

August 15, 2002

Paul Dzubek, PE
Department of Public Works
Town of Ludlow
198 Sportsmen's Road
Ludlow, MA 01056

Dear Mr. Dzubek:

The Pioneer Valley Planning Commission (PVPC) has completed its work on the Local Technical Assistance (LTA) request for the Town of Ludlow at the intersection of East Street with Miller Street. This request included PVPC staff to conduct a traffic signal warrant analysis, and develop recommendations to improve traffic flow and safety at the intersection. The result of the signal warrant analysis indicate the intersection of East Street with Miller Street meets the requirements for the installation of a traffic signal as defined in the Millennium edition of the Manual on Uniform Traffic Control Devices (MUTCD). The following sections present more information on the results of the analysis.

Geometrics and Roadway Characteristics

The intersection of East Street with Miller Street is a four-way unsignalized intersection with both approaches of Miller Street operating under "STOP" sign control. Land uses in the immediate vicinity of the intersection consist of single family homes, a construction yard, a collision repair shop, and one bar/nightclub located on the southwest corner of the intersection. There are no shoulder markings painted on the road, and no sidewalk is present in this area. Some bituminous asphalt curbing is provided in the vicinity of the intersection.

East Street runs in an east/west alignment and provides one lane of traffic in each direction. This roadway operates as the major street, providing a 21 foot through lane in the eastbound direction and a 17 foot through lane in the westbound direction. Pavement markings on East Street consist of a double yellow center line in fair to good condition. An intersection warning sign is provided on the westbound approach.

Miller Street runs on a north/south alignment and also provides one lane of traffic in each direction. The roadway operates as the minor street with a 12 foot through lane in the northbound direction, and a 16 foot through lane in the southbound direction. Pavement markings consist of a double yellow center line, with white stop lines in fair to good condition placed on both approaches at the intersection. Large "STOP" signs are located on each approach of Miller Street at its intersection with East Street.

East Street is functionally classified as a minor arterial, and Miller Street is functionally classified as a local roadway. The Massachusetts Highway Department (MassHighway) has jurisdictional responsibility over East Street, and the Town of Ludlow has jurisdictional responsibility over Miller Street.

Data Collection

Both manual and automatic traffic counts were performed in the study area during the month of April 2002. PVPC staff during the morning (7-9 AM) and afternoon (4-6 PM) peak hours performed manual turning movement counts. The 48-hour automatic traffic recorder counts were performed on each approach of the intersection of East Street with Miller Street. Copies of all traffic counts are attached to this document.

The Massachusetts Highway Department (MassHighway) develops traffic volume adjustment factors to reflect monthly variations, as traffic volumes tend to fluctuate over the course of the year. These factors were examined to determine how traffic conditions during the different months compare to average month conditions. For example, based on the MassHighway data, traffic volumes during the month of April were found to be slightly higher than the annual average. Therefore, all traffic count volumes were adjusted to reflect average month conditions. The adjusted weekday morning and afternoon peak hour traffic volumes are shown in Figure 1. Daily traffic volume information is summarized in Table 1.

Figure 1
2002 Morning and Afternoon Peak Hour Traffic Volumes

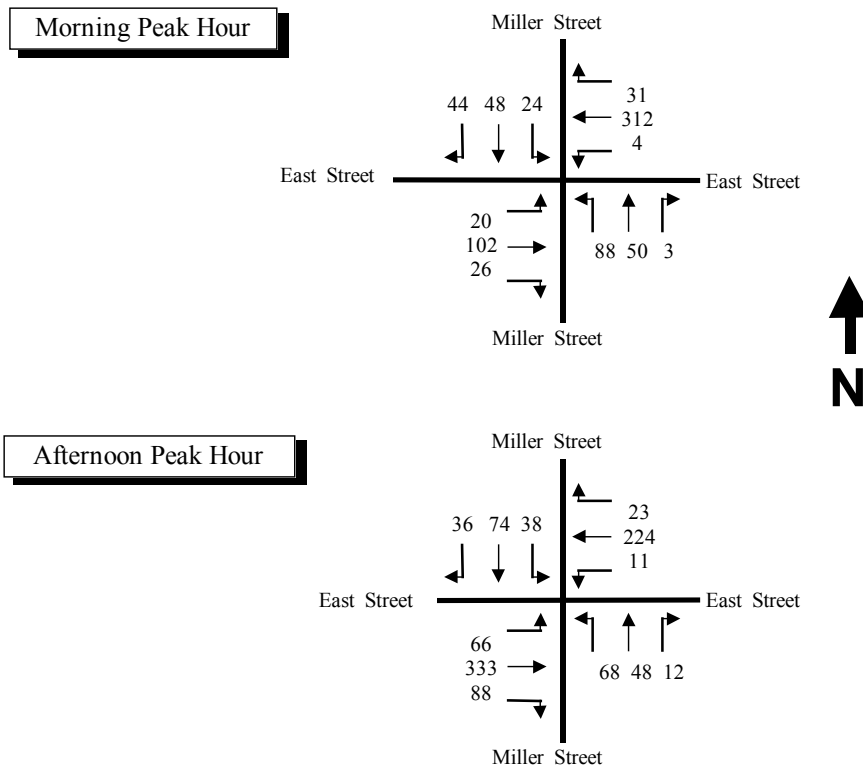


Table 1
Daily Traffic Volumes

Roadway	Total
East Street west of Miller Street	8,599
East Street east of Miller Street	6,821
Miller Street north of East Street	2,924
Miller Street south of East Street	4,736

Crash Data

The Ludlow Department of Public Works provided a crash history of the intersection. As summarized in Table 2, the intersection of East Street with Miller Street experienced a high number of crashes between January, 1998 and May, 2002. One third of all the crashes resulted in injury. Two crashes at this intersection resulted in fatal injuries. The average number of crashes per year is nine. The average crash rate per million entering vehicles for this intersection is 2.13. According to information from the Massachusetts Highway Department, the statewide average crash rate for unsignalized intersections is 0.66.

Information on the type of collision (angle, rear-end, head-on, etc.) was not available from local records. This information is useful in identifying trends and determining what types of improvements are required. It is recommended that the Town of Ludlow prepare a diagram of recent collisions at this intersection to assist in the development of future improvement alternatives.

Table 2
Crash History Summary

Location	Dates	Total Number of Crashes	Injury	Fatality
East St. at Miller St.	Jan. 1, 1998 – May 31, 2002	23	6	2
Miller St. at East St.	Jan. 1, 1998 – May 31, 2002	8	4	-

There are many reasons why this intersection experiences a high number of crashes. The posted travel speed of 45 mph requires larger gaps in the traffic stream for vehicles attempting to enter from Miller Street. During long delays on Miller Street, driver frustration causes motorists to accept smaller gaps in the travel speed. This often results in an increase in accidents. In addition, travel lanes along East Street are much wider than the 12 foot standard. This can contribute to higher travel speeds along the roadway. Finally, no “Intersection Ahead” warning sign is located on the eastbound approach of East Street to the intersection.

Travel Speeds

Travel Speed measurements were collected for the East Street at Miller Street intersection. The average speed of all vehicles was measured at 51 mph. The percent of vehicles traveling at speeds greater than 55 mph was calculated to be 15.86%. The posted speed on both East Street and Miller Street is 45 mph with segments of the roadways posted at 40 mph. The high travel speeds along East Street contribute to the high rate of personal injury and fatality crashes experienced at this intersection.

Capacity Analysis

The intersection of East Street with Miller Street was examined with regard to capacity and delay characteristics to determine the existing Level of Service (LOS). LOS is an indicator of the operating conditions which occur on a roadway under different volumes of traffic and is defined in the 2000 Highway Capacity Manual by six levels, “A” to “F”. A number of operational factors can influence the LOS including geometry, travel speeds, delay, and the number of pedestrians crossing the street.

Depending on the time of day and year, a roadway may operate at varying levels. Level of Service “A” represents the best operating conditions and is an indicator of ideal travel conditions with vehicles operating at or above posted speed limits with little or no delays. Conversely, LOS “F”, or failure, generally indicates forced flow conditions illustrated by long delays and vehicle queues. Level of Service “C” indicates a condition of stable flow and is generally considered satisfactory in rural areas. Under LOS “D” conditions, delays are considerably longer than under LOS “C”, but are considered acceptable in urban

areas. At LOS “E” the roadway begins to operate at unstable flow conditions as the facility is operating at or near its capacity. A summary of the existing LOS at the intersection of East Street with Miller Street is shown in Table 3.

Table 3
Level of Service Summary
East Street with Miller Street

	AM Peak		PM Peak	
	<u>Delay*</u>	<u>LOS</u>	<u>Delay*</u>	<u>LOS</u>
East Street EB All Moves	8.2	A	8.0	A
East Street WB All Moves	7.5	A	8.3	A
Miller Street NB All Moves	25.6	D	47.9	E
Miller Street SB All Moves	15.9	C	32.8	D

* *measured in seconds per vehicle*

The basic assumption at an unsignalized intersection is that through moving traffic on the major street is not hindered by other movements. In reality, as minor street delays increase, vehicles are more likely to accept smaller gaps in the traffic stream causing through moving vehicles to reduce speed and suffer some delay. The left turn movement off the minor street approach is the most heavily opposed movement and typically suffers the greatest delay. Therefore this movement is used as a gage to determine the overall operations at an unsignalized intersection.

Based on the results of the analysis, the northbound approach of the intersection of East Street with Miller Street currently operates at LOS “D” during the morning peak hour and LOS “E” during the afternoon peak hour. The southbound approach operates at LOS “D” during the afternoon peak hour. Generally, LOS “D” is considered acceptable in built-up urban areas, and LOS “C” is considered acceptable in rural areas.

Traffic Signal Warrants Analysis

The unsignalized intersection was checked to determine if the minimum warrants for the installation of a traffic signal are met. The Millennium edition of the Manual on Uniform Traffic Control Devices (MUTCD) sets forth the criteria for eight warrants of which, the requirements of one or more should be fully satisfied before a signal is installed. In addition, the installation of a traffic signal must improve the safety and operation of the location under study.

The intersection of East Street with Miller Street has been evaluated under the MUTCD standards for a rural location. The intersection qualifies as a rural location because the major street (East Street) travel speed is greater than or equal to 40 mph. For rural locations, 70% of the volume requirements is sufficient to satisfy a warrant. As shown in **Table 4**, two warrants are 100% satisfied, as defined in the MUTCD. Warrant analysis worksheets are attached to this document.

Table 4
Warrant Criteria Satisfaction
East Street with Miller Street

Warrant	Satisfaction of Warrant Criteria
Warrant 1- Eight-Hour Vehicular volume	YES
Warrant 2- Four-Hour Vehicular Volume	YES
Warrant 3- Peak Hour	Not Satisfied
Warrant 4- Pedestrian Volume	Not Satisfied
Warrant 5- School Crossing	Not Applicable
Warrant 6- Coordinated signal System	Not Satisfied
Warrant 7- Crash experience	Potentially, requires accident type information
Warrant 8- Roadway Network	Not satisfied

The high crash rate at the intersection of East Street with Miller Street does make it a candidate for Warrant #7 – Crash Experience. The Crash Experience signal warrant conditions are intended for application where the severity and frequency of crashes are the principal reasons to consider installing a traffic control signal. Warrant 7 requires five or more reported crashes, of types susceptible to correction by a traffic control signal, having occurred within a 12-month period. A trial of less restrictive remedies must be tested and proven ineffective before a signal can be installed under this warrant. Examples of less restrictive remedies include the installation of flashing warning beacons, conversion of the intersection to four-way stop sign control, improvements to stopping sight distance, installation of additional pavement markings and signs, and geometric improvements to the intersection.

Conclusions and Recommendations

Based on the results of this analysis, it is recommended that a traffic signal be installed at the intersection of East Street with Miller Street. Additional information on the type of collisions occurring at this intersection should also be identified to assist in designing a signal to improve both traffic flow and safety. The Town of Ludlow should also consider the following improvements to improve safety prior to the installation of a traffic signal:

- An Intersection Warning sign (W2-1) should be placed on the eastbound approach of East Street to alert drivers of the upcoming intersection.
- The Town of Ludlow should request the Massachusetts Highway Department to define a 12 foot travel lane along East Street with painted single white edge lines. Edge lines assist in providing visual references to guide road users, define the traveled way, and give the illusion of a narrower roadway which could assist in reducing travel speeds in this area.
- The word “STOP” should be painted according to the guidelines of the MUTCD on both approaches of Miller Street at its intersection with East Street to supplement the existing “STOP” signs.
- The Town of Ludlow should assess the existing street lights provided in the vicinity of the intersection to determine if adequate lighting is provided during evening hours.
- Prior to the installation of a traffic signal, a flashing warning beacon could be installed at the intersection to alert drivers of the approaching intersection.

Prior to the implementation of any changes to this intersection, the Town of Ludlow is encouraged to contact the Massachusetts Highway Department District 2 office. It is also recommended that the Town

obtain the services of a licensed professional engineer. The Pioneer Valley Planning Commission is pleased to have conducted this analysis as part of the Local Technical Assistance Program. Please feel free to call me if you have any questions or require additional information.

Sincerely,

Gary M. Roux
Principal Planner

cc: T. Brennan, PVPC
A. Kouzekanni, PVPC