



BOSTON REGION METROPOLITAN PLANNING ORGANIZATION

Stephanie Pollack, MassDOT Secretary and CEO and MPO Chair
Karl H. Quackenbush, Executive Director, MPO Staff

TECHNICAL MEMORANDUM

DATE: July 27, 2016
TO: Town of Stow
FROM: Chen-Yuan Wang, MPO Staff
RE: Route 117 (Great Road) at Hudson Road, Stow
CC: J. Frawley, MassDOT Highway Division District 3

The Boston Region Metropolitan Planning Organization's (MPO) Community Transportation Technical Assistance program provides analysis and advice about local transportation issues to municipal officials. At the request of the Town of Stow, MPO staff examined existing operations at the intersection of Route 117 (Great Road) at Hudson Road because of a nearby roadway capacity reduction and explored potential short- and long-term improvements.

1 STUDY BACKGROUND

In January 2016, the Massachusetts Department of Transportation (MassDOT) installed traffic control signals and changed the traffic operation from continuous two-way to alternating one-way on the Route 62 bridge spanning the Assabet River in Stow's Gleasondale Village. A safety inspection of the bridge made the change necessary.

The reduction of the bridge's operational capacity likely has altered the traffic patterns on Route 62 (Gleasondale Road) and the surrounding roadways, most notably Hudson Road, a north-south collector parallel to Route 62. Hudson Road would be the most efficient alternative to accessing Main Street in Hudson to the south and Route 117 in Stow to the north.

Specifically, the town is concerned with the traffic impact to the Hudson Road intersection at Route 117. The intersection carries heavy commuter traffic during peak hours and is currently unsignalized. Traffic conditions are also complicated by the curb cuts at one corner of the intersection, where a popular gas station (with a Dunkin' Donuts inside) is located.

The Town also expressed concerns about the intersection's safety. Vehicles usually travel through the intersection at a relatively high speed (Route 117 has a speed limit of 40 miles per hour in this area). There is no exclusive left-turn lane

from Route 117 westbound to Hudson Road, and the turning vehicles frequently block through traffic during peak hours, increasing the potential for crashes.

2 TRAFFIC DATA COLLECTION

In order to examine potential traffic impacts and existing traffic operations at the intersection, MPO staff requested MassDOT's assistance in collecting traffic counts and crash data. These data include:

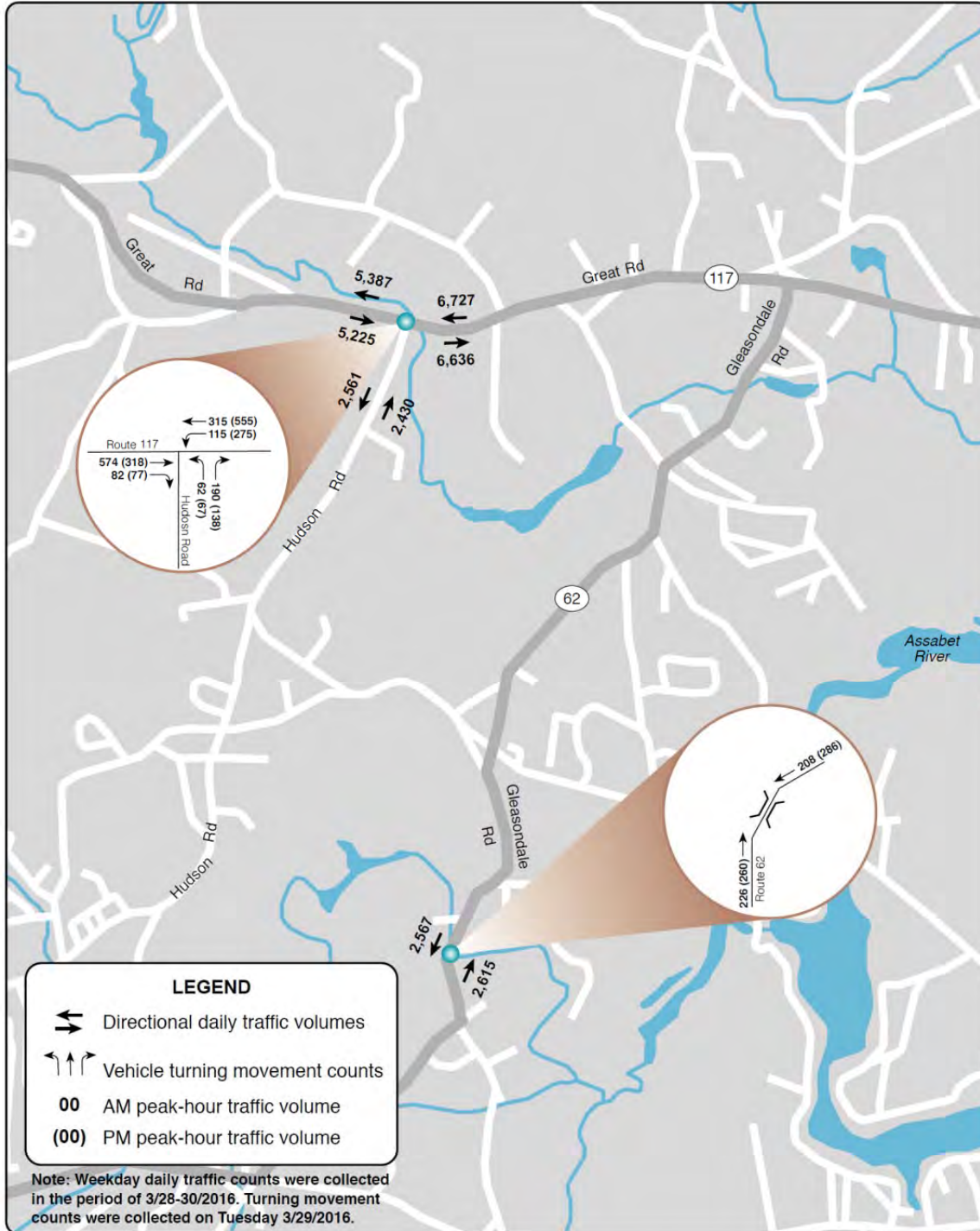
- Weekday daily traffic counts at four locations (collected in the week of March 28, 2016):
 - Route 117 (Great Road) east of Hudson Road
 - Route 117 west of Hudson Road
 - Hudson Road south of Route 117
 - Route 62 (Gleasondale Road) north of Rockbottom Road
- Turning movement counts, including vehicles, pedestrians, and bicycles (6:00–9:00 AM and 3:00–6:00 PM, March 29, 2016)

Detailed breakdowns of these data are included Appendices A and B. Appendix A contains hourly traffic counts from March 28 to March 30 at the four locations. Appendix B presents a summary of the AM and PM peak-hour turning-movement counts.

Figure 1 shows average weekday directional traffic volumes at the four locations and observed turning movements at the intersection. The intersection carries about 1,350 vehicles in the AM peak hour and 1,450 vehicles in the PM peak hour. No pedestrians or cyclists were observed during the counting periods (winter season). As for daily traffic, Route 117 carried about 13,400 vehicles east of the intersection and about 10,500 vehicles west of the intersection. Hudson Road carried nearly 5,000 vehicles per day.

At the bridge location, Route 62 carried about 5,200 vehicles per day in the week of March 28, 2016. Adjusted by seasonal and axle factors¹, it carries about 5,000 vehicles per average day. According to MassDOT, the same location carried about 6,000 vehicles in 2014. Presumably, about 1,000 vehicles were diverted to other roadways because of the bridge's one-way operation.

¹ Based on MassDOT's estimation and the roadway's functional class, staff applied a seasonal factor of 1.01 (the ratio of annual average and March average) and an axle factor of 0.96 to the count.



BOSTON
REGION
MPO

Figure 1
Weekday Daily and Peak Hour Traffic Volumes
Route 117 (Great Road) at Hudson Road, Stow

Community
Transportation
Technical
Assistance

Source: Central Transportation Planning Staff.

3 CRASH DATA ANALYSIS

In order to analyze the collision patterns, locations, and causes of crashes at the intersection, MPO staff obtained recent three-year (2013–2015) crash reports from the Stow Police Department. In total, there were 17 reported crashes at the intersection in the last three years.

Table 1 summarizes the crash data by severity, collision type, pedestrian or cyclist involvement, peak or non-peak traffic period, and weather and pavement conditions. About 20 percent of the crashes caused personal injuries. Nearly half of the crashes were rear-end collisions. No crashes involved pedestrians. One crash involved a cyclist. About 65 percent of the crashes occurred during the peak traffic periods.

Table 1
Summary of Stow Police Crash Reports 2013–2015

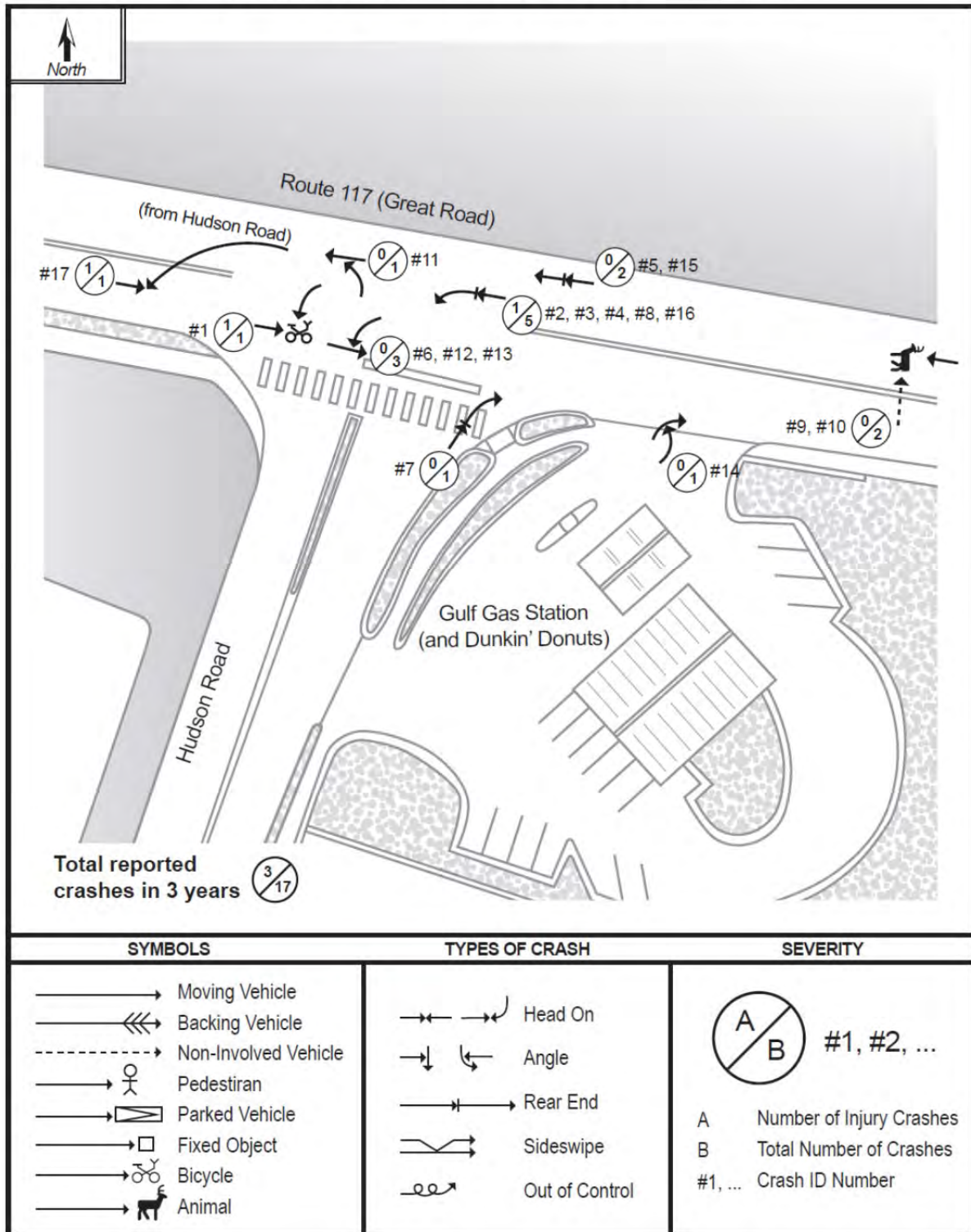
Statistics Period		2013	2014	2015	3-Yr. Total	Annual Avg.
Total number of crashes		5	7	5	17	5.7
Severity	Property damage only	4	7	3	14	4.7
	Non-fatal injury	1	0	2	3	1.0
	Fatality	0	0	0	0	0.0
	Not reported/unknown	0	0	0	0	0.0
Collision type	Single vehicle	0	2	0	2	0.7
	Rear-end	4	2	2	8	2.7
	Angle	1	3	1	5	1.7
	Sideswipe, same direction	0	0	0	0	0.0
	Sideswipe, opposite direction	0	0	0	0	0.0
	Head-on	0	0	2	2	0.7
	Rear-to-rear	0	0	0	0	0.0
	Not reported/unknown	0	0	0	0	0.0
Involved pedestrian(s)		0	0	0	0	0.0
Involved cyclist(s)		1	0	0	1	0.3
Occurred during weekday peak periods*		4	5	2	11	3.7
Wet or icy pavement conditions		0	1	0	1	0.3
Dark conditions (lit or unlit)		0	2	0	2	0.7

* Peak periods are defined as 7:00–10:00 AM and 3:30–6:30 PM.

Source: Stow Police Department.

Figure 2 presents a collision diagram of the intersection. For reference, Table 2 summarizes major factors of each of the crashes in the diagram by crash identification number.

Figure 2
Collision Diagram: Route 117 (Great Road) at Hudson Road
Stow Police Reports: January 2013–December 2015



Source: Central Transportation Planning Staff.

Table 2
List of Stow Police Crash Reports 2013–2015

#	Crash Date	Day	Time	Crash Severity	Collision Type	Surface	Lighting	Ped/Bike	Driver Contribution Code
1	07-May-2013	Tuesday	6:14 PM	Non-fatal injury	Angle	Dry	Daylight	Bike	Sun glare, inattention
2	31-May-2013	Friday	8:36 AM	Property damage only	Rear-end	Dry	Daylight	-	Inattention
3	6-Jun-2013	Thursday	7:08 AM	Property damage only	Rear-end	Dry	Daylight	-	Followed too closely
4	07-Sep-2013	Saturday	5:43 PM	Property damage only	Rear-end	Dry	Daylight	-	Distracted
5	10-Oct-2013	Thursday	4:19 PM	Property damage only	Rear-end	Dry	Daylight	-	Inattention
6	24-Apr-2014	Thursday	8:52 AM	Property damage only	Angle	Dry	Daylight	-	Failed to yield right of way
7	10-Jul-2014	Thursday	9:47 AM	Property damage only	Rear-end	Dry	Daylight	-	Inattention
8	31-Jul-2014	Thursday	3:37 PM	Property damage only	Rear-end	Dry	Daylight	-	Fatigued/asleep
9	9-Oct-2014	Thursday	7:16 PM	Property damage only	Single vehicle	Dry	Dark-not lighted	-	No Improper Driving
10	18-Oct-2014	Saturday	7:42 PM	Property damage only	Angle	Dry	Dark-not lighted	-	No Improper Driving
11	22-Oct-2014	Wednesday	8:37 AM	Property damage only	Single vehicle	Wet	Daylight	-	Failed to yield right of way
12	29-Nov-2014	Saturday	4:10 PM	Property damage only	Angle	Dry	Daylight	-	Failed to yield right of way
13	15-Apr-2015	Wednesday	6:55 PM	Property damage only	Head-on	Dry	Daylight	-	Glare
14	8-May-2015	Friday	7:57 AM	Property damage only	Angle	Dry	Daylight	-	Made an improper turn
15	10-Jul-2015	Friday	11:53 AM	Property damage only	Rear-end	Dry	Daylight	-	Inattention
16	27-Sep-2015	Sunday	9:13 AM	Non-fatal injury	Rear-end	Dry	Daylight	-	Operating vehicle in erratic, reckless, careless, negligent or aggressive manner
17	6-Nov-2015	Friday	7:28 AM	Non-fatal injury	Head-on	Dry	Daylight	-	Unknown

Source: Stow Police Department.

The collision diagram shows that nearly half of the crashes occurred on the Route 117 westbound approach. Five of them were rear-end collisions involving a left-turning vehicle. Another two rear-end collisions, not involving a left-turning vehicle, were caused by a sudden slow-down or stop in response to a left-turning vehicle.

Another prominent collision pattern involved a westbound left-turning vehicle and an eastbound through vehicle. There were three such crashes like this, presumably resulting from a left turn taken within an insufficient traffic gap. There was also a crash involving a cyclist with a westbound left-turning vehicle. The driver said that the evening sun glare affected his view of the cyclist.

Two crashes involved a vehicle turning left from Hudson Road onto Route 117. Both occurred in the morning peak period (7:00–9:00). Further east (about 150 to 200 feet) from the intersection, two crashes occurred involving a westbound vehicle and a crossing deer. It appears that the area (the eastern bank of Elizabeth Brook) could be a deer traveling path.

The two crashes involving a deer, both in 2014, are not related to the intersection operations; excluding them, the intersection had five crashes in each of the last three years. There is no noticeable increase in the number of crashes at the intersection from 2013 to 2015. As the Route 62 bridge operation changes in 2016, the crash data at this intersection should be monitored annually.

4 INTERSECTION CAPACITY ANALYSIS

4.1 Existing Conditions Analysis

Based on the turning movement counts, MPO staff used the Synchro traffic analysis and simulation program to conduct intersection capacity analysis to evaluate the intersection's existing operations.² Table 3 summarizes the analysis results. Under the current conditions (with diverted traffic from Route 62), the Hudson Road (northbound) approach is estimated to endure about half a minute delay per vehicle in the AM peak hour and about one minute per vehicle in the PM peak hour. Details of these analyses are included in Appendix C.

Table 3
Intersection Capacity Analysis: Existing Traffic Conditions

Intersection Approach	AM Peak Hour		PM Peak Hour	
	LOS	Average Delay	LOS	Average Delay
Route 117 Eastbound	A	-	A	-
Route 117 Westbound	A	4 sec	A	6 sec
Hudson Road	D	26 sec	F	76 sec
Intersection Overall	-	6 sec	-	14 sec

LOS = Level of service. This is a qualitative measure used to relate the quality of traffic service. For unsignalized intersections, an approach is defined as LOS A with an average delay of 10 seconds or less, as LOS D with an average delay between 25 and 35 seconds (or equal to 35 seconds), or as LOS F with an average delay of 50 seconds or more.

Sec = Seconds.

Source: Highway Capacity Manual.

As no historical counts at the intersection are available for analysis, staff used 80 percent of the existing traffic to and from Hudson Road to represent the scenario of no traffic diversions from the Route 62 capacity reduction for comparison. Table 4 summarizes the analysis results for this scenario. In this case, the Hudson Road approach would endure less delay, especially in the PM peak period.

² Synchro Version 9.0 was used for the analyses. This software is developed and distributed by Trafficware Ltd.

Table 4
Intersection Capacity Analysis: No Traffic Diversion Assumption

Intersection Approach	AM Peak Hour		PM Peak Hour	
	LOS	Average Delay	LOS	Average Delay
Route 117 Eastbound	A	-	A	-
Route 117 Westbound	A	3 sec	A	5 sec
Hudson Road	C	22 sec	D	29 sec
Intersection Overall	-	5 sec	-	6 sec

LOS = Level of Service. Level of Service is a qualitative measure used to relate the quality of traffic service. For unsignalized intersections, an approach is defined as LOS A with an average delay of 10 seconds or less, as LOS C with an average delay between 15 and 25 seconds (or equal to 25 seconds), or as LOS D with an average delay between 25 and 35 seconds (or equal to 35 seconds).

Sec = seconds.

Source: Highway Capacity Manual.

4.2 Preliminary Traffic Signal Needs Analysis

Staff also conducted a preliminary analysis of the need for a traffic signal at the intersection. According to the Manual on Uniform Traffic Control Devices (MUTCD), the investigation should include an analysis of factors related to the existing operation and safety conditions of the intersection, the potential to improve these conditions, and the applicable factors contained in the following traffic signal warrants:

- Warrant 1: Eight-Hour Vehicular Volume
- Warrant 2: Four-Hour Vehicular Volume
- Warrant 3: Peak Hour
- Warrant 4: Pedestrian Volume
- Warrant 5: School Crossing
- Warrant 6: Coordinated Signal System
- Warrant 7: Crash Experience
- Warrant 8: Roadway Network
- Warrant 9: Intersection Near a Grade Crossing

At this location, Warrants 1, 2 and 7 are applicable. Based on the recent traffic counts, staff examined these warrants under two scenarios: 2016 existing traffic conditions and 2016 no traffic diversion (80 percent traffic reduction). The analyses (summarized in two tables in Appendix D) indicate that Warrants 1 and

2 are satisfied under the first scenario and only Warrant 1 is satisfied under the second scenario.³

4.3 Traffic Signal Scenario Analysis

Staff also found that, operationally and with respect to safety, the intersection would work best if an exclusive westbound left-turn lane of storage length of at least 75 feet (100 feet desirable) were installed at the intersection.⁴ The MassDOT Road Inventory file indicates that the section of Route 117 that runs through this area, which has a right-of-way of 60 feet, is a candidate for the expansion. However, it should be examined further at the design stage, including the constraint created by the adjacent bridge over Elizabeth Brook located east of the intersection.

Table 5 summarizes the capacity analysis of the signal scenario under existing traffic conditions (containing the diverted traffic). The scenario uses a cycle length of 70 seconds, including an on-demand exclusive pedestrian signal phase of 21 seconds.

Table 5
Intersection Capacity Analysis: Signal Scenario under Existing Traffic

Intersection Approach	AM Peak Hour		PM Peak Hour	
	LOS	Average Delay	LOS	Average Delay
Route 117 Eastbound	B	16 sec	B	17 sec
Route 117 WB Left-turn	A	9 sec	A	7 sec
Route 117 WB Through	A	5 sec	A	6 sec
Hudson Road	C	25 sec	C	22 sec
Intersection Overall	B	15 sec	B	12 sec

LOS = Level of Service. Level of Service is a qualitative measure used to relate the quality of traffic service. For signalized intersections, an approach is defined as LOS A with an average delay of 10 seconds or less, as LOS B with an average delay between 10 and 20 seconds (or equal to 20 seconds), or as LOS C with an average delay between 20 and 35 seconds (or equal to 35 seconds).

Sec = seconds.

Source: Highway Capacity Manual.

³ MUTCD emphasizes that satisfying a signal warrant or warrants should not necessarily require installation of a traffic signal. Further engineering studies based on detailed and updated data are needed in order to justify a signal installation at this location.

⁴ Staff examined different signal settings under the existing layout (with no westbound left-turn exclusive lane) and found that the westbound approach would endure extensive traffic queuing during the peak hours, especially in the evening. Meanwhile, the split-phase setting is not suitable for Route 117 and would increase delays on both approaches.

The analysis indicates that the traffic signal would reduce delays on the Hudson Road approach and maintain minimal delays on the Route 117 approaches. It also has the potential to improve safety for all users at the intersection, including pedestrians and cyclists.

Appendix E contains Highway Capacity Manual (HCM) reports of both the AM and PM peak-hour intersection capacity analyses. Appendix F contains Synchro reports with details of the timing settings for both the AM and PM peak-hour analyses.

5 PROPOSED IMPROVEMENTS

MPO staff met with Stow and MassDOT's Highway Division District 3 officers on June 6, 2016, to review the analyses and discuss potential improvements. The following proposed improvements include suggestions made by the town and MassDOT District 3 during the meeting (see Appendix G for a summary of the items discussed).

In the short term, MPO staff propose the following improvements:

- Re-stripe the faded crosswalk on Hudson Road and relocate the stop bar to behind the crosswalk
- Repair the sidewalk and wheelchair ramp pavement and improve drainage conditions at the southwest corner of the intersection
- Install "Side Road" intersection warning signs (W2-2, MUTCD) about 300 feet from the intersection in both directions of Route 117
- Examine suitable locations for installing "Deer Crossing" warning signs (W11-3, MUTCD)⁵
- Continue monitoring traffic conditions and crash data at the intersection until the bridge is reconstructed

In the long-term, MPO staff recommend that Stow further pursue possible signalization of the intersection, preferably preparing a 25 percent functional design report for submission to MassDOT. The traffic signal design should include the following items:

- Add a westbound left-turn lane
- Redesign the substandard traffic median on Hudson Road⁶

⁵ The need for deer-crossing signs should be examined comprehensively for the entire corridor.

- Install pedestrian signal phasing and facilities, including a refuge on Hudson Road and assessing the potential for a crosswalk on Route 117
- Consider bicycle accommodations
- Create an access management plan for the nearby gas station, including examining the potential for right-in and right-out only access on Route 117⁷
- Consider adding sun glare deterrent on signal displays
- Explore potential for coordinating with the traffic signal on Route 117 at Harvest Drive

CW/cw

⁶ The small median is deteriorated and frequently run over by vehicles turning from Route 117. It should be upgraded to be six feet wide. If necessary, a MUTCD R4-7 (Keep Right) sign facing Route 117 may be installed on the median.

⁷ See detailed discussions in Appendix G.