



## Traffic Study

### Intersection of Mammoth Road and East/West Meadow Road



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8/4/15

## Executive Summary

The intersection of Mammoth Road and West/East Meadow Road is located in the Pawtucketville neighborhood near the Dracut town line. Mammoth Road is a major commuting route into the City of Lowell with an annual average daily traffic count (AADT) of 12,000 vehicles per day.<sup>1</sup> The intersection is currently stop-controlled at all four approaches, which makes it relatively safe but causes extensive traffic delays. Due to continuing development pressures and increased traffic congestion, the following traffic study was conducted by the City's Transportation Engineer to determine possible improvements.

Findings: Data was collected and analyzed regarding crash history, traffic volumes, pedestrian flows, parking and zoning for the area surrounding the study intersection. The following findings were made:

- The intersection is currently functioning at a level of service F (LOS F), which is the worst possible measurement of traffic delay for an intersection. During the PM rush hour, motorists on Mammoth Road are experiencing an average of 68 seconds of delay and queue lengths of 13 vehicles.
- The intersection meets traffic volume warrants for a signalized intersection.
- The intersection is relatively safe, with an equivalent property damage only (EPDO) rating of 23 which is relatively low.
- The intersection is zoned for Traditional Mixed-Use (TMU) development, and various development proposals have been submitted for increased commercial development at the intersection.
- On-street parking is technically allowed at the approaches to the intersection.
- There are no sidewalks on the northwest quadrant of the intersection.
- There is effectively a continuous driveway entrance for the liquor store and gas station on the northwest quadrant which allows vehicles to back up directly into the intersection.

Recommendations: Based on the analysis of data and existing conditions, the following recommendations are made:

1. Place the intersection of Mammoth Road and West/East Meadow Road on the Traffic Signal Improvement Capital Improvement Plan and proceed to engineering design, which would include a new traffic/pedestrian signal and sidewalks on all four quadrants;
2. Prohibit parking on all four approaches to the intersection;
3. The City Engineer, Transportation Engineer, and Development Services will require future commercial development at the intersection to be pedestrian friendly and to provide vehicular access from the minor streets.

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<sup>1</sup> NMCOG 2014 traffic count at Mammoth Road at the Dracut Town Line.

## Intersection Layout and Existing Conditions

The study intersection has four approaches: Mammoth Road northbound and southbound, East Meadow Road and West Meadow Road. The intersection has a slight skew with the south section of Mammoth Road forming an acute angle with West Meadow Road. (see Figure 1 below)

Mammoth Road is an Urban Minor Arterial running in a southeasterly direction from the Towns of Pelham and Hudson New Hampshire (where it is also known as Route 128) into the City of Lowell. It crosses the Merrimack River and becomes School St. It is a major commuter route into and through the City of Lowell.

Figure 1 - Intersection



East Meadow and West Meadow Roads are Urban Collectors running in a southwesterly direction and connecting University Ave. to Varnum Ave. Mammoth Road has a 40' width (20' lanes) to the south and 36' width (18' lanes) to the north. East Meadow and West Meadow Road has a 29' width (14.5' lanes).

The existing sidewalks are 5' wide. There is a large mast arm and foundation on the southeast corner where the sidewalk narrows to a 3' width. There are crosswalks and stop bars painted at each approach.

The LRTA's Pawtucketville Route (#7) runs along East Meadow Road and Mammoth Road. While there are no officially designated bus stops near the study intersection, riders were observed disembarking on Mammoth Road south of the intersection.

Mammoth Road, East Meadow and West Meadow Roads are listed in §266-47 Stop Intersections as being stop-controlled at this intersection. There are 30” stop signs at each approach and a flashing red beacon suspended over the intersection from a mast arm.

The surrounding land use is a mix of single family residential and light commercial activity. There is a liquor store, barber shop and gas station on the northwestern quadrant and a dinner and office space just north of the intersection on the northeastern quadrant. There have been a couple of proposals before the Planning Board to convert the residential structure on the southeastern corner of the intersection into a mixed-commercial development.

The intersection faces a downward grade to the south and an upward grade to the east. It is relatively flat to the other directions.

## Parking and Access Management

Technically, on-street parking is allowed on Mammoth Road because there is no ordinance specifically prohibiting it. Since the travel lanes are 20’ and 18’ wide a vehicle could park in the street and still leave a 10’ travel lane as is required in §266-50 F. West Meadow Road and East Meadow Road on the other hand are too narrow for on-street parking, and while not specifically prohibited, on-street parking would not meet the 10’ travel lane requirements of §266-50 F.

In order to increase the safety and traffic flow at the intersection, it is recommended that parking be eliminated on the approaches to the intersection by amending §266-56 – Parking Prohibited on Certain Streets at all Times as follows:

<b>Name of Street</b>	<b>Side</b>	<b>Location</b>
East Meadow Road	Both	From the easterly curbline of Mammoth Road to the easterly curbline of Shea Street
West Meadow Road	Both	From the westerly curbline of Mammoth Road to the westerly curbline of Monarch Street
Mammoth Road	Both	From the northerly curbline of Chase Avenue to the southerly curbline of Wellworth Street

There is also a 15 minute parking zone designated in §266-51 A in front of 369 Mammoth Road defined as follows: “Beginning at a point 213 feet north of the northerly curbline of West Meadow Road running southerly a distance of 20 feet”. It is recommended that this 15 minute parking zone be left in place in order to accommodate the existing businesses.

There is no curb or sidewalk on the northwesterly quadrant of the intersection, and effectively, there exists a 75' driveway entrance for the liquor store and gas station. This causes a great deal of commotion because vehicles are backing out of the businesses directly into the intersection. This poses a safety problem for both vehicles and pedestrians.

Figure 2 - Lack of Access Management



As shown in Figure 2 above, the crosswalks lead directly to the parking lot and the sidewalk is non-existent.

It is recommended that sidewalks on the northwest quadrant be built and that the driveway entrances to the liquor store and gas station be better defined in order to improve both pedestrian safety and vehicular access.

## Applicable Zoning

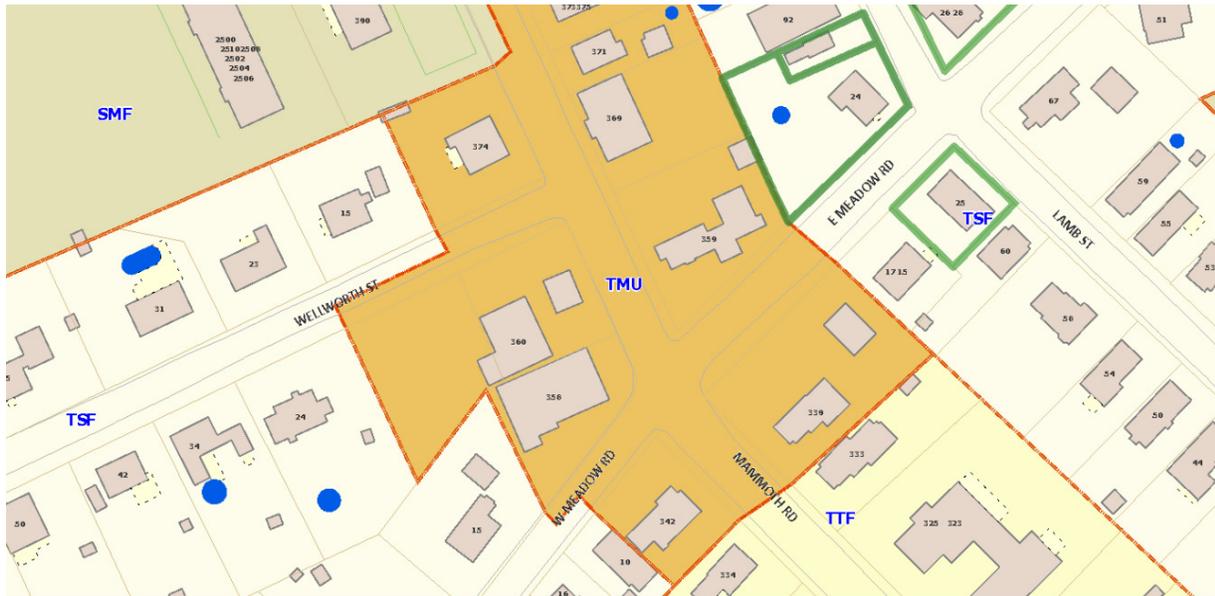
The surrounding properties at this intersection are zoned as TMU – Traditional Mixed Use which is a subset of the Traditional Neighborhood District. This zoning allows for small commercial (<5,000 SF) developments such as salons, restaurants, and convenience stores. Due to development pressures it is likely that the remaining parcels at this intersection will be developed into small neighborhood commercial operations. This development should be guided to have access from the minor streets if possible and to have pedestrian amenities.

Outside the immediate area of the intersection, the neighborhood is zoned as follows:

- TTF – Traditional Two-Family
- TSF – Traditional Single-Family
- SMF – Suburban Multi-Family

These uses offer a mix of residential densities which could very well support the small businesses that will be likely built around the intersection.

Figure 3 - Zoning



## Traffic Counts

Mammoth Road has an AADT of 12,000 vehicles per day.<sup>2</sup> Traffic counts were not readily available for East or West Meadow Road.

Turning movement counts were conducted by the Department of Planning and Development (DPD) in June 2015 at the study intersection during the morning and afternoon rush hours. These counts are included in Appendix pg. 1-4. Please note that these counts were conducted after the final day of classes for both UMass Lowell and the primary schools. Were these counts to be conducted while the schools are in session, it is likely that a higher number of school buses, pedestrians, and commuters would be observed.

The morning peak hour lasts from 7:15 to 8:15 AM with 1,308 vehicles traversing the intersection. The peak 15 minute period lasts from 7:30 to 7:45 AM with a peak hour factor of 95.6%. The majority of traffic (43%) is incoming vehicles traveling southbound on Mammoth Road.

The afternoon peak hour lasts from 4:45 to 5:45 PM with 1,439 vehicles traversing the intersection. The peak 15 minute period lasts from 5:15 to 5:30 PM with a peak hour factor of 92.2%. The majority of traffic (34%) is outgoing vehicles traveling northbound on Mammoth Road.

Eight pedestrians were observed during the AM peak hour and nine during the PM peak hour. LRTA transit buses were observed four times during each of the peak hours. Trucks accounted for less than 1% of observed traffic.

<sup>2</sup> NMCOG 2014 traffic count at Mammoth Road at the Dracut Town Line.

## Intersection Level of Service (LOS) Analysis

The intersection is currently operating at a Level of Service F (LOS F) as shown in the analysis included in Appendix pg. 5. LOS F is the worst possible level of intersection operation as measured in the averaged delay experienced by motorists. During the PM rush hour, motorists on Mammoth Road are experiencing an average of 68 seconds of delay and queue lengths of 13 vehicles or more. This level of congestion leads to increased emissions as well as increased level of driver frustration.

Figure 4 - Typical Queue



## Crash Data

Crash data from 2010 to 2014 was collected and analyzed from the LPD incident database. From 2010 to 2014 there were a total of 23 motor vehicle accidents at this intersection. Data compiled from LPD records show one injury crash and two crashes with possible injuries occurring at the intersection. There were several other crashes that occurred at adjacent parking lots or on nearby streets which were not analyzed since they are not “susceptible to correction by a traffic control signal.”<sup>3</sup>

The crash history shows a majority of the crashes (61%) are right angle crashes. This type of crash is typically the most dangerous, however, due to the stop control and congested nature of the intersection the crashes tend to occur at low vehicle speeds. As a result only one reported injury and two possible injuries were reported in the five year period – all stemming from right-angle crashes. The single injury crash involved a motorcycle.

The crash data is represented graphically in Appendix pg. 8 and in Tables 1 through 3.

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<sup>3</sup> Manual of Uniform Traffic Control Devices (MUTCD) 2009 – Section 4C.08

Table 1 - Crash History

Type of crash	Totals	2010	2011	2012	2013	2014
Rear End	6	0	1	2	1	2
Right Angle	14	3	0	2	5	4
Glancing	2	0	0	1	1	0
Fixed Object	1	0	0	0	1	0
<b>Grand Total</b>	<b>23</b>	<b>3</b>	<b>1</b>	<b>5</b>	<b>8</b>	<b>6</b>

Table 2 - Crash Severity

Injuries	Count
MVA NO INJURY	20
MVA UNKNOWN INJURIES	2
MVA WITH INJURY	1
<b>Grand Total</b>	<b>23</b>

Table 3 - Crash Time of Day

Time of day	Count	Rate (per hour)
Early Morning (5 - 7 AM)	2	1.0
AM Rush hour (7 - 9 AM)	1	0.5
Mid-day (9 AM - 4 PM)	8	1.15
PM Rush hour (4 - 6 PM)	6	3.0
Evening (6 – 9 PM)	5	1.67
Late night (9 PM -5 AM)	1	0.15
<b>Grand Total</b>	<b>23</b>	

The higher crash rates appear to be during the afternoon and evening, which typically see higher traffic volumes.

It is important to note that this is not a high accident intersection, with an EPDO of 23 points it does not register in the top 100 accident intersections for the NMCOG region. The Equivalent Property Damage Only (EPDO) Method takes into account total number of crashes at a location and the severity of each crash. This system is currently used by MassDOT and NMCOG in its development of the Top Crash Locations. The EPDO method is a system of ranking intersections in terms of safety. The system is point based with different types of crashes receiving different point values. The formula for determining the EPDO is as follows:<sup>4</sup>

$$\text{EPDO} = (1 \times \text{Property Damage Only Crash}) + (5 \times \text{Injury Crash}) + (10 \times \text{Fatal Crash})$$

For comparison purposes the Mammoth Road intersection with Fourth Avenue has an EPDO of 50, and the Mammoth Road intersection with VFW has an EPDO of 266.

<sup>4</sup> NMCOG Regional Transportation Safety guidelines

## Traffic Control Signal Warrant Analysis

A traffic control signal can often help reduce traffic congestion and vehicle crashes by providing an orderly method of directing traffic flows. However, traffic signals are very expensive and can actually cause traffic problems when located in unwarranted intersections.

In order to adequately determine the necessity for a traffic control signal, the federal Manual of Uniform Traffic Control Devices (MUTCD) and MassDOT design guides require that “[a]n engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed to determine whether installation of a traffic control signal is justified at a particular location.”<sup>5</sup>

There are eight (8) separate traffic analyses which determine if a traffic signal is appropriate for an intersection. Only one of the eight warrants needs to be satisfied for a traffic control signal to be deemed appropriate.

Based on the traffic conditions as explained *supra*, the intersection of Mammoth Road and East/West Meadow Road satisfies at least two volume related warrants:

### Warrant 2: Four Hour Vehicular Volume

The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal.<sup>6</sup>

The traffic counts conducted for this study have found that for the 4 hours investigated, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) all far exceed the applicable curve in Figure 4C-1 for the existing combination of approach lanes. (see Appendix pg. 6)

### Warrant 3: Peak Hour Volume

The Peak Hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street.

The traffic counts conducted for this study have found that for the PM peak hour, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) all far exceed the applicable curve in Figure 4C-3 for the existing combination of approach lanes. (see Appendix pg. 7)

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<sup>5</sup> Manual of Uniform Traffic Control Devices (MUTCD) 2009 – Section 4C.01

<sup>6</sup> Manual of Uniform Traffic Control Devices (MUTCD) 2009 – Section 4C.03

There are two additional traffic control signal warrants which require 8 hours of traffic data – Warrant 1: Eight Hour Vehicular Volume and Warrant 7: Crash Experience. However, due to limited resources this traffic study only conducted four hours of traffic movement counts. It is likely that the study intersection would meet these warrants; however, further analysis is not required since Warrants 2 and 3 have already been surpassed.

## Recommendations

Based on the analysis of data and existing conditions as detailed herein, the following recommendations are made:

1. Place the intersection of Mammoth Road and West/East Meadow Road on the Traffic Signal Improvement Capital Improvement Plan and proceed to engineering design:
  - a. Design should include plans for replacing or co-locating a new traffic signal at the site of the existing mast arm;
  - b. Design should include pedestrian phase to allow for crossing of intersection;
  - c. Design should include sidewalks and ADA compliant ramps at all four quadrants;
  - d. Design should include plans for constraining curb cuts so that vehicles cannot back into the intersection;
2. Add parking ordinances to prohibit parking on all four approaches to the intersection as detailed in page 3;
3. Review future commercial development site plans to assure:
  - a. Pedestrian friendly design;
  - b. Managed access from side streets to minimize traffic disruptions at the intersection.

## APPENDIX

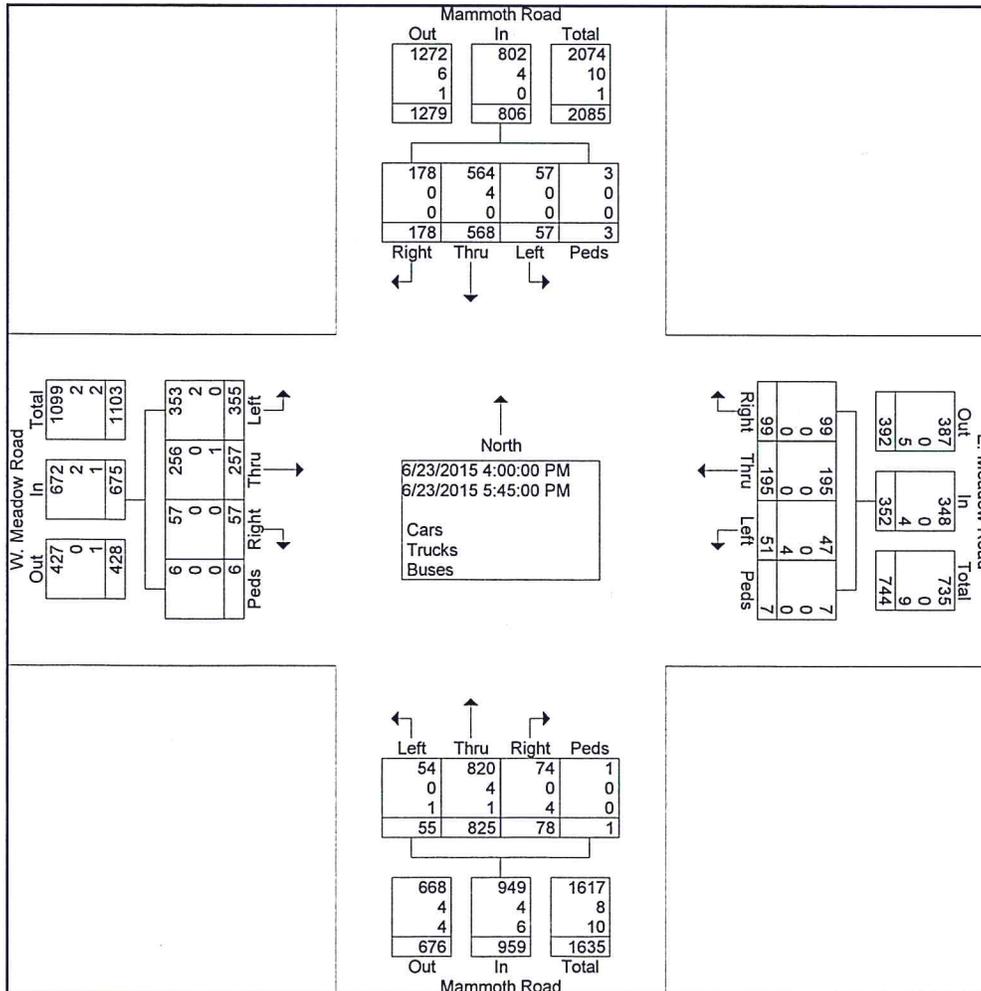
Turning Movement Counts .....	1-4
Synchro Analysis .....	5
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Crash Diagram.....	8

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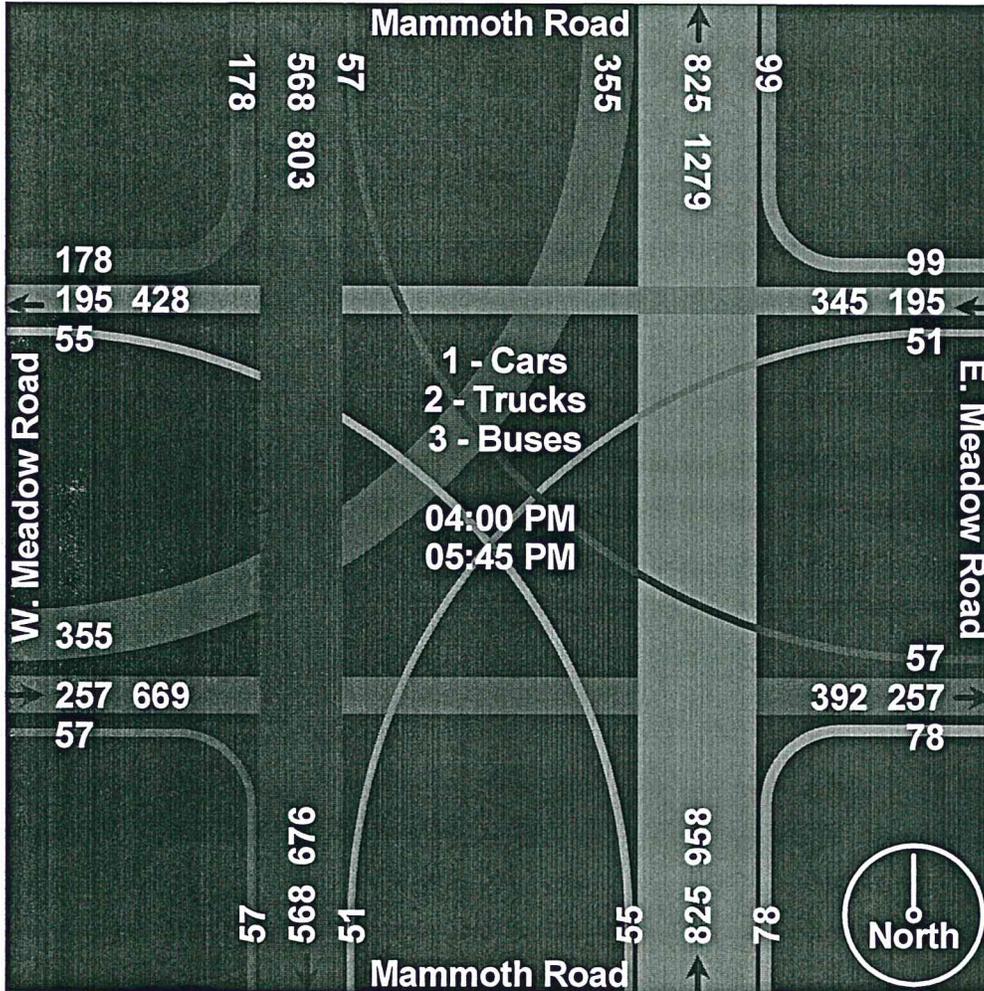
Groups Printed- Cars - Trucks - Buses

Start Time	Mammoth Road From North					E. Meadow Road From East					Mammoth Road From South					W. Meadow Road From West					Int. Total
	Rig ht	Thru	Left	Ped s	App. Total	Rig ht	Thru	Left	Ped s	App. Total	Rig ht	Thru	Left	Ped s	App. Total	Rig ht	Thru	Left	Ped s	App. Total	
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
04:00 PM	24	64	9	0	97	13	22	5	0	40	11	108	9	0	128	2	37	54	0	93	358
04:15 PM	24	78	11	0	113	9	24	7	0	40	12	113	7	0	132	6	30	38	0	74	359
04:30 PM	22	57	6	0	85	11	31	6	1	49	9	90	5	0	104	4	31	45	3	83	321
04:45 PM	19	74	3	1	97	11	22	5	1	39	8	103	7	0	118	9	31	28	0	68	322
Total	89	273	29	1	392	44	99	23	2	168	40	414	28	0	482	21	129	165	3	318	1360
05:00 PM	28	67	10	0	105	13	22	8	2	45	7	111	8	1	127	9	44	51	0	104	381
05:15 PM	19	95	6	1	121	17	27	6	1	51	10	115	6	0	131	9	29	49	0	87	390
05:30 PM	22	64	5	1	92	14	25	7	1	47	14	95	2	0	111	13	34	49	0	96	346
05:45 PM	20	69	7	0	96	11	22	7	1	41	7	90	11	0	108	5	21	41	3	70	315
Total	89	295	28	2	414	55	96	28	5	184	38	411	27	1	477	36	128	190	3	357	1432
Grand Total	178	568	57	3	806	99	195	51	7	352	78	825	55	1	959	57	257	355	6	675	2792
Apprch %	22.1	70.5	7.1	0.4		28.1	55.4	14.5	2.0		8.1	86.0	5.7	0.1		8.4	38.1	52.6	0.9		
Total %	6.4	20.3	2.0	0.1	28.9	3.5	7.0	1.8	0.3	12.6	2.8	29.5	2.0	0.0	34.3	2.0	9.2	12.7	0.2	24.2	

1439



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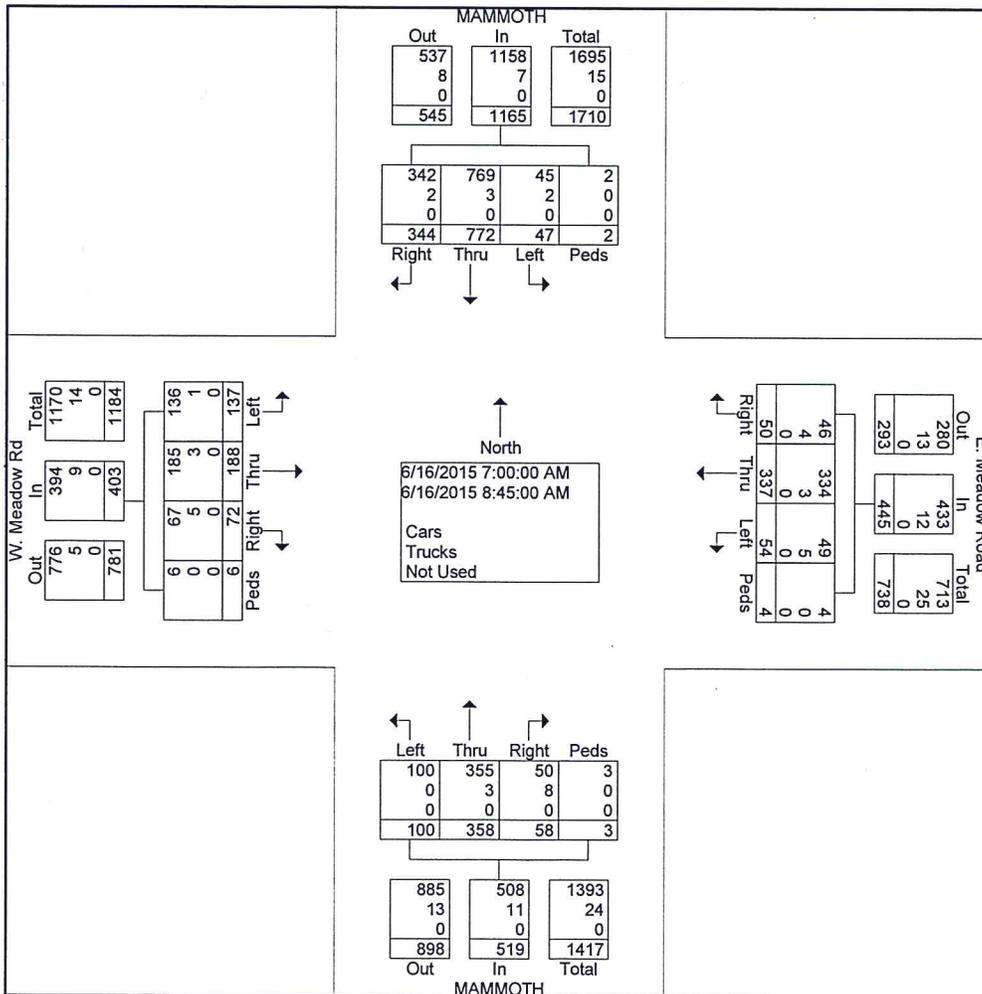


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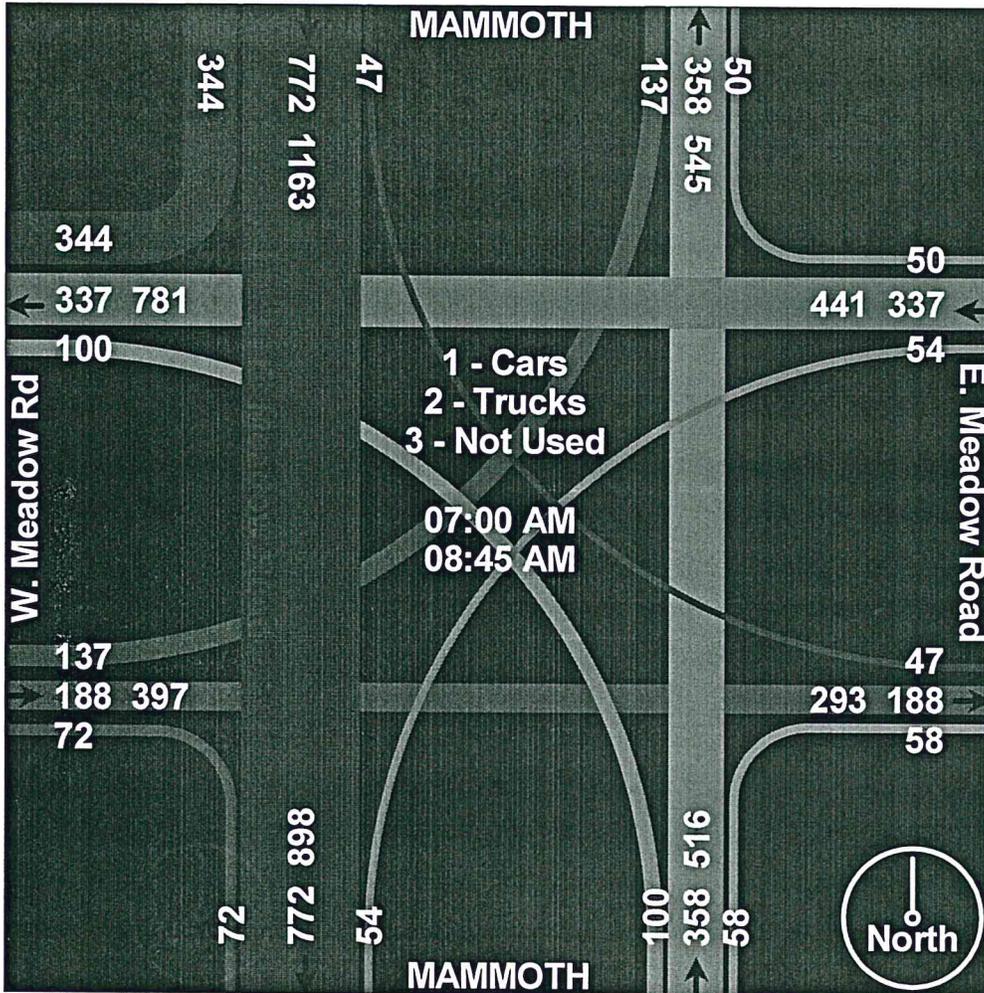
Groups Printed- Cars - Trucks - Not Used

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Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
07:00 AM	40	111	7	0	158	7	47	8	1	63	7	32	8	1	48	10	24	12	1	47	316
07:15 AM	50	97	3	0	150	8	54	10	0	72	6	39	10	0	55	10	21	22	1	54	331
07:30 AM	48	90	4	0	142	7	51	5	1	64	11	51	21	1	84	9	25	17	1	52	342
07:45 AM	38	87	8	0	133	3	50	8	0	61	6	31	24	0	61	14	23	19	2	58	313
Total	176	385	22	0	583	25	202	31	2	260	30	153	63	2	248	43	93	70	5	211	1302
08:00 AM	51	83	5	1	140	9	33	5	1	48	5	43	17	0	65	16	32	21	0	69	322
08:15 AM	46	94	9	0	149	4	42	6	0	52	11	51	6	0	68	6	26	14	1	47	316
08:30 AM	30	104	4	1	139	8	22	7	1	38	6	47	7	0	60	2	14	18	0	34	271
08:45 AM	41	106	7	0	154	4	38	5	0	47	6	64	7	1	78	5	23	14	0	42	321
Total	168	387	25	2	582	25	135	23	2	185	28	205	37	1	271	29	95	67	1	192	1230
Grand Total	344	772	47	2	1165	50	337	54	4	445	58	358	100	3	519	72	188	137	6	403	2532
Apprch %	29.5	66.3	4.0	0.2		11.2	75.7	12.1	0.9		11.2	69.0	19.3	0.6		17.9	46.7	34.0	1.5		
Total %	13.6	30.5	1.9	0.1	46.0	2.0	13.3	2.1	0.2	17.6	2.3	14.1	3.9	0.1	20.5	2.8	7.4	5.4	0.2	15.9	

1308



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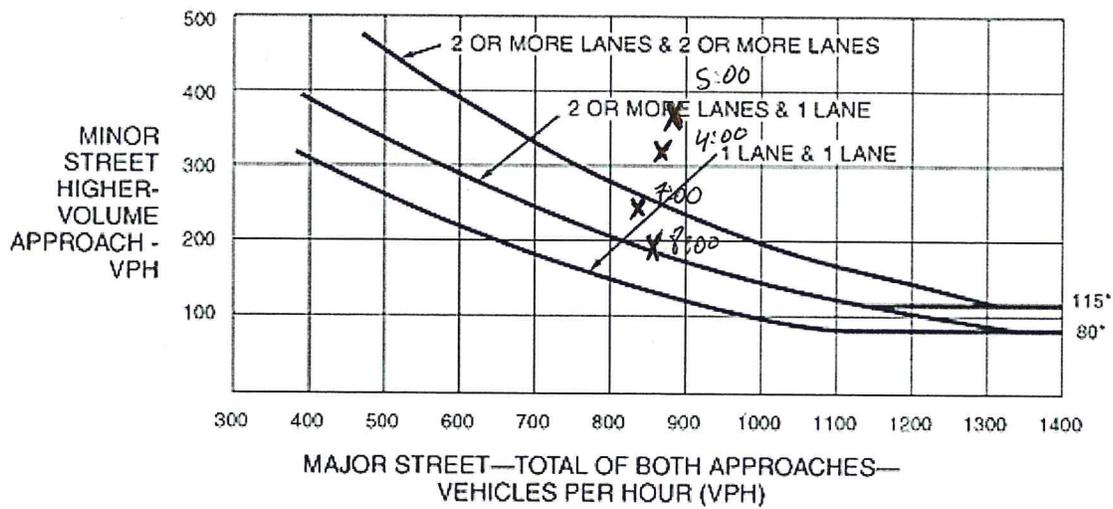


Intersection										
Intersection Delay, s/veh	56.7									
Intersection LOS	F									
Movement	SBU	SBL	SBR	NWU	NWL	NWR	NEU	NEL	NET	NER
Vol, veh/h	0	297	88	0	27	419	0	176	138	40
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	0	323	96	0	29	455	0	191	150	43
Number of Lanes	0	1	0	0	1	0	0	0	1	0

Approach	NW	NE
Opposing Approach		SW
Opposing Lanes	0	1
Conflicting Approach Left	NE	SB
Conflicting Lanes Left	1	1
Conflicting Approach Right	SB	NW
Conflicting Lanes Right	1	1
HCM Control Delay	68.6	46.1
HCM LOS	F	E

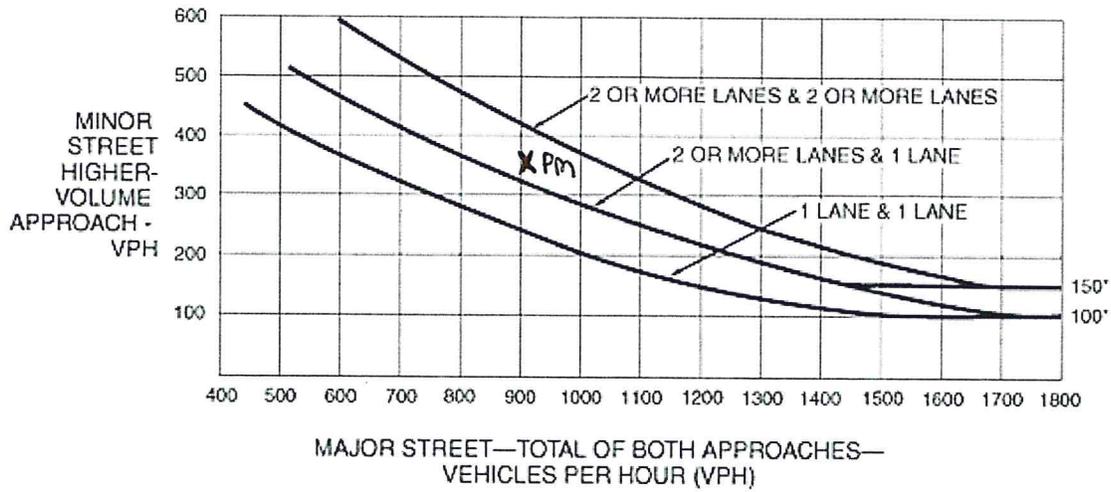
Lane	NELn1	NWLn1	SBLn1	SWLn1
Vol Left, %	50%	6%	78%	14%
Vol Thru, %	39%	0%	0%	55%
Vol Right, %	11%	94%	22%	31%
Sign Control	Stop	Stop	Stop	Stop
Traffic Vol by Lane	354	483	409	175
LT Vol	176	27	321	24
Through Vol	138	0	0	96
RT Vol	40	456	88	55
Lane Flow Rate	385	525	445	190
Geometry Grp	1	1	1	1
Degree of Util (X)	0.87	1	0.985	0.479
Departure Headway (Hd)	8.285	7.458	7.978	9.067
Convergence, Y/N	Yes	Yes	Yes	Yes
Cap	439	488	458	398
Service Time	6.285	5.509	6.001	7.104
HCM Lane V/C Ratio	0.877	1.076	0.972	0.477
HCM Control Delay	46.1	68.6	67.3	20.2
HCM Lane LOS	E	F	F	C
HCM 95th-tile Q	8.9	13.4	12.5	2.5

Figure 4C-1. Warrant 2, Four-Hour Vehicular Volume



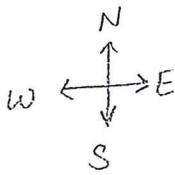
\*Note: 115 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor-street approach with one lane.

Figure 4C-3. Warrant 3, Peak Hour



\*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

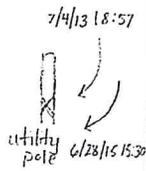
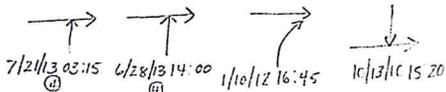
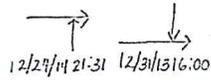
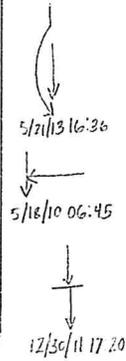
Pa 7



Liquor Store

□ 314V  
9/28/12 22:13

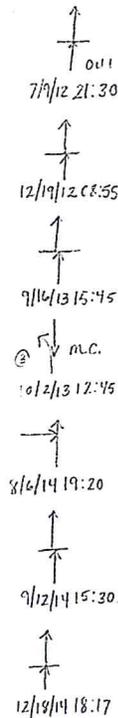
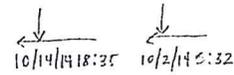
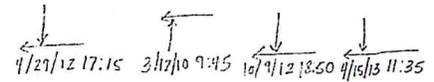
W. Meadow Rd.



Lowell, MA

Dracut, MA ↑

E. Meadow Rd.



Marioneth D. ...