Adam Duchesneau

From: Jason Sobel <jsobel@greenintl.com>
Sent: Monday, October 16, 2017 10:01 AM
To: Adam Duchesneau
Subject: 700, 750, & 800 Mass Ave - sight distance follow-up
Attachments: AASHTO sight distances.pdf; 10162017094821-0001.pdf

Hello Adam,

As we discussed on Friday, I'm sending you some follow-up information regarding the sight distances. First, please see the attached PDF for a few relevant pages from the AASTHO "A Policy on Geometric Design of Highways and Streets (aka the "Green Book"). There were some questions about the language that AASHTO uses to discuss why longer sight distances beyond the minimum requirements are "desirable".

- Page 9-28, I've highlighted the portion where it says that Stopping Sight Distance (SSD) is fundamental to intersection operation.
- Page 9-29, I've highlighted the portion where it says that the SSD is the minimum required, but that longer distances are "desirable".
- Page 9-36, I've highlighted where AASHTO essentially defines what "desirable" is, i.e. "most major-road drivers should not need to reduce speed to less than 70% of their initial speed".

The minimum required Stopping Sight Distances are based on a reaction time of 2.5 seconds (for drivers on the major road), and AASHTO states that this "exceeds the 90^{th} percentile of reaction time for all drivers" (including older drivers). The minimum required Stopping Sight Distances are based on a deceleration rate of 11.2 ft/s^2, while AASHTO states that "approximately 90% of all drivers decelerate at rates greater than 11.2 ft/s^2".

In regards to trucks traveling along Massachusetts Avenue, AASHTO acknowledges that while trucks needs longer distances to stop, due to the substantially higher seat position, truck drivers are typically able to see farther distances along the roadway. Likewise, for vehicles exiting the site, drivers will be able to see oncoming trucks from farther away because trucks are substantially taller vehicles. The available intersection sight distance was measured based on typical AASHTO requirements and is based on a height of 3.5 ft above the surface of the roadway. Due to these factors, AASHTO states that "separate stopping sight distances for trucks and passenger cars, therefore, are not generally used in highway design".

Now, specific to the proposed site, here's a summary of the minimum & desirable distances:

Proposed site driveway, looking to the west:

Based on 85^{th} percentile speed (46 mph), 4% downgrade

- Minimum required = 398 ft
- Desirable = 507 ft

Based on posted speed limit (40 mph), 4% downgrade

- Minimum required = 320 ft
- Desirable = 445 ft

Available sight distance looking to the west = 375 ft

While the available sight distance does not meet the minimum required distance for vehicles traveling at the 85th percentile speed of 46 mph, the 375 ft does meet the minimum requirements for vehicles traveling at 44 mph, and of course also meets the minimum requirements for vehicles traveling at the posted speed limit of 40 mph.

Proposed site driveway, looking to the east:

Based on 85th percentile speed (44 mph), 4% upgrade

- Minimum required = 328 ft
- Desirable = 485 ft

Based on posted speed limit (40 mph), 4% upgrade

- Minimum required = 285 ft
- Desirable = 445 ft

Available sight distance looking to the east = 375 ft

The 375 ft of available intersection sight distance exceeds the minimum requirements for vehicles traveling at both the posted speed limit (40mph) and the 85th percentile speed (44 mph). Please also note that the 375 ft was estimated by the Applicant's traffic consultant and presented in the Dec 2016 traffic study for this project. The latest plans that I've seen (revised Aug 30, 2017) show that the area being re-graded and cleared to the east of the proposed driveway is more than sufficient to obtain the 375 ft of sight distance. On the attached PDF, the red line shows the 375 ft of intersection sight distance. The green shaded triangle behind the red line shows what would be needed to obtain the desirable distance of 485 ft (based on the 85th percentile speed). Based on the area to be regraded, as shown on this plan, the available sight distance looking to the west will be beyond the 375 ft estimated by the applicant's traffic engineer.

I hope this helps to clarify the sight distances. I apologize for not having the minimum/desirable distances looking to the east with me in the field on Friday. As we stated in our Sept 6, 2017 letter (comment #11), the area to be regraded/cleared on the plans is more than sufficient to provide adequate intersection sight distance looking to the east, and I thought that that issue was already resolved.

Please let me know if you have any questions or if you would like to discuss any of this further. I'll be in the office all day, if you want to talk before tonight's planning board meeting.

Thanks,
Jason

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at its junction with the major road. For simple unchannelized intersections involving low design speeds and stop or signal control, it may be desirable to warp the crowns of both roads into a plane at the intersection; the appropriate plane depends on the direction of drainage and other conditions. Changes from one cross slope to another should be gradual. Intersections at which a minor road crosses a multilane divided highway with a narrow median on a superelevated curve should be avoided whenever practical because of the difficulty in adjusting grades to provide a suitable crossing. Gradelines of separate turning roadways should be designed to fit the cross slopes and longitudinal grades of the intersection legs.

The alignment and grades are subject to greater constraints at or near intersections than on the open road. At or near intersections, the combination of horizontal and vertical alignment should provide traffic lanes that are clearly visible to drivers at all times, clearly understandable for any desired direction of travel, free from the potential for conflicts to appear suddenly, and consistent in design with the portions of the highway just traveled.

The combination of vertical and horizontal curvature should allow adequate sight distance at an intersection. As discussed in Section 3.5 on "Combinations of Horizontal and Vertical Alignment," a sharp horizontal curve following a crest vertical curve is undesirable, particularly on intersection approaches.

9.5 INTERSECTION SIGHT DISTANCE

9.5.1 General Considerations

Each intersection has the potential for several different types of vehicular conflicts. The possibility of these conflicts actually occurring can be greatly reduced through the provision of proper sight distances and appropriate traffic controls. The avoidance of conflicts and the efficiency of traffic operations still depend on the judgment, capabilities, and response of each individual driver.

Stopping sight distance is provided continuously along each highway or street so that drivers have a view of the roadway ahead that is sufficient to allow drivers to stop. The provision of stopping sight distance at all locations along each highway or street, including intersection approaches, is fundamental to intersection operation.

Vehicles are assigned the right-of-way at intersections by traffic-control devices or, where no traffic-control devices are present, by the rules of the road. A basic rule of the road, at an intersection where no traffic-control devices are present, requires the vehicle on the left to yield to the vehicle on the right if they arrive at approximately the same time. Sight distance is provided at intersections to allow drivers to perceive the presence of potentially conflicting vehicles. This should occur in sufficient time for a motorist to stop or adjust their speed, as appropriate, to avoid colliding in the intersection. The methods for determining the sight distances needed by drivers approaching intersections are based on the same principles as stopping sight distance, but incorporate modified assumptions based on observed driver behavior at intersections.

The driver of a vehicle approaching an intersection should have an unobstructed view of the entire intersection, including any traffic-control devices, and sufficient lengths along the intersecting highway to permit the driver to anticipate and avoid potential collisions. The sight distance needed under various

assumptions of physical conditions and driver behavior is directly related to vehicle speeds and to the resultant distances traversed during perception-reaction time and braking.

Sight distance is also provided at intersections to allow the drivers of stopped vehicles a sufficient view of the intersecting highway to decide when to enter the intersecting highway or to cross it. If the available sight distance for an entering or crossing vehicle is at least equal to the appropriate stopping sight distance for the major road, then drivers have sufficient sight distance to anticipate and avoid collisions. However, in some cases, a major-road vehicle may need to stop or slow to accommodate the maneuver by a minor-road vehicle. To enhance traffic operations, intersection sight distances that exceed stopping sight distances are desirable along the major road.

9.5.2 Sight Triangles

Specified areas along intersection approach legs and across their included corners should be clear of obstructions that might block a driver's view of potentially conflicting vehicles. These specified areas are known as clear sight triangles. The dimensions of the legs of the sight triangles depend on the design speeds of the intersecting roadways and the type of traffic control used at the intersection. These dimensions are based on observed driver behavior and are documented by space-time profiles and speed choices of drivers on intersection approaches (*12*). Two types of clear sight triangles are considered in intersection design—approach sight triangles and departure sight triangles.

Approach Sight Triangles

Each quadrant of an intersection should contain a triangular area free of obstructions that might block an approaching driver's view of potentially conflicting vehicles. The length of the legs of this triangular area, along both intersecting roadways, should be such that the drivers can see any potentially conflicting vehicles in sufficient time to slow or stop before colliding within the intersection. Figure 9-15A shows typical clear sight triangles to the left and to the right for a vehicle approaching an uncontrolled or yield-controlled intersection.

very unlikely another potentially conflicting vehicle will be encountered as the first vehicle departs the intersection.

Case B—Intersections with Stop Control on the Minor Road

Departure sight triangles for intersections with stop control on the minor road should be considered for three situations:

- Case B1—Left turns from the minor road;
- Case B2—Right turns from the minor road; and
- Case B3—Crossing the major road from a minor-road approach.

Intersection sight distance criteria for stop-controlled intersections are longer than stopping sight distance to allow the intersection to operate smoothly. Minor-road vehicle operators can wait until they can proceed safely without forcing a major-road vehicle to stop.

Case B1—Left Turn from the Minor Road

Departure sight triangles for traffic approaching from either the right or the left, like those shown in Figure 9-15B, should be provided for left turns from the minor road onto the major road for all stop-controlled approaches. The length of the leg of the departure sight triangle along the major road in both directions, shown as distance b in Figure 9-15B, is the recommended intersection sight distance for Case B1.

The vertex (decision point) of the departure sight triangle on the minor road should be 4.4 m [14.5 ft] from the edge of the major-road traveled way. This represents the typical position of the minor-road driver's eye when a vehicle is stopped relatively close to the major road. Field observations of vehicle stopping positions found that, where needed, drivers will stop with the front of their vehicle 2.0 m [6.5 ft] or less from the edge of the major-road traveled way. Measurements of passenger cars indicate that the distance from the front of the vehicle to the driver's eye for the current U.S. passenger car population is nearly always 2.4 m [8 ft] or less (*12*). Where practical, it is desirable to increase the distance from the edge of the major-road traveled way to the vertex of the clear sight triangle from 4.4 m to 5.4 m [14.5 to 18 ft]. This increase allows 3.0 m [10 ft] from the edge of the major-road traveled way to the front of the stopped vehicle, providing a larger sight triangle. The length of the sight triangle along the minor road (distance *a* in Figure 9-15B) is the sum of the distance from the major road plus $^1/_2$ lane width for vehicles approaching from the left, or $1^1/_2$ lane widths for vehicles approaching from the right.

Field observations of the gaps in major-road traffic actually accepted by drivers turning onto the major road have shown that the values in Table 9-5 provide sufficient time for the minor-road vehicle to accelerate from a stop and complete a left turn without unduly interfering with major-road traffic operations. The time gap acceptance time does not vary with approach speed on the major road. Studies have indicated that a constant value of time gap, independent of approach speed, can be used as a basis for intersection sight distance determinations. Observations have also shown that major-road drivers will reduce their speed to some extent when minor-road vehicles turn onto the major road. Where the time gap acceptance values in Table 9-5 are used to determine the length of the leg of the departure sight triangle, most major-road drivers should not need to reduce speed to less than 70 percent of their initial speed (*12*).

MASSACHUSETTS AVENUE

#773

#723

#800

APPROXIMATE (BOH RECORDS)

WELL

12" C.I. CULVERT
INV. IN=321.95
INV. OUT = 321.67
EXTEND CULVERT.

CULVERT
INV. IN=296.91
INV. OUT = 296.45
EXTEND CULVERT
L=31'±; S=0.01'±

PROPOSED
5' WIDE SIDEWALK
PER MASSDOT
(TYPICAL)

PROPOSED
CULVERT EXTENSION
TO HEADWALL

PROPOSED
SIGHT DISTANCE
GRADING & CLEARING AREA
(6" LOAM & SEED)
(NO VEGETATION OVER 3-FEET)

PROPOSED
STREET SIGN
AND STOP SIGN

PROPOSED
RETAINING WALL
(BY OTHERS)
T.W.=VARIES 326'+

PROPOSED
GUARDRAIL
AND FENCE

PROPOSED
RESERVED
PARKING AREA
14 SPACES
6" LOAM AND SEED

REPLACE
EXISTING
GUARDRAIL

EXIST.
PAVED
DRIVE

EXIST.
DWELLING
TO BE RAZED

163.56'

126.44'

244.03

94.79'

97.11'

100' BUFFER ZONE
(ALRA - BYLAW)

100' W-DISTRICT
BUFFER

BORDERING VEGETATED
WETLANDS CONFIRMED BY
ORAD DEP FILE #113-501
(END WF 157)

FIRE POND

ISOLATED VEGETATED
WETLAND AREA
WF (#C1-#C4)
AREA=686± S.F.
(NOT SUBJECT TO
M.GL.c.131, s.40)

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