

Truck Turning Study for Main Street Intersection, Orange



Franklin Regional Council of Governments
September 2015

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Prepared under Contract #75369 in cooperation with the Massachusetts Department of
Transportation, the U.S. Department of Transportation, and the Federal Highway
Administration

Introduction

This study has been prepared for the Town of Orange to evaluate the effects of turning movements by heavy vehicles at the intersection of North Main Street, East Main Street, South Main Street and West Main Street. Large trucks and buses are observed encroaching on opposing lanes of traffic or into the corners of the intersection when making right turns. This report will examine the extent of truck turning encroachments and their impact on operation of the intersection, provide recommendations to mitigate the impact of encroachments, and propose methods to implement the recommendations.

Study Area

The area under study consists of the approaches to and intersection of East and West Main Street (Route 2A), South Main Street (Route 122) and North Main Street in downtown Orange, a commercial/residential area. The intersection is a conventional four-way intersection controlled by a traffic signal.

West Main Street and East Main Street are designated as Route 2A, an east-west route providing local access from Route 2 in Erving, through Orange, into Athol and points east. Both streets are classified as urban principal arterial routes. This section of Route 2A is part of the Mohawk Trail Scenic Byway.

South Main Street is designated as Route 122, a north-south route that begins in south/central Massachusetts and ends at the intersection with North Main Street in Orange. Route 122, also a Scenic Byway, provides a connection with US Route 202 south of the study area. South Main Street is classified as an urban minor arterial.

North Main Street is an urban collector that runs north-south between the downtown area and north Orange. All of the roadways approaching the intersection are under local jurisdiction within the study area, as is the traffic signal controlling the intersection.

Existing Conditions

This section describes the existing roadway conditions in the vicinity of the intersection. Parallel parking lanes are provided on both sides of East Main Street and South Main Street, on the south side of West Main Street, and on the east side of North Main Street. All sidewalks in the area are constructed with straight granite curb and sloped ramps at each end of the crosswalks that are present on all four intersection approaches. In the spring of 2015, the pavement markings, including crosswalks, stop lines, and yellow center lines, were significantly faded within the intersection.

East Main Street is approximately 36 feet wide, with 11-ft travel lanes and 7-ft wide parallel parking lanes on either side. There is an uphill grade to the roadway in the westbound direction. The parking lane on the south side of East Main Street begins approximately 35 feet from the southeast corner of the intersection and the parking lane on the north side ends approximately 30 feet from the northeast corner. The westbound stop line is about 11 feet from the end of the parking lane, which is 5 feet back from the 8-ft wide crosswalk. One travel lane is provided in each direction, with left-turning, through, and right-turning vehicles sharing one lane at the intersection. There are 7.5-ft. wide sidewalks on either side of East Main Street, with commercial buildings built up to the back of the sidewalk.

North Main Street is 36 feet wide at the intersection, with a 7-ft wide parallel parking lane with two spaces on the east side of the street. There is a relatively steep downhill grade to the roadway in the southbound direction. The parking lane is approximately 45 feet from the northeast corner. A 7-ft wide crosswalk is about 7 feet from the corner, with the southbound stop line about 5 feet before the crosswalk. There is a 7.5 ft.-wide sidewalk on the east side of the street. On the west side of the street there is a brick paved walkway that is approximately 47 feet long and 17 feet wide at the intersection. There is one travel lane in each direction, with left-turn, right-turn, and through vehicles sharing one lane at the southbound intersection approach.

West Main Street is approximately 46 feet wide at the intersection, with a 7-ft wide parallel parking lane on the south side of the street. The roadway is at a level grade at the intersection approach. There are two eastbound lanes at the intersection, one for right-turning vehicles and one shared left-turn/through traffic lane; both eastbound lanes and the westbound lane on West Main Street are approximately 13 feet wide. The parking lane ends approximately 55 feet from the corner of the intersection, although during site visits, commercial trucks were observed using this no-parking zone to make deliveries to a nearby business. The 7-ft wide crosswalk is approximately 3 feet from the corner, with the eastbound stop line 5 feet from the crosswalk. There is a 9-ft wide concrete sidewalk on the

south side of the street in front of a vacant lot and a parking lot at the southwest corner, both owned by the town of Orange. On the north side, the brick-paved sidewalk on the west side of North Main Street forms a bump-out at the northwest corner of the intersection, with five head-in parking spaces set back about 15 feet from the westbound travel lane.



Photo: View of intersection from West Main Street. June 2015

South Main Street is approximately 45 feet wide at the intersection, with 7-ft wide parallel parking lanes on both sides of the street. The roadway is at basically a level grade at the intersection approach. The parking lane on the east side of the street is 44 feet from the southeast corner while the parking lane on the west side is about 30 feet from the southwest corner. A 7-ft wide crosswalk is set about 9 feet back from the southeast corner, with the northbound stop line set about 6 feet back from the crosswalk. One travel lane, approximately 15 ft. wide, is provided in each direction, with all northbound vehicles sharing the lane at the intersection. Sidewalks are provided on both sides of the street, 10 feet wide on the east side, 7.5 feet wide on the west side.

There are multiple fixed objects in place within the sidewalks at all four corners of the intersection, mostly set back 1 ft. to 2 ft. from the curb. Two large posts installed in the northeast and southwest corners support the span wires for the traffic signal head mounted over the intersection; additional signal heads and signal control equipment are attached to the large posts. There is also a short upright steel post that is approximately 8 inches from the edge of the curb, protecting the southwest signal post; the short post is visibly marked

from being struck or grazed by right-turning vehicles. Ground-mounted traffic signal equipment is mounted on posts in the southeast and northwest corners. In addition, there are ground-mounted posts with directional signs for Route 2A and Route 122 in the northwest and southwest corners and a fire hydrant in the northeast corner that is approximately 5 inches from the edge of the curb. There are also ornamental and overhead street lighting posts installed in the sidewalks adjacent to the corners of the intersection.

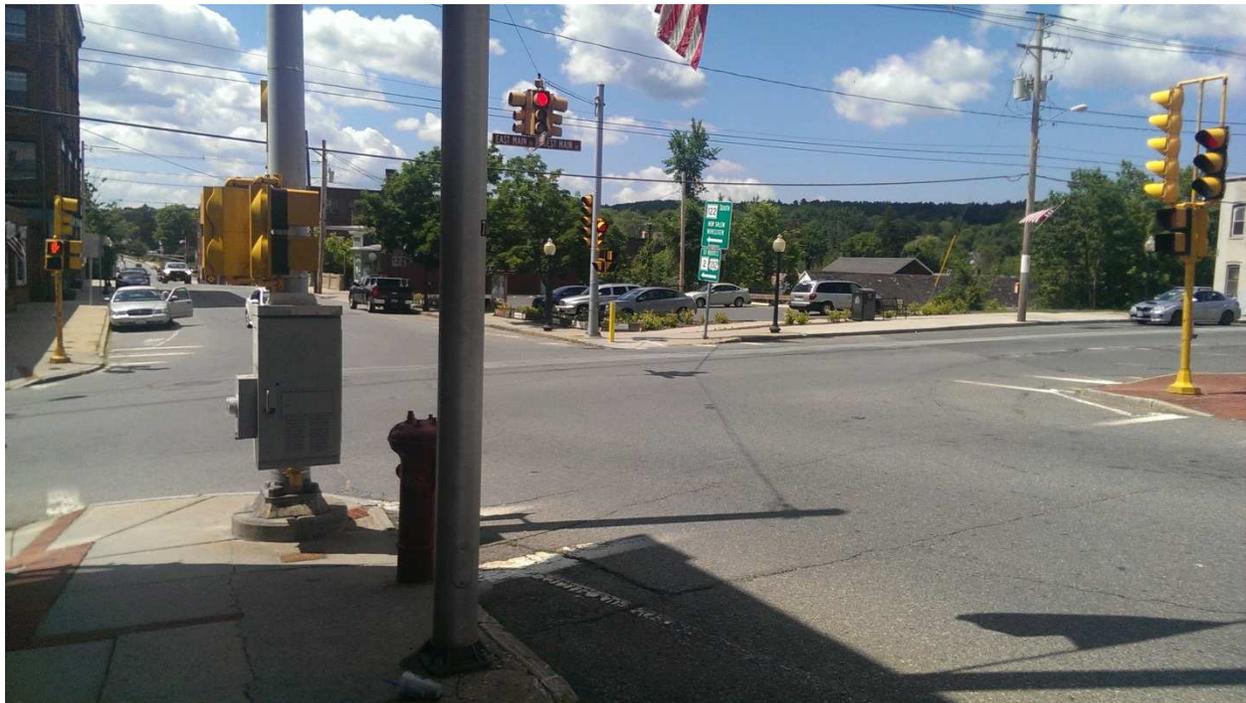


PHOTO: View of intersection from North Main Street. June 2015

Traffic Operations

The FRCOG conducted automatic traffic recorder counts in the vicinity of the intersection on North Main Street in October 2006 and on East Main, West Main, and South Main Streets in September 2013. The results of these counts were reviewed to determine the average daily volume of all vehicles, the percentage of heavy vehicles (large trucks and buses) in the traffic stream, and the peak traffic hours for the intersection.

The average daily traffic on each leg of the intersection is summarized in Table 1. The total volume of traffic traveling through the intersection on an average day is approximately 10,515 vehicles per day (vpd).

Table 1. Overall Intersection Volume [vpd]

Street	Direction of Travel*				Total
	Northbound	Eastbound	Southbound	Westbound	
North Main	2,185		1,775		3,960
West Main		2,110		1,865	3,975
South Main	3,100		3,100		6,200
East Main		3,530		3,530	7,060
Intersection	3,100	2,110	1,775	3,530	10,515

*Traffic direction approaching the intersection is indicated in **BOLD**

The data collected in the 2013 traffic counts on East, West, and South Main Streets included a breakdown of vehicle types, indicating the percentage of buses and large trucks in the traffic stream (this data was not collected in the 2006 traffic count on North Main Street). For the purposes of this study, heavy vehicle refers to trucks or buses with six wheels on two axles and all vehicles with three or more axles. Based on their turning radius and thus their ability to navigate the corners of the intersection, pickup trucks, single-unit panel trucks with four wheels, and vans were not considered as heavy vehicles. The results, summarized in Table 2, indicate that heavy vehicles constitute six percent (6%) of the overall traffic traveling through the intersection on an average day.

Table 2. Large Truck Summary

Street Approach	Heavy Vehicles [vpd]	% of All Vehicles
West Main, Eastbound	176	8%
South Main, Northbound	363	12%
East Main, Westbound	91	3%
Intersection*	630	6%

*Intersection total does not include North Main Street.

The automatic traffic recorder counts indicate that the proportion of large trucks navigating the intersection on an average weekday is highest between the hours of 7:00 to 9:00 a.m. and 2:00 to 4:00 p.m. Manual counts of vehicle turning movements were conducted in February 2015 during these peak hours to determine what proportion of the large trucks are making right turns through the intersection. The results are illustrated in Figures 1 and 2.

The color-coordinated bands in the figures symbolize the proportion of heavy vehicles making right turns, left turns, and through movements in each direction approaching the intersection. In the morning peak period, the highest volume of heavy-vehicle right-turns occurs at the southeast corner, with 14 out of 28 heavy vehicles on South Main Street turning right onto East Main Street. In the afternoon peak period, the southwest corner

experiences the highest volume of heavy-vehicle right turns, with 7 out of 20 heavy vehicles turning right from West Main Street onto South Main Street. The turning movement counts also indicate that heavy-vehicle right turns are least prevalent at the northwest corner, with only one heavy vehicle turning from North Main Street onto West Main Street in the morning peak period, and none during the afternoon peak.

Figure 1: Heavy Vehicle Turning Movements, Morning Peak Period

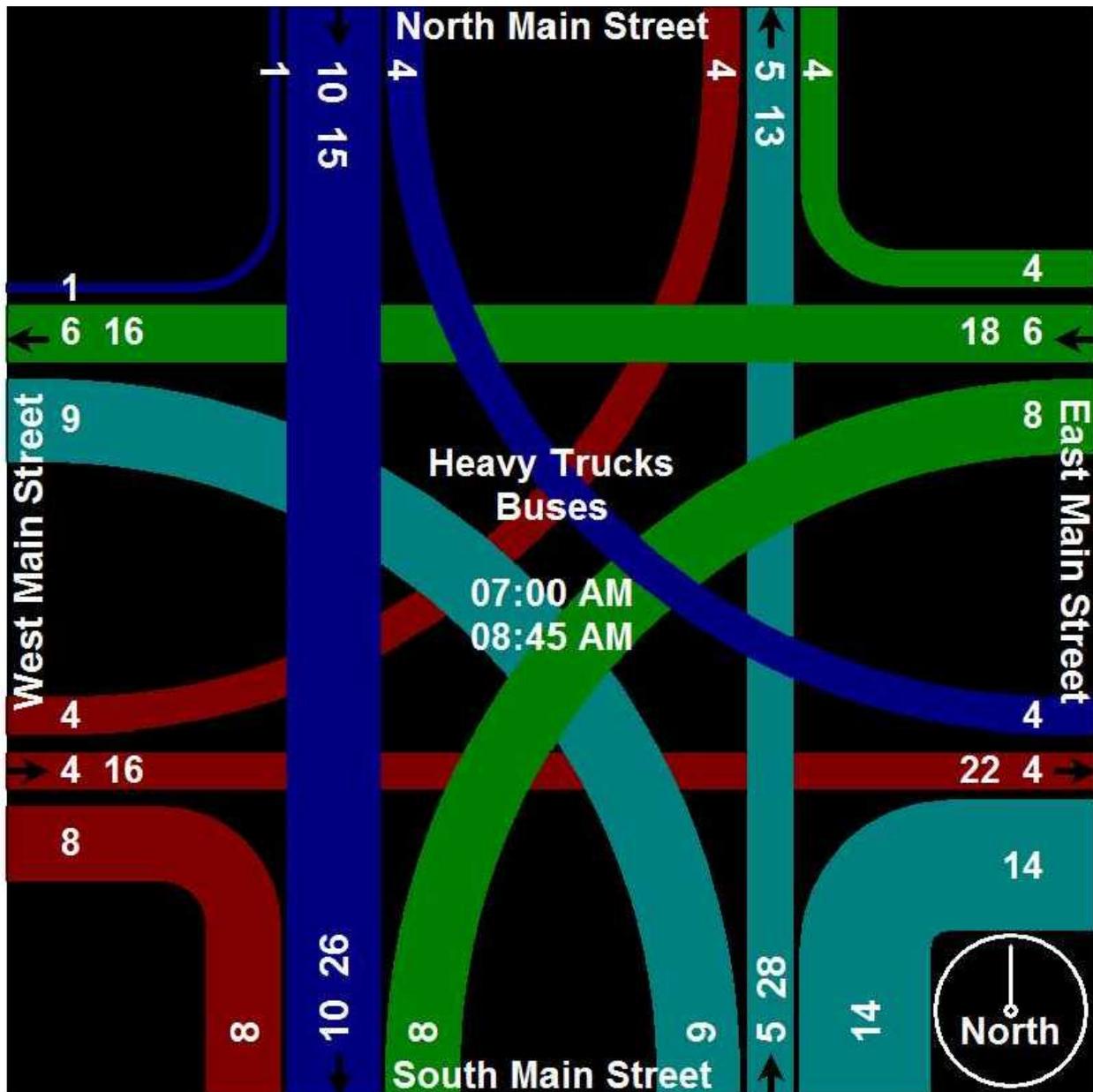
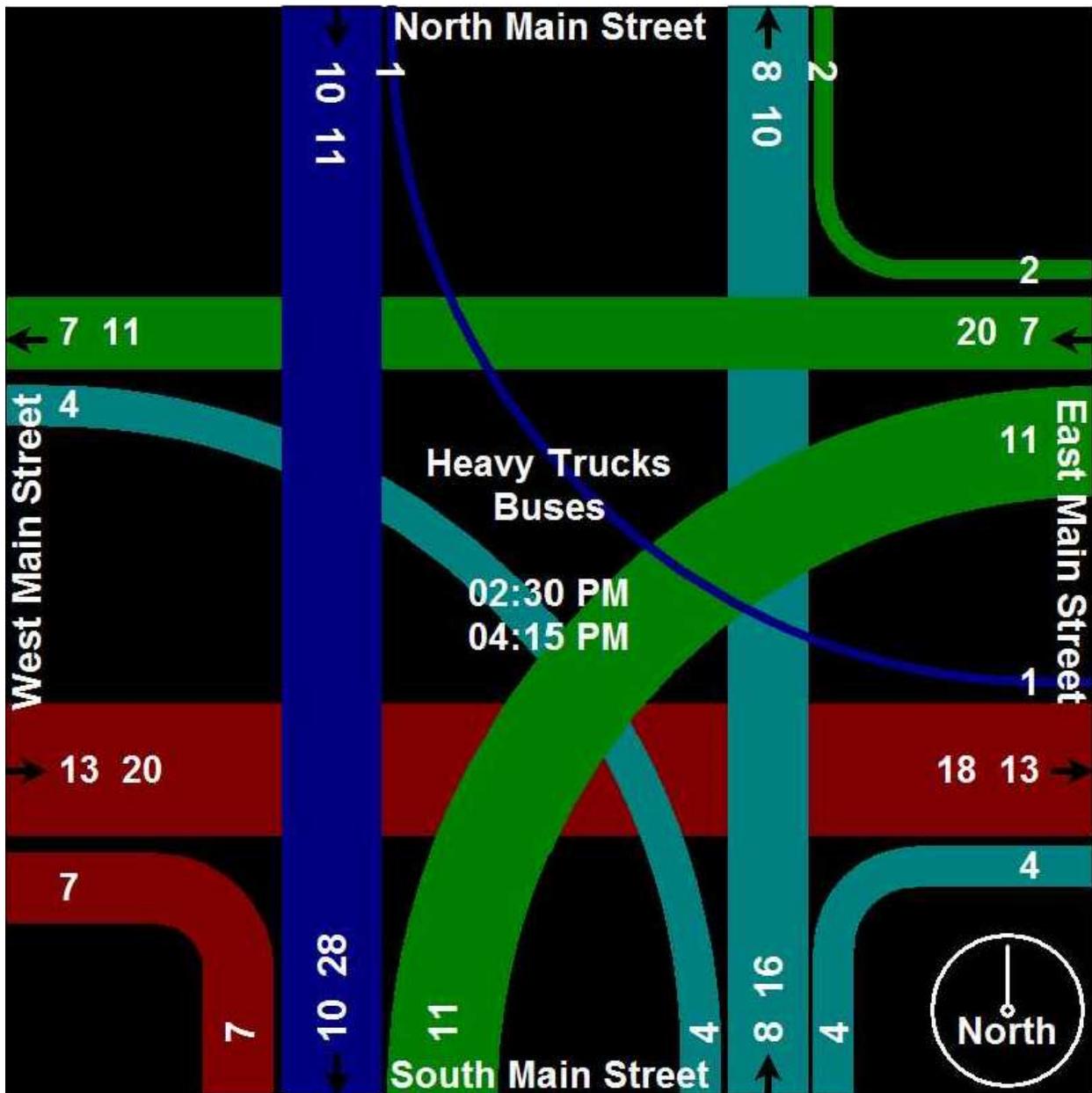


Figure 2: Heavy Vehicle Turning Movements, Afternoon Peak Period



Turning Maneuvers

Large trucks and buses are wider and have longer wheelbases than conventional passenger cars and so typically require more room within the roadway to complete left and right turns. Tractor-trailer trucks also need a wider path to accommodate for the sweep of the articulated trailer behind the cab of the truck. In conditions like the Main Street intersection, narrow travel lanes and infrastructure built up at the corners constrain the turning

maneuvers of heavy vehicles. Although a significant portion of heavy vehicles are making left turns within the intersection, there is enough room within the center of the intersection for drivers to complete left turns without encroaching on opposing traffic.

A Policy on Geometric Design of Highway and Streets, published by the American Association of State Highway and Transportation Officials (AASHTO) and also known as the “Green Book”, is the standard reference for the practice of roadway design. It provides recommended minimum design radii for various classes of motor vehicles and procedures for determining the allowable turning radius of an existing intersection. The existing right-turn radius of each corner of the Main Street intersection was measured for this study using field measurements and aerial photography. The centerline radius was measured from the center of each travel lane and the maximum turning radius was measured from the outside of the travel lane. Table 3 compares the existing right-turn radii to those recommended in the Green Book for passenger cars, single-unit trucks, conventional school buses, and 67-ft tractor-trailers. (The 67-ft tractor-trailer was largest truck observed in the traffic counts conducted by FRCOG and has an equivalent turning radius to a 50-ft truck, which is the most common tractor-trailer on highways in the Northeast region.)

Table 3. Design Radius for Right Turns [ft.]

	Centerline Turning Radius ¹	Minimum Turning Radius ²	Maximum Turning Radius ³
Main Street Intersection			
Southeast Corner	32	-	37.5
Northeast Corner	30	-	35.5
Northwest Corner	32	-	38.5
Southwest Corner	30	-	36.5
Design Vehicles			
Passenger Car	21	24	25.5
Conventional School Bus	37.8	38.9	39.5
Single-unit Truck*	38	42	43.5
WB-67**	41	45	46.4

Source: *A Policy on Geometric Design of Highway and Streets, 5th Edition, 2004. AASHTO*

*Single-unit truck with 6 wheels

**Combination tractor-trailer with 67-ft wheelbase

1. Turning radius at center of front axle
2. Path of left front wheel
3. Path of front overhang

Examining each corner of the intersection, it is apparent that the available turning room in the intersection is inadequate for the common types of heavy vehicles to complete right turns within the path of travel, particularly at the northeast and southwest corners. This is confirmed by observations from local people who are familiar with the intersection.

Heavy vehicles turning right from East Main Street or West Main Street will swing wide into the center of the intersection, encroaching on opposing travel lanes, to avoid striking fixed objects in the sidewalk. Drivers familiar with the intersection will stop well back of the stop line on South Main Street and North Main Street to leave room for heavy vehicles to complete right turns, while unfamiliar drivers who stop at the stop line may need to reverse to make room; when more than one vehicle is queued on South or North Main Street and the first car cannot reverse, the oncoming heavy vehicle may wait until the queue is cleared before making the right turn. On West Main Street, a truck in the right-turn lane might wait for vehicles in the adjacent through/left-turn lane to clear the intersection before swinging out, preventing vehicles following the truck from proceeding. These maneuvers increase the delay experienced by all drivers through the intersection. When drivers of heavy vehicles cannot or do not swing wide into the intersection to make a turn, they risk striking the curb or the signal equipment and sign posts in the sidewalk, potentially damaging the equipment and the vehicle.

Recommendations

Based upon the existing turn radii and the presence of heavy vehicles in the traffic stream, right-turning heavy vehicles pose a risk of colliding with other vehicles and infrastructure at the Main Street intersection. This section describes several recommendations to improve heavy vehicle turning operations at the intersection.

- Infrastructure Changes:
 - Consider reconstructing the southwest corner of the intersection to provide a larger turning radius for heavy vehicles. The demolition of the old building at this corner provides an opportunity to widen the roadway while maintaining public parking lot.
 - Consider replacing the existing span-wire traffic signal assembly, which requires two large posts on opposite corners, with a mast-arm assembly, which would require only one post to support overhead traffic signals on a cantilevered arm and could be located further from the edge of the curb. Smaller posts located on the downstream side of each corner could support secondary traffic signal heads and pedestrian activation buttons.

- Please keep in mind that this intersection is the crossroads of the Mohawk Trail Scenic Byway and the Route 122 Scenic Byway. Any changes made should be done in a manner that supports the goals of the Scenic Byways.
- Construction of these recommended infrastructure changes is eligible for implementation through the regional Transportation Improvement Program, which allocates federal aid funds for transportation improvements, however, federal dollars are extremely competitive. The town of Orange is already prioritized to receive \$4,831,725 in FFY 2018 & FFY 2019 for reconstruction of North Main Street. Given the limited dollars available for transportation improvements through this program and the need for regional equity in supporting such improvements, it would likely be a significant amount of time before another project in Orange would be prioritized. It is an option to pursue design and construction with town funds.
- Opportunities for revising the design of the southeast and northeast corners of the intersection are limited by the existing buildings, which include basements that extend beyond the building footprints. The northwest corner has the largest existing maximum turning radius as well as the lowest frequency of right-turning heavy vehicles, so geometric changes there would have little impact on traffic operations.
- Consider relocating stop lines on South Main Street and North Main Street further back from the intersection by 5-10 feet. This would allow more room for heavy vehicles to maneuver and protect other motorists from being trapped in the path of an oncoming right-turning truck.
- Consider signage to designate an Alternate Truck Route. Although trucks cannot be excluded from traveling on numbered routes such as Route 2A and Route 122, signs can be installed on Route 2 and Route 202 at the appropriate exits indicating a preferred route for heavy vehicles to avoid the Main Street intersection. Contact the Traffic Engineer at MassDOT District 2 to discuss the installation of Alternate Truck Route signs.
- Work with local police to enforce the existing No Parking zones at the corners. Delivery vehicles should be discouraged from using these zones for short-term loading and unloading.
- Consider extending the No Parking Zones on the southwest and northeast corners of the intersection, providing more room for heavy vehicles to maneuver within their designated path of travel.