TRAFFIC IMPACT STUDY

Ellsworth Village

Town of Acton, Massachusetts

Prepared for

Town of Acton

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PLANNING DEPARTMENT

Prepared by

DAVID J. FRIEND
Transportation Planning Services
Bedford, MA 01730

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Adequacy of Stopping Sight Distances @ Intersection of Pope Road and Brabrook Road

Even though it is existing and approved local street, Brabrook Road intersects Pope Road at a location that has raised the question of whether or not there is adequate stopping sight distance (SSD) for motorists traveling on Pope Road. A safe stopping sight distance is the distance necessary for a motorist approaching on a major street (Pope Road) to perceive, react to, and stop before reaching a stationary object in its path. A safe SSD would provide for occasional events such as a vehicle pulling out from Brabrook Road onto Pope Road and then stalling. Conversely, it is also the distance for those exiting Brabrook Road to make a decision whether or not to pull out onto Pope Road. The following evaluation examines the adequacy of the stopping sight distances at the intersection of Brabrook and Pope Roads by comparing the available sight distances with the distances necessary to stop under the conditions that are present (referred to as the "safe" sight distances).

Definition of Stopping Sight Distance. By definition, sight distance is the distance along a roadway throughout which an object of specified height is continuously visible to the driver.[7] Stopping sight distance is the sum of two distances: (1) the distance traversed by the vehicle the instant the driver sights an object necessitating a stop to the instant the brakes are applied; and (2) the distance needed to stop the vehicle from the instant the brake is applied. The stopping sight distance that may be available at a specific location will be influenced by the speed of approaching vehicles, the grade of the road (vertical profile), the curvature of the road (horizontal profile), and the presence of roadside vegetation or other objects (e.g., trees, signs, stone walls, fences). Stopping sight distances are measured from a seeing height of 3.5 feet (height of driver's eye in vehicle approaching on major road) to an object height of 2.0 feet (taillight height of a passenger car), and from a distance of 10' from the edge of pavement.[8]

Estimation of Available Sight Distances on Pope Road. The actual sight distances that are available on Pope Road at the location of the proposed site driveway are determined on the basis of the horizontal and vertical alignment of the street in that area and the existence of any obstructions adjacent to the travel way but in the line of sight.

As can be seen in **Figure 4**, motorists traveling southbound on Pope Road towards Brabrook Road from the direction of Strawberry Hill Road traverse a section of the street that is relatively straight (see horizontal profile) and flat until it reaches a point south of Wingate Lane where it begins to slope downward at a 3% grade (see vertical profile) towards Brabrook Road. As indicated by the solid red line in the vertical profile, the vertical alignment of Pope Road does not interfere with the sight line in that direction. However, as shown by the solid red line in the horizontal profile and the corresponding elevations shown in green on the vertical profile, the contour of the land surface that lies between the edge of the roadway and the stone wall is higher than the elevation of Brabrook Road when looking in the north direction. This surface contour, together with the trunks of several large oak trees, limits the available sight distance in that direction to less than 100 feet. If the property edge were contoured from the wall to the pavement edge and the large trees removed, however, a clear sight line of approximately 350 feet would be created.

Although **Figure 4** does not show the profile of the road south of Brabrook Road for an extended distance, motorists traveling northbound on Pope Road towards Brabrook Road from the direction of Route 2A enjoy a relatively long, unobstructed view. Motorists approaching Brabrook Road from this direction traverse a section of Pope Road that is also very straight (see horizontal profile) but on an upward grade of roughly 4% (see vertical profile). With no roadside obstructions in the line of sight (see solid blue line), a clear sight line to and from Brabrook Road exists for a distance of over 400 feet along the section of Pope Road that lies south of Brabrook Road.

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[7] See American Association of State Highway and Transportation Officials (AASHTO), *A Policy on Geometric Design of Highways and Streets* (Washington, D.C., 2001), pp. 110-114.

[8] Ibid., p. 127.

Estimation of Safe Stopping Sight Distances. When the terrain is not level, the minimum or safe stopping distance (d) is calculated by the following formula[9]:

$$d = 1.47\,Vt + \frac{V^2}{30((a/32.2)\pm G)}$$

where V = speed, in miles per hour (mph)
t = perception + reaction time (2.5 seconds)
a = deceleration rate on wet pavement (11.2 ft/s^2)
G = percent of grade divided by 100 (+ when uphill; - when downhill)

It follows from the above formulae that the stopping sight distances shown in **Table 7** are those considered safe for the indicated vehicle speeds and grades.

TABLE 7. Safe Stopping Sight Distances for Selected Travel Speeds

	Travel Speed (mph)			
Grade	30	35	40	41
- 3 %	205'	257'	315'	330'
+ 4 %	190'	235'	290'	300'

Comparison of Available and Safe Stopping Sight Distances. The posted speed limit on Pope Road in the vicinity of Brabrook Road is 35 mph. However, as described earlier in Table 4, the actual travel speed (85th percentile speed) of motorists at the location of Brabrook Road is 40 mph traveling northbound and 41 mph in the southbound direction.[10] At these travel speeds, it follows from Table 7 that (a) a clear sight line of at least **290 feet** is desirable for motorists traveling northbound on Pope Road towards Brabrook Road from Route 2A, while (b) a clear sight line of at least **330 feet** would be desirable for motorists traveling southbound on Pope Road towards Brabrook Road.

Conclusion. With over 400 feet of sight distance available to motorists approaching from the south, and an estimated 290 feet necessary to stop safely, the stopping sight distance for motorists traveling northbound on Pope Road is considered adequate (safe) in the vicinity of Brabrook Road. However, with less than 100 feet of sight distance available to motorists currently approaching from the north, and 330 feet necessary to stop safely, the stopping sight distance for motorists traveling southbound on Pope Road is presently inadequate for the travel conditions that exist at Brabrook Road.

The applicant has agreed to mitigate this deficiency, however, by regrading the contour of the west side of Pope Road and removing several of the large oak trees that currently obscure the sight line in that direction. Once these improvements are made, motorists would have an available sight line of about 350 feet and this would be considered safe for the speed of vehicles traveling from that direction.

[9] Ibid., p.114.

[10] 40-41 mph represents the 85th percentile speeds that were found to exist on Pope Road in the vicinity of Brabrook Road. The 85th percentile speed is typically used to determine safe stopping sight distance rather than the mean or 50th percentile travel speed. In this case, the mean and 50th percentile speeds that were found on Pope Road approximate the posted speed limit of 35 mph.

Maintaining Safe Conditions on Brabrook Road

As described earlier in Table 4, residents abutting Brabrook Road currently experience very light traffic volumes (only 120 vehicle trips per day) traveling at relatively low travel speeds (25-27 mph). The introduction of an additional 150 vehicle trips daily from Ellsworth Village will not only double the level of vehicular activity on Brabrook Road, but also increase the number of potential conflicts between vehicles and pedestrians who walk along the road for recreation and use the road to reach the bus stop on Pope Road at the end of the street. The number of potential conflicts between vehicles-vehicles will also increase as motorists entering and exiting Flagg Road onto Brabrook Road will now encounter additional traffic to and from Ellsworth Village. Because all roads are expected to have a non-zero number of accidents per unit of time, no road or intersection is ever said to be "safe." However, it is often possible by controlling the physical environment on a street (e.g, provide adequate sight lines, provide good drainage, separate travel ways, etc.) to make a street "safer" than it might now be.

In response to resident concerns about safety along Brabrook Road, the applicant has agreed to implement the following physical improvements and traffic controls:

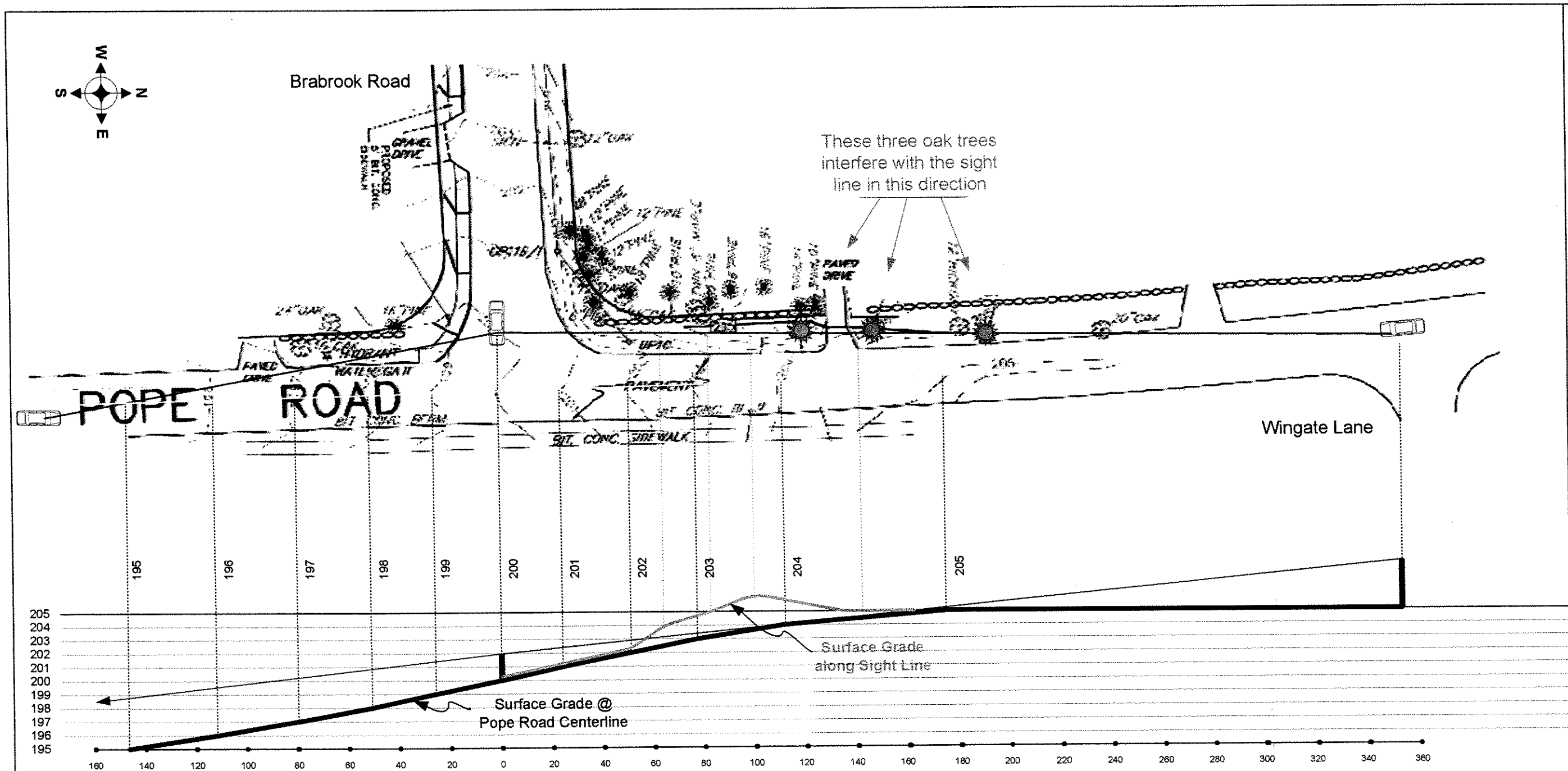
- **Installation of Sidewalk:** a new 5' wide bituminous sidewalk will be installed from Ellsworth Village along the south side of Brabrook Road all the way to Pope Road. This sidewalk will serve a dual purpose. On the one hand, it will provide a grade-separated and exclusive "travelway" for pedestrians who now walk in the road. By providing a definitive edge to the street (although not decreasing the width of the travelway on the street), the sidewalk will also change the visual environment for motorists in a way that may also encourage slower travel speeds.[11]

- **Installation of STOP sign on Ellsworth Village Road at exit from Ellsworth Village:** a STOP sign with stop bar will be installed on the outbound (south) side of Ellsworth Village Road where it first "intersects" with Brabrook Road. The stop control will make it easier and safer for residents living adjacent to the Village entrance to exit their properties onto Brabrook Road. It will also ensure that vehicles exiting Ellsworth Village are not traveling at higher than desired speeds once they enter Brabrook Road.

- **Installation of STOP sign on Flagg Road @ Brabrook Road:** a STOP sign with stop bar will also be installed on the outbound (west) side of Flagg Road at its intersection with Brabrook Road. Residents who live on Flagg Road presently encounter minimal conflicts when turning left onto Brabrook and traveling towards Pope Road. Upon the completion of Ellsworth Village, however, Brabrook Road/Ellsworth Village Road will clearly become the "major" street and Flagg will become a "minor" street. Although traffic volume warrants would not be satisfied, the installation of a STOP sign at this location is desirable so as to modify the current driving behavior of those exiting Flagg Road and reinforce the fact Brabrook Road is now the "major" street on which traffic should have the right-of-way. It will also have the beneficial effect of slowing the speeds of vehicles who now exit Flagg Road without slowing when turning left to reach Pope Road.

- **Installation of STOP sign on Brabrook Road @ Pope Road:** a STOP sign with stop bar will also be installed on the outbound (south) side of Brabrook Road at its intersection with Pope Road. This intersection is not currently STOP-controlled. Placement of a STOP sign at this location will ensure that vehicles exiting Brabrook Road come to a complete stop (versus a "rolling" stop) before entering the traffic stream on Pope Road.

[11] Despite the generous width of the travelway on Brabrook Road, the speeds of motorists traveling on Brabrook Road are not excessive in either direction. These conditions, when coupled with the fact that the street is relatively short, render the installation of speed bumps or other physical devices on the street ineffective and unnecessary.



Horizontal Profile

Vertical Profile

Conclusion: Neither the horizontal or vertical alignment of Pope Road interferes with the sight line in this direction. In addition, there are no surface contour or vegetative obstructions along the sight line in this direction. Over 400 feet of clear sight line is currently available for motorists traveling northbound on Pope Road

Conclusion: Neither the horizontal or vertical alignment of Pope Road interferes with the sight line in this direction. However, the elevation of the area between the edge of pavement and existing stone wall, along with three large oak trees, do obstruct the sight line in this direction. Only abut 100 feet of clear sight line currently exists for motorists traveling southbound on Pope Road. Re-grading the shoulder of the road and removing the three oak trees in the right-of-way would increase the available sight distance to approximately 350 feet.

Available Stopping Sight Distances on Pope Road @ Brabrook Road