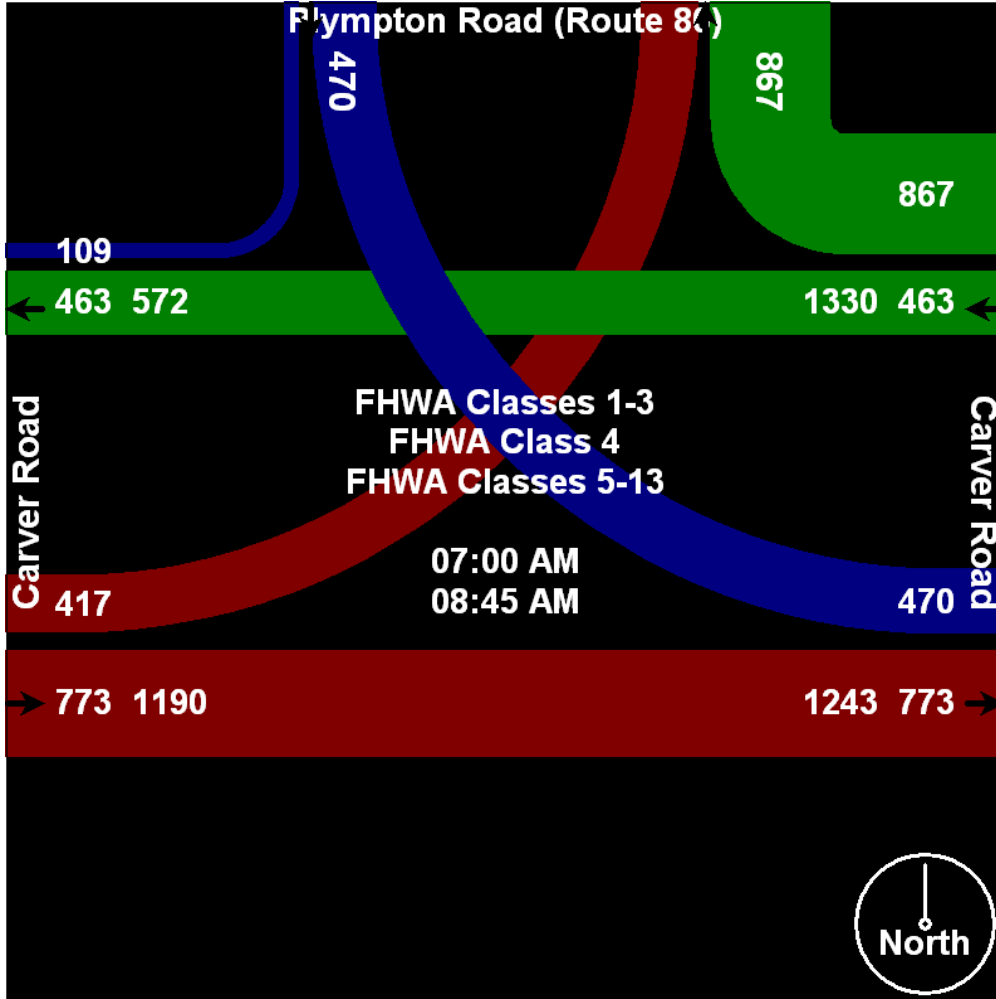
Start Time Factor	Plympton Road (Route 80) Southbound				Carver Road Westbound				Carver Road Eastbound				Int. Total
	Left	Right	Peds	App. Total	Thru	Right	Peds	App. Total	Left	Thru	Peds	App. Total	
07:00 AM	36	15	0	51	39	73	0	112	40	107	0	147	310
07:15 AM	47	8	0	55	39	98	0	137	48	99	0	147	339
07:30 AM	53	9	0	62	60	145	0	205	68	76	0	144	411
07:45 AM	77	18	0	95	42	153	0	195	67	107	0	174	464
Total	213	50	0	263	180	469	0	649	223	389	0	612	1524
08:00 AM	71	11	0	82	60	97	0	157	40	98	0	138	377
08:15 AM	47	13	0	60	64	89	0	153	41	83	0	124	337
08:30 AM	64	12	0	76	72	101	0	173	57	102	0	159	408
08:45 AM	75	23	0	98	87	111	0	198	56	101	0	157	453
Total	257	59	0	316	283	398	0	681	194	384	0	578	1575
Grand Total	470	109	0	579	463	867	0	1330	417	773	0	1190	3099
Apprch %	81.2	18.8	0		34.8	65.2	0		35	65	0		
Total %	15.2	3.5	0	18.7	14.9	28	0	42.9	13.5	24.9	0	38.4	
FHWA Classes 1-3	450	103	0	553	436	852	0	1288	408	750	0	1158	2999
% FHWA Classes 1-3	95.7	94.5	0	95.5	94.2	98.3	0	96.8	97.8	97	0	97.3	96.8
FHWA Class 4	3	1	0	4	14	2	0	16	6	8	0	14	34
% FHWA Class 4	0.6	0.9	0	0.7	3	0.2	0	1.2	1.4	1	0	1.2	1.1
FHWA Classes 5-13	17	5	0	22	13	13	0	26	3	15	0	18	66
% FHWA Classes 5-13	3.6	4.6	0	3.8	2.8	1.5	0	2	0.7	1.9	0	1.5	2.1



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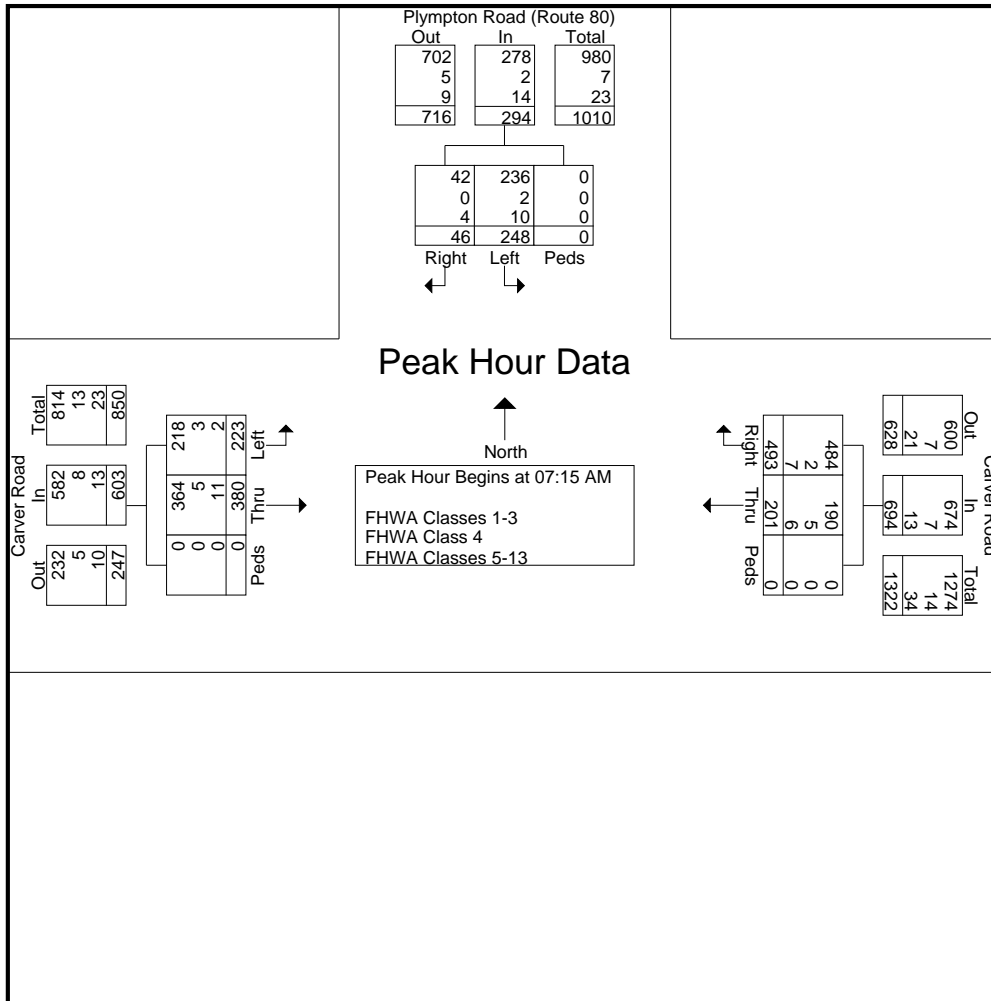


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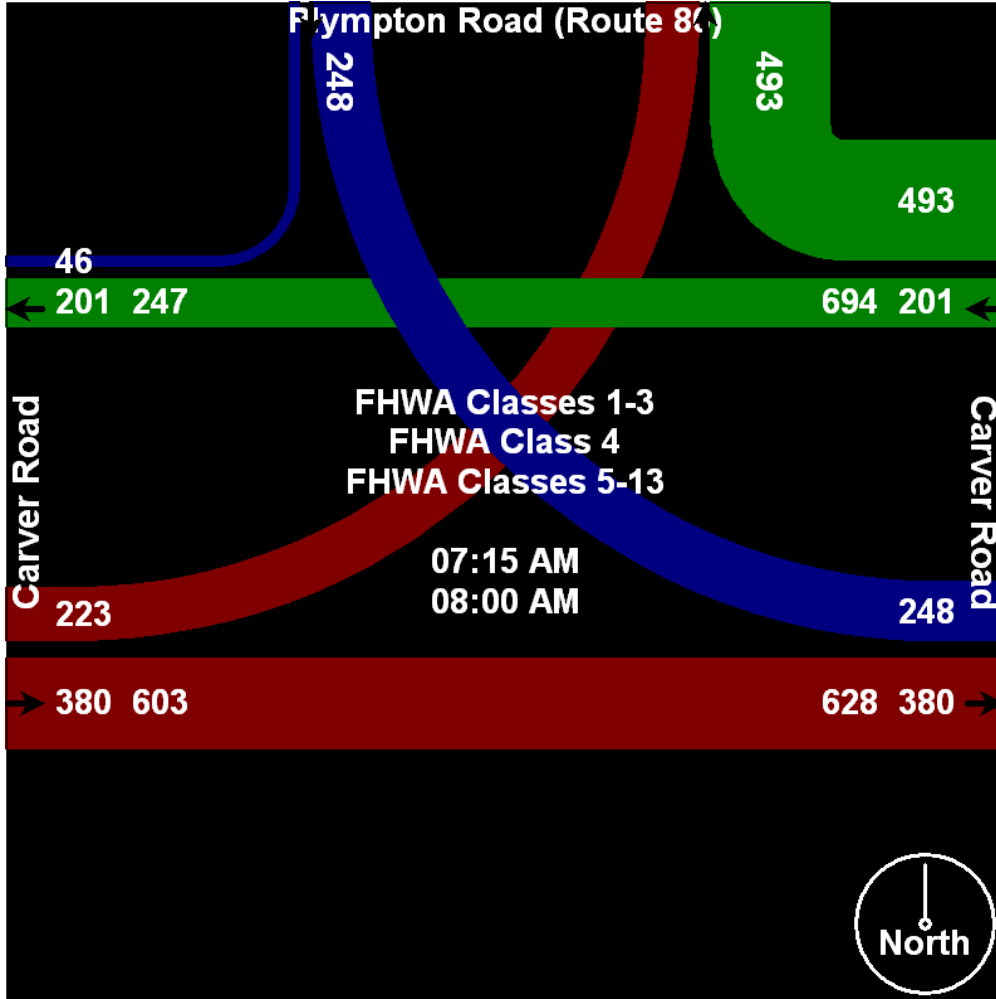
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	Left	Right	Peds	App. Total	Thru	Right	Peds	App. Total	Left	Thru	Peds	App. Total	
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 07:15 AM													
07:15 AM	47	8	0	55	39	98	0	137	48	99	0	147	339
07:30 AM	53	9	0	62	60	145	0	205	68	76	0	144	411
07:45 AM	77	18	0	95	42	153	0	195	67	107	0	174	464
08:00 AM	71	11	0	82	60	97	0	157	40	98	0	138	377
Total Volume	248	46	0	294	201	493	0	694	223	380	0	603	1591
% App. Total	84.4	15.6	0		29	71	0		37	63	0		
PHF	.805	.639	.000	.774	.838	.806	.000	.846	.820	.888	.000	.866	.857
FHWA Classes 1-3	236	42	0	278	190	484	0	674	218	364	0	582	1534
% FHWA Classes 1-3	95.2	91.3	0	94.6	94.5	98.2	0	97.1	97.8	95.8	0	96.5	96.4
FHWA Class 4	2	0	0	2	5	2	0	7	3	5	0	8	17
% FHWA Class 4	0.8	0	0	0.7	2.5	0.4	0	1.0	1.3	1.3	0	1.3	1.1
FHWA Classes 5-13	10	4	0	14	6	7	0	13	2	11	0	13	40
% FHWA Classes 5-13	4.0	8.7	0	4.8	3.0	1.4	0	1.9	0.9	2.9	0	2.2	2.5



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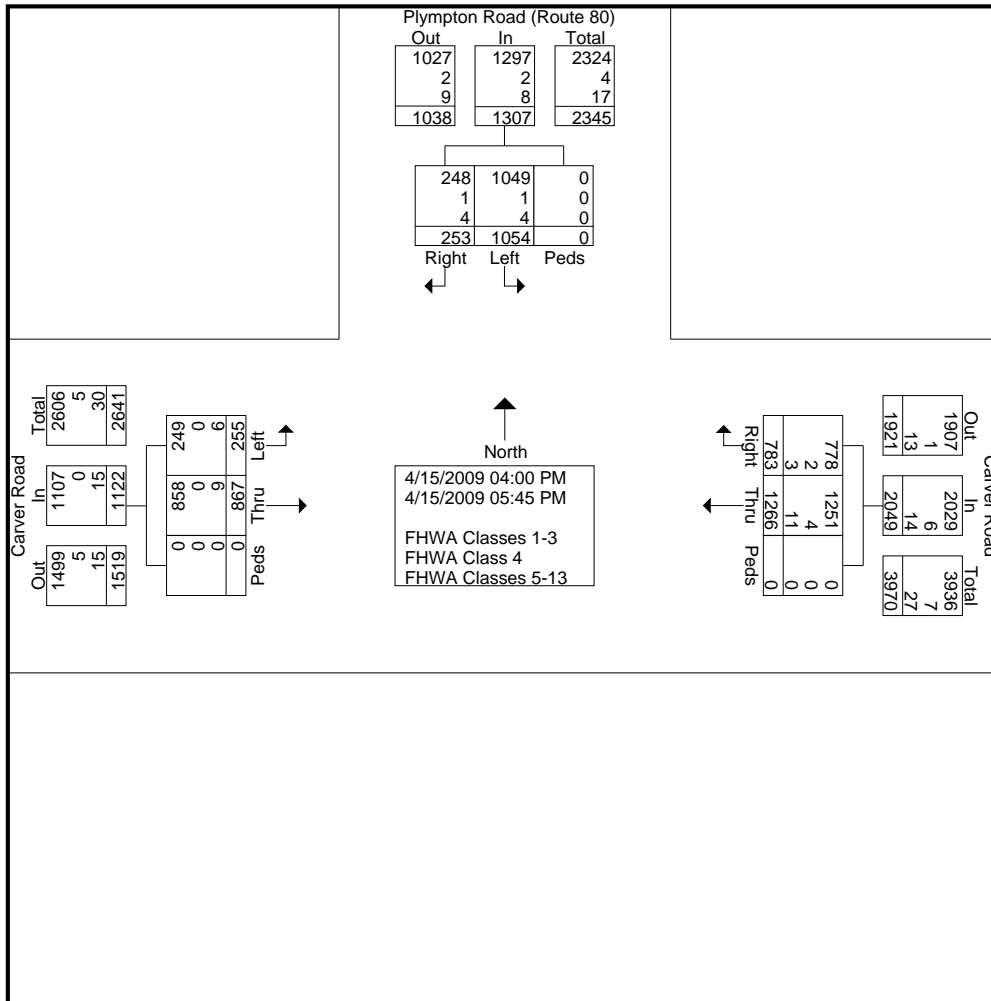
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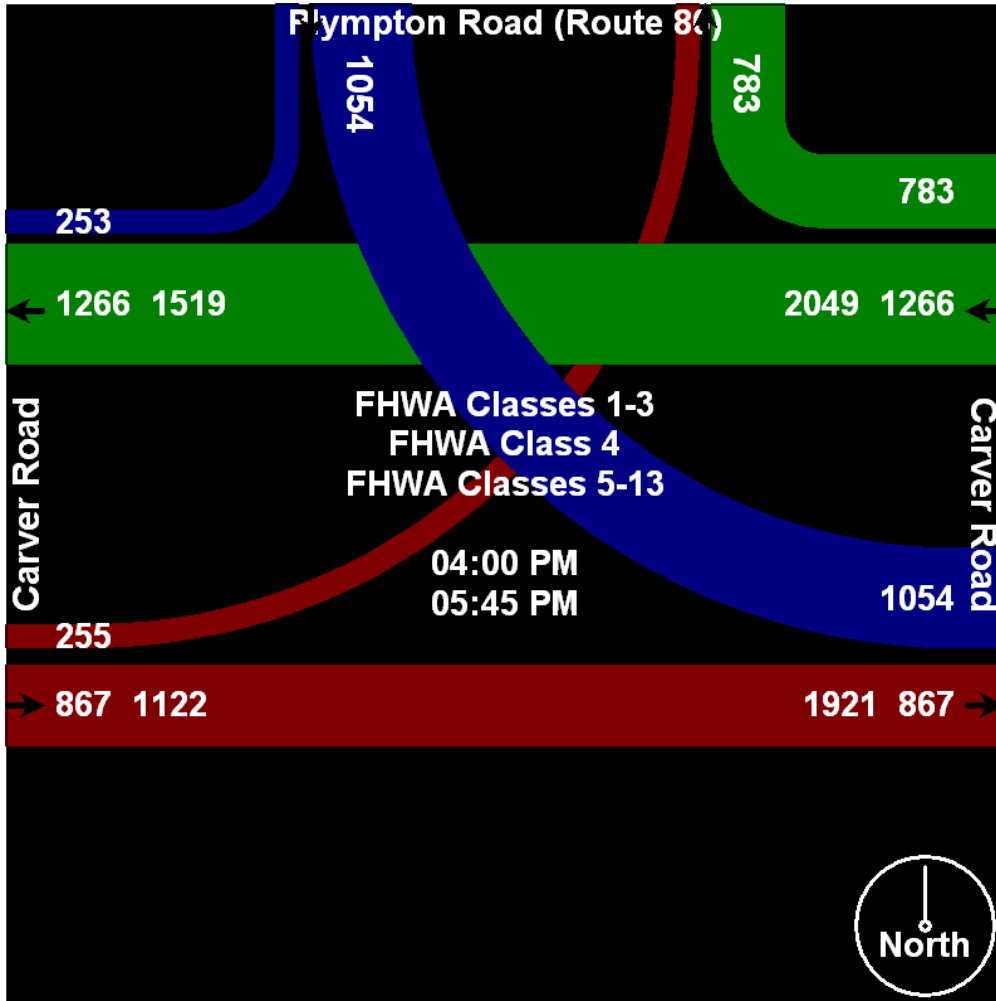
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	Left	Right	Peds	App. Total	Thru	Right	Peds	App. Total	Left	Thru	Peds	App. Total	
04:00 PM	104	33	0	137	115	92	0	207	25	113	0	138	482
04:15 PM	126	30	0	156	160	99	0	259	24	95	0	119	534
04:30 PM	119	25	0	144	165	101	0	266	27	110	0	137	547
04:45 PM	126	48	0	174	164	93	0	257	31	93	0	124	555
Total	475	136	0	611	604	385	0	989	107	411	0	518	2118
05:00 PM	118	26	0	144	170	110	0	280	43	116	0	159	583
05:15 PM	146	38	0	184	156	104	0	260	42	109	0	151	595
05:30 PM	169	25	0	194	167	82	0	249	27	105	0	132	575
05:45 PM	146	28	0	174	169	102	0	271	36	126	0	162	607
Total	579	117	0	696	662	398	0	1060	148	456	0	604	2360
Grand Total	1054	253	0	1307	1266	783	0	2049	255	867	0	1122	4478
Apprch %	80.6	19.4	0		61.8	38.2	0		22.7	77.3	0		
Total %	23.5	5.6	0	29.2	28.3	17.5	0	45.8	5.7	19.4	0	25.1	
FHWA Classes 1-3	1049	248	0	1297	1251	778	0	2029	249	858	0	1107	4433
% FHWA Classes 1-3	99.5	98	0	99.2	98.8	99.4	0	99	97.6	99	0	98.7	99
FHWA Class 4	1	1	0	2	4	2	0	6	0	0	0	0	8
% FHWA Class 4	0.1	0.4	0	0.2	0.3	0.3	0	0.3	0	0	0	0	0.2
FHWA Classes 5-13	4	4	0	8	11	3	0	14	6	9	0	15	37
% FHWA Classes 5-13	0.4	1.6	0	0.6	0.9	0.4	0	0.7	2.4	1	0	1.3	0.8



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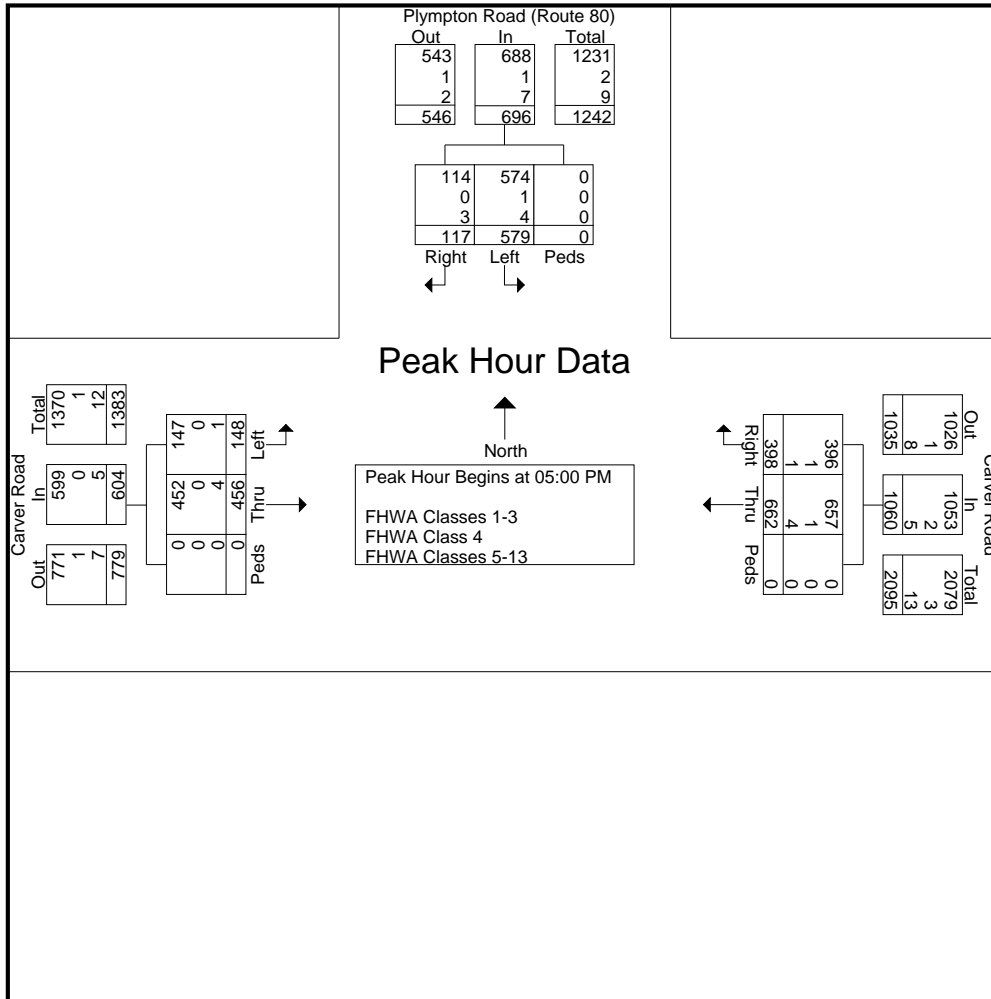


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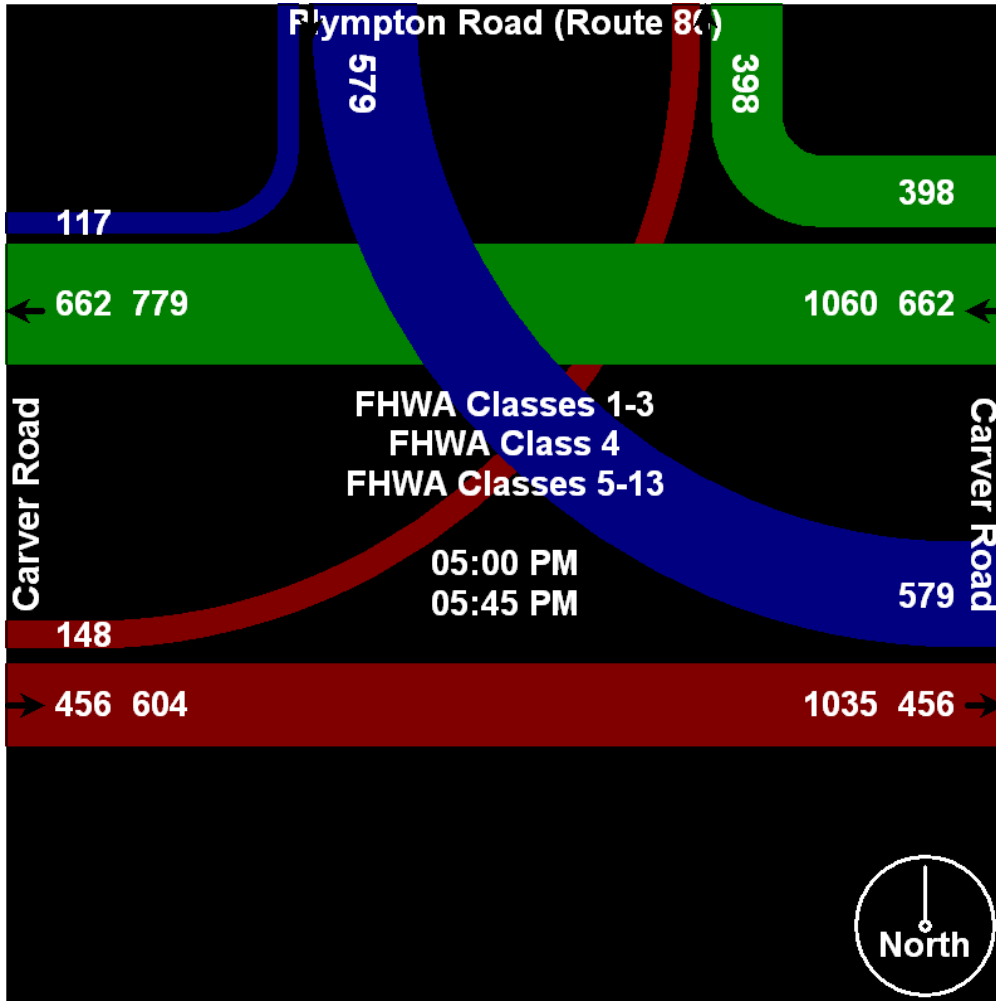
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Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 05:00 PM													
05:00 PM	118	26	0	144	170	110	0	280	43	116	0	159	583
05:15 PM	146	38	0	184	156	104	0	260	42	109	0	151	595
05:30 PM	169	25	0	194	167	82	0	249	27	105	0	132	575
05:45 PM	146	28	0	174	169	102	0	271	36	126	0	162	607
Total Volume	579	117	0	696	662	398	0	1060	148	456	0	604	2360
% App. Total	83.2	16.8	0		62.5	37.5	0		24.5	75.5	0		
PHF	.857	.770	.000	.897	.974	.905	.000	.946	.860	.905	.000	.932	.972
FHWA Classes 1-3	574	114	0	688	657	396	0	1053	147	452	0	599	2340
% FHWA Classes 1-3	99.1	97.4	0	98.9	99.2	99.5	0	99.3	99.3	99.1	0	99.2	99.2
FHWA Class 4	1	0	0	1	1	1	0	2	0	0	0	0	3
% FHWA Class 4	0.2	0	0	0.1	0.2	0.3	0	0.2	0	0	0	0	0.1
FHWA Classes 5-13	4	3	0	7	4	1	0	5	1	4	0	5	17
% FHWA Classes 5-13	0.7	2.6	0	1.0	0.6	0.3	0	0.5	0.7	0.9	0	0.8	0.7



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Carver Road @ Route 80
3: Carver Road & Route 80

Existing Conditions - 2011 AM Peak Hour LOS



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕↕			↕↕						↕	↕
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	4.0
Lane Util. Factor		0.95			0.95						1.00	1.00
Frt		1.00			0.89						1.00	0.85
Flt Protected		0.98			1.00						0.95	1.00
Satd. Flow (prot)		3408			3131						1719	1538
Flt Permitted		0.58			1.00						0.95	1.00
Satd. Flow (perm)		2000			3131						1719	1538
Volume (vph)	223	380	0	0	201	493	0	0	0	248	0	46
Peak-hour factor, PHF	0.87	0.87	0.87	0.85	0.85	0.85	0.92	0.92	0.92	0.77	0.77	0.77
Growth Factor (vph)	102%	102%	102%	102%	102%	102%	102%	102%	102%	102%	102%	102%
Adj. Flow (vph)	261	446	0	0	241	592	0	0	0	329	0	61
RTOR Reduction (vph)	0	0	0	0	266	0	0	0	0	0	0	45
Lane Group Flow (vph)	0	707	0	0	567	0	0	0	0	0	329	16
Heavy Vehicles (%)	4%	4%	4%	3%	3%	3%	2%	2%	2%	5%	5%	5%
Turn Type	Perm			Perm						Perm		Perm
Protected Phases		4			8						6	
Permitted Phases	4			8						6		6
Actuated Green, G (s)		23.6			23.6						11.2	11.2
Effective Green, g (s)		23.6			23.6						11.2	11.2
Actuated g/C Ratio		0.55			0.55						0.26	0.26
Clearance Time (s)		4.0			4.0						4.0	4.0
Vehicle Extension (s)		3.0			3.0						3.0	3.0
Lane Grp Cap (vph)		1103			1726						450	402
v/s Ratio Prot					0.18							
v/s Ratio Perm		c0.35									0.19	0.01
v/c Ratio		0.93dl			0.33						0.73	0.04
Uniform Delay, d1		6.7			5.3						14.4	11.8
Progression Factor		1.00			1.00						1.00	1.00
Incremental Delay, d2		1.3			0.1						6.0	0.0
Delay (s)		7.9			5.4						20.5	11.8
Level of Service		A			A						C	B
Approach Delay (s)		7.9			5.4			0.0			19.1	
Approach LOS		A			A			A			B	

Intersection Summary

















HCM Average Control Delay	9.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	42.8	Sum of lost time (s)	8.0
Intersection Capacity Utilization	63.2%	ICU Level of Service	B
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

c Critical Lane Group

Carver Road @ Route 80
3: Carver Road & Route 80

Existing Conditions - 2011 PM Peak Hour LOS

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	4.0
Lane Util. Factor		0.95			0.95						1.00	1.00
Frt		1.00			0.94						1.00	0.85
Flt Protected		0.99			1.00						0.95	1.00
Satd. Flow (prot)		3531			3373						1787	1599
Flt Permitted		0.53			1.00						0.95	1.00
Satd. Flow (perm)		1902			3373						1787	1599
Volume (vph)	148	456	0	0	662	398	0	0	0	579	0	117
Peak-hour factor, PHF	0.93	0.93	0.93	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.90
Growth Factor (vph)	102%	102%	102%	102%	102%	102%	102%	102%	102%	102%	102%	102%
Adj. Flow (vph)	162	500	0	0	711	427	0	0	0	656	0	133
RTOR Reduction (vph)	0	0	0	0	112	0	0	0	0	0	0	41
Lane Group Flow (vph)	0	662	0	0	1026	0	0	0	0	0	656	92
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	2%	2%	2%	1%	1%	1%
Turn Type	Perm			Perm						Perm		Perm
Protected Phases		4			8						6	
Permitted Phases	4			8						6		6
Actuated Green, G (s)		27.8			27.8						28.1	28.1
Effective Green, g (s)		27.8			27.8						28.1	28.1
Actuated g/C Ratio		0.44			0.44						0.44	0.44
Clearance Time (s)		4.0			4.0						4.0	4.0
Vehicle Extension (s)		3.0			3.0						3.0	3.0
Lane Grp Cap (vph)		827			1467						786	703
v/s Ratio Prot					0.30							
v/s Ratio Perm		c0.35									0.37	0.06
v/c Ratio		1.45dl			0.70						0.83	0.13
Uniform Delay, d1		15.6			14.7						15.8	10.6
Progression Factor		1.00			1.00						1.00	1.00
Incremental Delay, d2		5.6			1.5						7.6	0.1
Delay (s)		21.2			16.1						23.5	10.7
Level of Service		C			B						C	B
Approach Delay (s)		21.2			16.1			0.0			21.3	
Approach LOS		C			B			A			C	

Intersection Summary

















HCM Average Control Delay	19.0	HCM Level of Service	B
HCM Volume to Capacity ratio	0.82		
Actuated Cycle Length (s)	63.9	Sum of lost time (s)	8.0
Intersection Capacity Utilization	91.6%	ICU Level of Service	F
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

c Critical Lane Group

Carver Road @ Route 80
3: Carver Road & Route 80

Forecast Conditions - 2016 AM PH LOS (No Changes)

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	4.0
Lane Util. Factor		0.95			0.95						1.00	1.00
Frt		1.00			0.89						1.00	0.85
Flt Protected		0.98			1.00						0.95	1.00
Satd. Flow (prot)		3408			3131						1719	1538
Flt Permitted		0.56			1.00						0.95	1.00
Satd. Flow (perm)		1933			3131						1719	1538
Volume (vph)	223	380	0	0	201	493	0	0	0	248	0	46
Peak-hour factor, PHF	0.87	0.87	0.87	0.85	0.85	0.85	0.92	0.92	0.92	0.77	0.77	0.77
Growth Factor (vph)	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%
Adj. Flow (vph)	274	467	0	0	253	621	0	0	0	345	0	64
RTOR Reduction (vph)	0	0	0	0	297	0	0	0	0	0	0	44
Lane Group Flow (vph)	0	741	0	0	577	0	0	0	0	0	345	20
Heavy Vehicles (%)	4%	4%	4%	3%	3%	3%	2%	2%	2%	5%	5%	5%
Turn Type	Perm			Perm						Perm		Perm
Protected Phases		4			8						6	
Permitted Phases	4			8						6		6
Actuated Green, G (s)		25.7			25.7						15.5	15.5
Effective Green, g (s)		25.7			25.7						15.5	15.5
Actuated g/C Ratio		0.52			0.52						0.32	0.32
Clearance Time (s)		4.0			4.0						4.0	4.0
Vehicle Extension (s)		3.0			3.0						3.0	3.0
Lane Grp Cap (vph)		1010			1636						542	485
v/s Ratio Prot					0.18							
v/s Ratio Perm		c0.38									0.20	0.01
v/c Ratio		1.25dl			0.35						0.64	0.04
Uniform Delay, d1		9.1			6.9						14.4	11.7
Progression Factor		1.00			1.00						1.00	1.00
Incremental Delay, d2		2.8			0.1						2.5	0.0
Delay (s)		11.9			7.0						16.9	11.7
Level of Service		B			A						B	B
Approach Delay (s)		11.9			7.0			0.0			16.1	
Approach LOS		B			A			A			B	

Intersection Summary

HCM Average Control Delay	10.6	HCM Level of Service	B
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	49.2	Sum of lost time (s)	8.0
Intersection Capacity Utilization	65.8%	ICU Level of Service	C
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

c Critical Lane Group

Carver Road @ Route 80
3: Carver Road & Route 80

Forecast Conditions - 2016 PM PH LOS (No Changes)



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕↕			↕↕						↕	↕
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0						4.0	4.0
Lane Util. Factor		0.95			0.95						1.00	1.00
Frt		1.00			0.94						1.00	0.85
Flt Protected		0.99			1.00						0.95	1.00
Satd. Flow (prot)		3531			3373						1787	1599
Flt Permitted		0.53			1.00						0.95	1.00
Satd. Flow (perm)		1895			3373						1787	1599
Volume (vph)	148	456	0	0	662	398	0	0	0	579	0	117
Peak-hour factor, PHF	0.93	0.93	0.93	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.90
Growth Factor (vph)	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%
Adj. Flow (vph)	170	525	0	0	746	448	0	0	0	688	0	139
RTOR Reduction (vph)	0	0	0	0	111	0	0	0	0	0	0	41
Lane Group Flow (vph)	0	695	0	0	1083	0	0	0	0	0	688	98
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	2%	2%	2%	1%	1%	1%
Turn Type	Perm			Perm						Perm		Perm
Protected Phases		4			8						6	
Permitted Phases	4			8						6		6
Actuated Green, G (s)		30.4			30.4						30.6	30.6
Effective Green, g (s)		30.4			30.4						30.6	30.6
Actuated g/C Ratio		0.44			0.44						0.44	0.44
Clearance Time (s)		4.0			4.0						4.0	4.0
Vehicle Extension (s)		3.0			3.0						3.0	3.0
Lane Grp Cap (vph)		835			1486						792	709
v/s Ratio Prot					0.32							
v/s Ratio Perm		c0.37									0.38	0.06
v/c Ratio		1.68dl			0.73						0.87	0.14
Uniform Delay, d1		17.0			15.9						17.4	11.4
Progression Factor		1.00			1.00						1.00	1.00
Incremental Delay, d2		7.1			1.8						10.0	0.1
Delay (s)		24.2			17.7						27.4	11.5
Level of Service		C			B						C	B
Approach Delay (s)		24.2			17.7			0.0			24.7	
Approach LOS		C			B			A			C	

Intersection Summary



















HCM Average Control Delay	21.5	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	69.0	Sum of lost time (s)	8.0
Intersection Capacity Utilization	95.6%	ICU Level of Service	F
Analysis Period (min)	15		

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

c Critical Lane Group

Carver Road @ Route 80
3: Carver Road & Route 80

Forecast Conditions - 2016 AM PH LOS (EB LT Lead)

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0						4.0	4.0
Lane Util. Factor	1.00	1.00			0.95						1.00	1.00
Frt	1.00	1.00			0.89						1.00	0.85
Flt Protected	0.95	1.00			1.00						0.95	1.00
Satd. Flow (prot)	1736	1827			3131						1719	1538
Flt Permitted	0.26	1.00			1.00						0.95	1.00
Satd. Flow (perm)	478	1827			3131						1719	1538
Volume (vph)	223	380	0	0	201	493	0	0	0	248	0	46
Peak-hour factor, PHF	0.87	0.87	0.87	0.85	0.85	0.85	0.92	0.92	0.92	0.77	0.77	0.77
Growth Factor (vph)	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%
Adj. Flow (vph)	274	467	0	0	253	621	0	0	0	345	0	64
RTOR Reduction (vph)	0	0	0	0	447	0	0	0	0	0	0	44
Lane Group Flow (vph)	274	467	0	0	427	0	0	0	0	0	345	20
Heavy Vehicles (%)	4%	4%	4%	3%	3%	3%	2%	2%	2%	5%	5%	5%
Turn Type	pm+pt				Perm						Perm	Perm
Protected Phases	7	4			8						6	6
Permitted Phases	4			8						6		6
Actuated Green, G (s)	19.5	19.5			11.3						12.8	12.8
Effective Green, g (s)	19.5	19.5			11.3						12.8	12.8
Actuated g/C Ratio	0.48	0.48			0.28						0.32	0.32
Clearance Time (s)	4.0	4.0			4.0						4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0						3.0	3.0
Lane Grp Cap (vph)	362	884			878						546	488
v/s Ratio Prot	c0.08	0.26			0.14							
v/s Ratio Perm	c0.29										0.20	0.01
v/c Ratio	0.76	0.53			0.49						0.63	0.04
Uniform Delay, d1	7.9	7.2			12.1						11.7	9.5
Progression Factor	1.00	1.00			1.00						1.00	1.00
Incremental Delay, d2	8.7	0.6			0.4						2.4	0.0
Delay (s)	16.7	7.8			12.5						14.1	9.5
Level of Service	B	A			B						B	A
Approach Delay (s)		11.1			12.5			0.0			13.4	
Approach LOS		B			B			A			B	
Intersection Summary												
HCM Average Control Delay			12.2		HCM Level of Service					B		
HCM Volume to Capacity ratio			0.68									
Actuated Cycle Length (s)			40.3		Sum of lost time (s)			8.0				
Intersection Capacity Utilization			69.1%		ICU Level of Service			C				
Analysis Period (min)			15									
c Critical Lane Group												

Carver Road @ Route 80
3: Carver Road & Route 80

Forecast Conditions - 2016 PM PH LOS (EB LT Lead)

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0						4.0	4.0
Lane Util. Factor	1.00	1.00			0.95						1.00	1.00
Frt	1.00	1.00			0.94						1.00	0.85
Flt Protected	0.95	1.00			1.00						0.95	1.00
Satd. Flow (prot)	1787	1881			3373						1787	1599
Flt Permitted	0.15	1.00			1.00						0.95	1.00
Satd. Flow (perm)	276	1881			3373						1787	1599
Volume (vph)	148	456	0	0	662	398	0	0	0	579	0	117
Peak-hour factor, PHF	0.93	0.93	0.93	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.90
Growth Factor (vph)	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%
Adj. Flow (vph)	170	525	0	0	746	448	0	0	0	688	0	139
RTOR Reduction (vph)	0	0	0	0	127	0	0	0	0	0	0	53
Lane Group Flow (vph)	170	525	0	0	1067	0	0	0	0	0	688	86
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	2%	2%	2%	1%	1%	1%
Turn Type	pm+pt				Perm						Perm	Perm
Protected Phases	7	4			8						6	6
Permitted Phases	4			8						6		6
Actuated Green, G (s)	31.3	31.3			23.3						28.0	28.0
Effective Green, g (s)	31.3	31.3			23.3						28.0	28.0
Actuated g/C Ratio	0.47	0.47			0.35						0.42	0.42
Clearance Time (s)	4.0	4.0			4.0						4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0						3.0	3.0
Lane Grp Cap (vph)	218	875			1168						743	665
v/s Ratio Prot	0.05	c0.28			c0.32							
v/s Ratio Perm	0.32										0.38	0.05
v/c Ratio	0.78	0.60			0.91						0.93	0.13
Uniform Delay, d1	15.2	13.4			21.0						18.7	12.1
Progression Factor	1.00	1.00			1.00						1.00	1.00
Incremental Delay, d2	16.1	1.1			10.9						17.4	0.1
Delay (s)	31.2	14.5			31.9						36.0	12.2
Level of Service	C	B			C						D	B
Approach Delay (s)		18.6			31.9			0.0			32.0	
Approach LOS		B			C			A			C	
Intersection Summary												
HCM Average Control Delay			28.5		HCM Level of Service					C		
HCM Volume to Capacity ratio			0.91									
Actuated Cycle Length (s)			67.3		Sum of lost time (s)			12.0				
Intersection Capacity Utilization			103.2%		ICU Level of Service			G				
Analysis Period (min)			15									
c Critical Lane Group												

Carver Road @ Route 80
3: Carver Road & Route 80

Forecast Conditions - 2016 AM PH LOS (EB LT Protected)

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0						4.0	4.0
Lane Util. Factor	1.00	1.00			0.95						1.00	1.00
Frt	1.00	1.00			0.89						1.00	0.85
Flt Protected	0.95	1.00			1.00						0.95	1.00
Satd. Flow (prot)	1736	1827			3131						1719	1538
Flt Permitted	0.95	1.00			1.00						0.95	1.00
Satd. Flow (perm)	1736	1827			3131						1719	1538
Volume (vph)	223	380	0	0	201	493	0	0	0	248	0	46
Peak-hour factor, PHF	0.87	0.87	0.87	0.85	0.85	0.85	0.92	0.92	0.92	0.77	0.77	0.77
Growth Factor (vph)	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%
Adj. Flow (vph)	274	467	0	0	253	621	0	0	0	345	0	64
RTOR Reduction (vph)	0	0	0	0	428	0	0	0	0	0	0	49
Lane Group Flow (vph)	274	467	0	0	446	0	0	0	0	0	345	15
Heavy Vehicles (%)	4%	4%	4%	3%	3%	3%	2%	2%	2%	5%	5%	5%
Turn Type	Prot			Perm						Perm		Perm
Protected Phases	7	4			8						6	
Permitted Phases				8						6		6
Actuated Green, G (s)	8.7	26.8			14.1						10.5	10.5
Effective Green, g (s)	8.7	26.8			14.1						10.5	10.5
Actuated g/C Ratio	0.19	0.59			0.31						0.23	0.23
Clearance Time (s)	4.0	4.0			4.0						4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0						3.0	3.0
Lane Grp Cap (vph)	333	1081			975						398	356
v/s Ratio Prot	c0.16	c0.26			0.14							
v/s Ratio Perm											0.20	0.01
v/c Ratio	0.82	0.43			0.46						0.87	0.04
Uniform Delay, d1	17.6	5.1			12.5						16.7	13.5
Progression Factor	1.00	1.00			1.00						1.00	1.00
Incremental Delay, d2	15.0	0.3			0.3						17.6	0.0
Delay (s)	32.6	5.4			12.9						34.4	13.5
Level of Service	C	A			B						C	B
Approach Delay (s)		15.4			12.9			0.0			31.1	
Approach LOS		B			B			A			C	
Intersection Summary												
HCM Average Control Delay			17.5			HCM Level of Service				B		
HCM Volume to Capacity ratio			0.63									
Actuated Cycle Length (s)			45.3			Sum of lost time (s)			8.0			
Intersection Capacity Utilization			69.1%			ICU Level of Service				C		
Analysis Period (min)			15									
c Critical Lane Group												

Carver Road @ Route 80
3: Carver Road & Route 80

Forecast Conditions - 2016 PM PH LOS (EB LT Protected)

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.0	4.0			4.0						4.0	4.0
Lane Util. Factor	1.00	1.00			0.95						1.00	1.00
Frt	1.00	1.00			0.94						1.00	0.85
Flt Protected	0.95	1.00			1.00						0.95	1.00
Satd. Flow (prot)	1787	1881			3373						1787	1599
Flt Permitted	0.95	1.00			1.00						0.95	1.00
Satd. Flow (perm)	1787	1881			3373						1787	1599
Volume (vph)	148	456	0	0	662	398	0	0	0	579	0	117
Peak-hour factor, PHF	0.93	0.93	0.93	0.95	0.95	0.95	0.92	0.92	0.92	0.90	0.90	0.90
Growth Factor (vph)	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%	107%
Adj. Flow (vph)	170	525	0	0	746	448	0	0	0	688	0	139
RTOR Reduction (vph)	0	0	0	0	128	0	0	0	0	0	0	52
Lane Group Flow (vph)	170	525	0	0	1066	0	0	0	0	0	688	87
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	2%	2%	2%	1%	1%	1%
Turn Type	Prot			Perm						Perm		Perm
Protected Phases	7	4			8						6	
Permitted Phases				8						6		6
Actuated Green, G (s)	7.0	34.0			23.0						27.8	27.8
Effective Green, g (s)	7.0	34.0			23.0						27.8	27.8
Actuated g/C Ratio	0.10	0.49			0.33						0.40	0.40
Clearance Time (s)	4.0	4.0			4.0						4.0	4.0
Vehicle Extension (s)	3.0	3.0			3.0						3.0	3.0
Lane Grp Cap (vph)	179	916			1111						712	637
v/s Ratio Prot	c0.10	0.28			c0.32							
v/s Ratio Perm											0.38	0.05
v/c Ratio	0.95	0.57			0.96						0.97	0.14
Uniform Delay, d1	31.2	12.7			22.9						20.5	13.4
Progression Factor	1.00	1.00			1.00						1.00	1.00
Incremental Delay, d2	52.0	0.9			17.8						25.4	0.1
Delay (s)	83.3	13.6			40.8						45.9	13.5
Level of Service	F	B			D						D	B
Approach Delay (s)		30.6			40.8			0.0			40.5	
Approach LOS		C			D			A			D	
Intersection Summary												
HCM Average Control Delay			38.1			HCM Level of Service					D	
HCM Volume to Capacity ratio			0.96									
Actuated Cycle Length (s)			69.8			Sum of lost time (s)			12.0			
Intersection Capacity Utilization			103.2%			ICU Level of Service					G	
Analysis Period (min)			15									
c Critical Lane Group												

MassHighway

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Plymouth COUNTY : DA DATE : 4/15/09

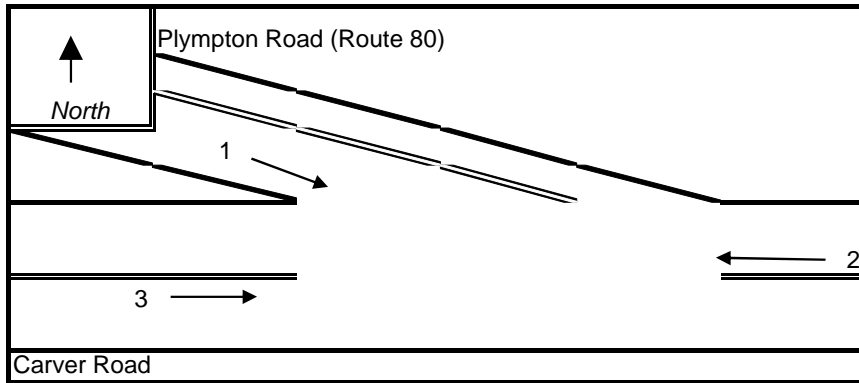
DISTRICT : 5 UNSIGNALIZED : SIGNALIZED :

- INTERSECTION DATA -

MAJOR STREET : Carver Road

MINOR STREET(S) : Plympton Road (Route 80)

**INTERSECTION
DIAGRAM**
(Label Approaches)



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	SB	WB	EB			
PEAK HOURLY VOLUMES (AM/PM) :	696	1,060	604			2,360

" K " FACTOR : INTERSECTION ADT (V) = TOTAL DAILY APPROACH VOLUME :

TOTAL # OF CRASHES : # OF YEARS : AVERAGE # OF CRASHES PER YEAR (A) :

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

Comments : _____

Project Title & Date: _____