

MEMORANDUM

DATE: September 25, 2015

TO: Karen M. Galligan, Superintendent
Town of Southborough DPW
147 Cordaville Road
Southborough, MA 01772

FROM: Robert J. Michaud, P.E. – Managing Principal
Mark L. Houle, E.I.T. – Transportation Engineer

RE: **Intersection Evaluation**
Parmenter Road/Pine Hill Road Intersection
Southborough, Massachusetts



MDM Transportation Consultants, Inc. (MDM) has prepared a safety and operations evaluation for the intersection of Parmenter Road and Pine Hill Road in Southborough, Massachusetts. The study location relative to area roadways is shown in **Figure 1**. This evaluation summarizes baseline traffic and safety conditions at the intersection including survey of daily and peak hour traffic volumes, travel speed data, intersection sight lines, and crash data. The purpose of the study will be to identify potential roadway and intersection improvements that are necessary to address existing traffic operations and safety.

Key findings of the traffic assessment are as follows:

- *Roadway Characteristics.* Parmenter Road is generally an east-west roadway that varies in pavement width between 20 and 22 feet providing a single travel lane in each direction. The existing roadway is classified as rolling terrain with both vertical and horizontal curves with roadside obstructions in close proximity to the travel way including vegetation, trees and stone walls.
- *Safety Characteristics.* Parmenter Road at Pine Hill Road experienced a crash rate slightly above the District-wide average, therefore safety countermeasures may be warranted at or near the intersection. A review of the MassDOT crash data indicates and roadway characteristics indicate that roadside obstructions, lack of clear zones, and limited sight distance are likely contributing factors in the reported crashes

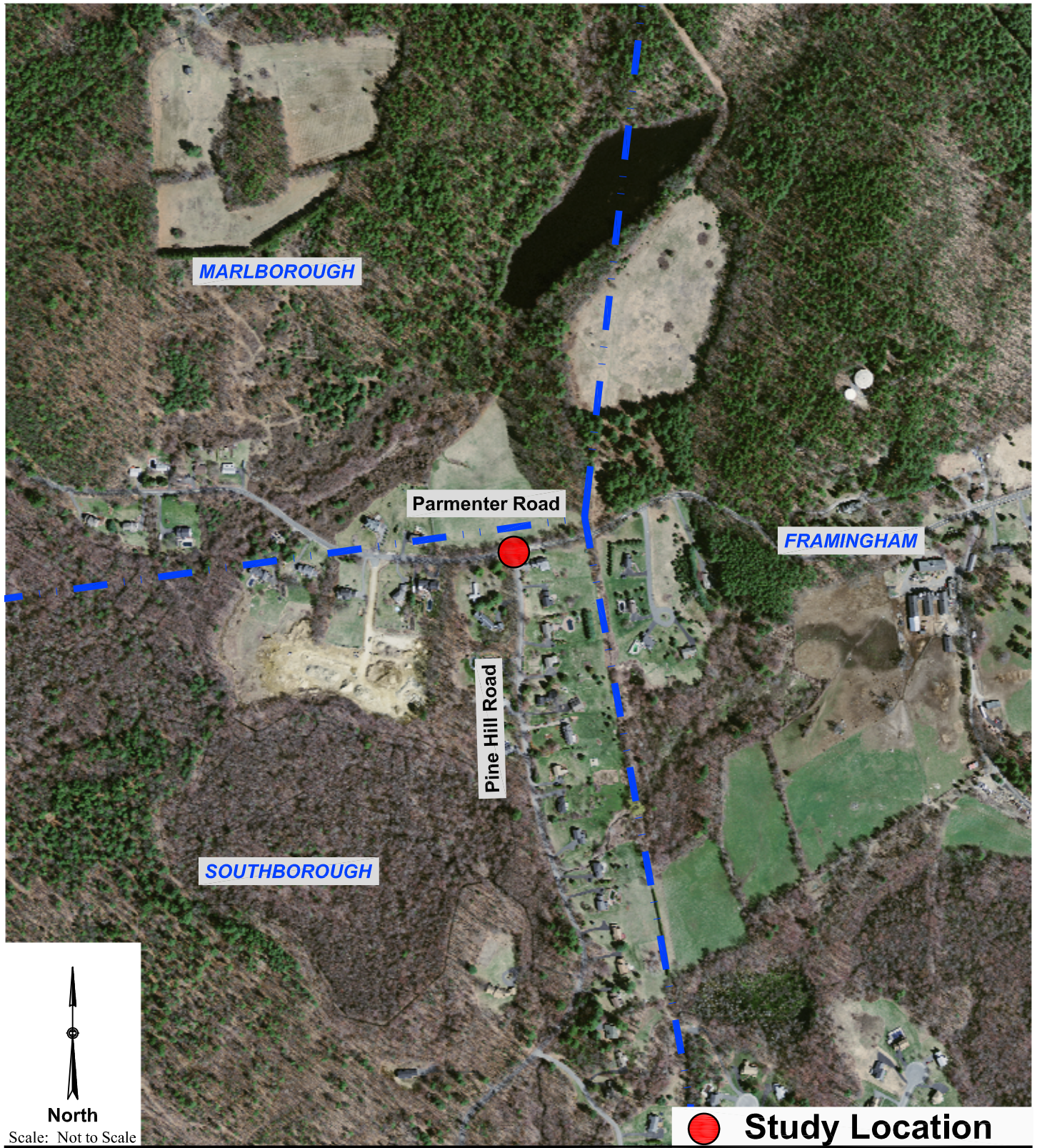


Figure 1

- *Adequate Capacity.* The intersection of Parmenter Road and Pine Hill Road experiences moderate traffic volumes on all three approaches with travel generally oriented south during the morning peak hour and north during the evening peak hour. During the critical peak hours, the northbound Pine Hill Road approach to Parmenter Road which is under “STOP” sign control operates at level of service (LOS) B or better with minimal delay while mainline travel along Parmenter Road currently operates unimpeded with minimal delay.
- *All-Way Stop Control.* It is the opinion of MDM that an all-way stop control is not desirable nor strongly supported at the intersection of Parmenter Road and Pine Hill Road given the low traffic volumes and ability to first try other remedial measures such as outlined under *Recommendations* which are specifically designed to reduce travel speeds, reduce vehicular conflicts, enhance intersection visibility and enhance sight lines. Should this set of remedial measures fail to enhance visibility and safety then an all-way STOP control may be considered.

In summary, there are several existing traffic and safety issues at the intersection of Parmenter Road and Pine Hill Road which should be addressed. Recommended roadway and intersection improvements have been identified under *Recommendations* that have been designed to address the existing traffic operations and safety issues within the study area. With the recommended improvements in place traffic operations and safety will be enhanced within the Town of Southborough along Parmenter Road and at the intersection of Parmenter Road and Pine Hill Road.

BASELINE TRAFFIC & SAFETY CHARACTERISTICS

An overview of existing roadway conditions, traffic volumes and safety characteristics of the area roadways are provided below.

Roadway Characteristics

Parmenter Road

Parmenter Road is classified by the Massachusetts Department of Transportation (MassDOT) as a rural minor collector roadway under local (Town) jurisdiction. Parmenter Road is generally an east-west roadway that varies in pavement width between 20 and 22 feet. The existing roadway is classified as rolling terrain with both vertical and horizontal curves with roadside obstructions in close proximity to the travel way including vegetation, trees and stone walls. Parmenter Road provides a connection among Broadmeadow Road in Marlborough to the west and turns into Edmands Road in Framingham to the east. Parmenter Road provides two-way travel with a single travel lane in each direction; while a double yellow centerline and single white edge lines are provided in the adjacent communities no pavement markings within the

Town of Southborough were evident at the time of this evaluation. No sidewalks along the roadway in the immediate project area. To date no special speed regulation (SSR) has been established for Parmenter Road within Southborough, so regulatory travel speed is established at 30 mph based on prima facie. The curved/rolling alignment and narrow travel widths have led to a SSR nearby in Framingham resulting in a posted regulatory speed limit of 20 mph. Land use along Parmenter Road is a primarily residential uses.

Pine Hill Road

Pine Hill Road is classified by the Massachusetts Department of Transportation (MassDOT) as a rural minor collector roadway under local (Town) jurisdiction. Pine Hill Road is generally a north-south roadway with a roadway width of approximately 21 feet with steep grades and curved alignment along most of its length. Pine Hill Road provides a connection among Parmenter Road to the north and Pleasant Street (Route 30) to the south. Pine Hill Road provides two-way travel with a single travel lane in each direction with no pavement marking evident. There are no sidewalks along the roadway in the immediate project area. The posted regulatory speed limit is 30 mph along Pine Hill Road with speed advisory plaques and warning signs at multiple locations along the roadway. Pine Hill Road is under “STOP” sign control at its intersection with Parmenter Road; however, visibility of the “STOP” sign is currently blocked by vegetation. Land use along Pine Hill Road is a primarily residential uses.

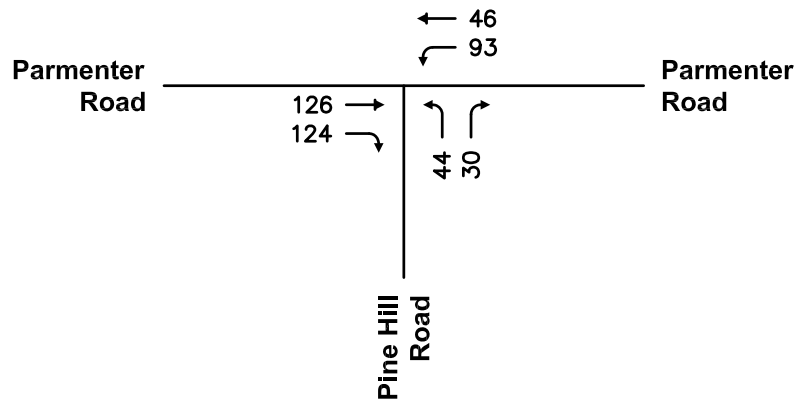
Baseline Traffic Data

Peak Hour Traffic

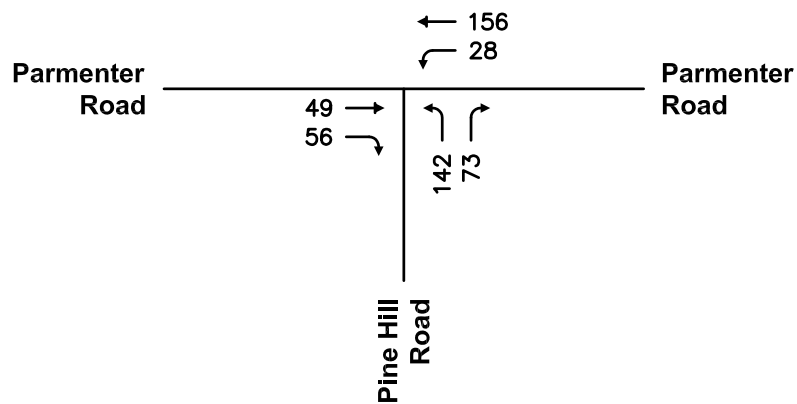
Traffic volume data were collected at the study intersection during the weekday morning peak period (7:00AM – 9:00 AM) and the weekday evening peak period (4:00 PM – 6:00 PM). Traffic data used in this evaluation were collected in July 2015, which represents average traffic conditions based on review of MassDOT count station data for the area, including latest available counts for the Pine Hill Road corridor conducted in March 2014. Traffic count data and MassDOT permanent count station data are provided in the **Attachments**. The weekday morning and weekday evening peak hour traffic volumes for the study intersection are shown in **Figure 2**.

Daily Traffic Volumes

Daily traffic volumes along Parmenter Road just east of Pine Hill Road were obtained using a radar-based automatic traffic recorder (ATR). Traffic volume data was collected in July 2015. The results of the counts are summarized in **Table 1**, and are discussed below. Traffic volume data is provided in the **Attachments**.



Weekday Morning Peak Hour



Weekday Evening Peak Hour



North

Scale: Not to Scale

NOTES:
NEGL. = Negligible

TABLE 1
EXISTING TRAFFIC VOLUME SUMMARY
PARMENTER ROAD

| Time Period | Daily Volume (vpd) ¹ | Percent Daily Traffic ² | Peak Hour Volume (vph) ³ | Peak Flow Direction ⁴ | Peak Hour Directional Volume (vph) ⁴ |
|---------------------------|------------------------------------|---------------------------------------|--|-------------------------------------|---|
| Weekday Morning Peak Hour | 3,587 | 9% | 322 | 78% EB | 250 |
| Weekday Evening Peak Hour | 3,587 | 13% | 455 | 74% EB | 336 |

¹Two-way daily traffic expressed in vehicles per day without seasonal adjustment.

²The percent of daily traffic that occurs during the peak hour.

³Two-way peak-hour volume expressed in vehicles per hour.

⁴EB = Eastbound, WB = Westbound

As summarized in **Table 1**, the weekday daily traffic volume on Parmenter Road in the intersection vicinity is approximately 3,587 vehicles per day (vpd) on a weekday. Peak hour traffic flow on Parmenter Road ranges from approximately 322 to 455 vehicles per hour (vph) representing approximately 9 to 13 percent of daily traffic flow.

Observed Travel Speeds

Vehicle speeds were obtained for the Parmenter Road eastbound and westbound travel direction using a radar-equipped ATR machine. **Table 2** summarizes the regulatory (prima facie) speed limit and observed average and 85th percentile speeds for Parmenter Road near Pine Hill Road. Field data are provided in the **Attachments**.

TABLE 2
SPEED STUDY RESULTS – PARMENTER ROAD

| Travel Direction | Regulatory Speed Limit ¹ | Travel Speed | |
|------------------|--|----------------------|---|
| | | Average ² | 85 th Percentile ³ |
| Eastbound | 30 | 32 | 34 |
| Westbound | 30 | 29 | 33 |

¹Regulatory Speed Limit is 30 mph (prima facie)

²Arithmetic Mean.

³The speed at or below which 85 percent of the vehicles are traveling.

As summarized in **Table 2**, the mean (average) travel speed on Parmenter Road near Pine Hill Road is 32 mph in the eastbound travel direction and 29 mph in the westbound travel direction. The 85th percentile travel speed was observed to be 34 mph for the eastbound travel direction and 33 mph for the westbound travel direction. The observed travel speeds are highly consistent with the prima facie speed limit of 30 mph.

Intersection Crash History

MassDOT Crash Data

Crash trends and safety characteristics for the study intersection are evaluated using the MassDOT crash database for the Town of Southborough for the three-year period 2011 through 2013 (the most recent available data). Crash data for the study intersections is summarized in **Table 3** with detailed data provided in the **Attachments**.

Crash rates are calculated for the study area intersections and are summarized in **Table 3**. The calculated crash rate quantifies the number of crashes per million entering vehicles. MassDOT has determined the official District 3 (which includes the Town of Southborough) crash rate to be 0.66 for unsignalized intersections. This rate represents MassDOT's "average" crash experience for District 3 communities and serves as a basis for comparing reported crash rates for the study intersections. Where calculated crash rates notably exceed the district average, some form of safety countermeasures may be warranted for further evaluation.

TABLE 3
INTERSECTION CRASH SUMMARY - 2011 THROUGH 2013¹

| Data Category | INTERSECTION |
|----------------------------------|-------------------------------------|
| | Parmenter Road at Pine Hill Road |
| Traffic Control | Unsignalized |
| Crash Rate ² | 0.71 |
| MHD District 3 Avg. ³ | 0.66 |
| <i>Year:</i> | |
| 2011 | 3 |
| 2012 | 0 |
| <u>2013</u> | <u>0</u> |
| Total | 3 |
| <i>Type:</i> | |
| Angle | 0 |
| Rear-End | 1 |
| Head-On | 0 |
| Sideswipe | 0 |
| Single Vehicle | 2 |
| Unknown/Other | 0 |
| <i>Severity:</i> | |
| P. Damage Only | 3 |
| Personal Injury | 0 |
| Fatality | 0 |
| Unknown | 0 |
| <i>Conditions:</i> | |
| Dry | 3 |
| Wet | 0 |
| Snow | 0 |
| Other/Unknown | 0 |
| <i>Time:</i> | |
| 7:00 to 9:00 AM | 0 |
| 4:00 to 6:00 PM | 0 |
| Rest of Day | 3 |

¹ Source: MassDOT Crash Database.

² Crashes per million entering vehicles (MEV)

³ District 3 Average Crash Rate

As summarized in **Table 3**:

- *Parmenter Road at Pine Hill Road.* There are a total of three (3) crashes reported at the Parmenter Road/Pine Hill Road unsignalized intersection during the three-year study period. The resulting crash rate for the intersection is 0.71 which is above the District 3 average of 0.66 for unsignalized intersections. Two of the crashes involved single vehicle collisions with fixed objects; a utility pole and a tree with the remaining crash resulting in a rear-end type collision. All crashes resulted in property damage only and under dry roadway conditions. All crashes occurred outside of the peak periods. No fatalities were reported during the three-year study period.

Southborough Police Department Crash Records

MDM had also obtained crash record data for the Parmenter Road at Pine Hill Road intersection for the period 2011 through August 2015 from the Southborough Police Department to develop a collision diagram to facilitate an understanding of potential causal factors for crashes. The collision diagram for the study intersection is shown in **Figure 3**.

In summary, Parmenter Road at Pine Hill Road experienced a crash rate slightly above the District-wide average, therefore safety countermeasures may be warranted at or near the intersection. A review of the MassDOT crash data indicates and roadway characteristics indicate that roadside obstructions, lack of clear zones, and limited sight distance are likely contributing factors in the reported crashes. A discussion of potential countermeasures is presented under Recommendations.

Sight Line Evaluation

Stopping Sight Distance (SSD)

Sight distance is the length of roadway visible to the motorist to a fixed object. The minimum sight distance available on a roadway should be sufficiently long enough to enable a below-average operator, traveling at or near a regulatory speed limit, to stop safely before reaching a stationary object in its path, in this case, a vehicle exiting Pine Hill Road onto Parmenter Road. The SSD criteria are defined by AASHTO based on design and operating speeds, anticipated driver behavior and vehicle performance, as well as physical roadway conditions. SSD includes the length of roadway traveled during the perception and reaction time of a driver to an object, and the distance traveled during brake application on wet level pavement. Adjustment factors are applied to account for roadway grades where applicable.

SSD was estimated in the field using AASHTO standards for driver's eye (3.5 feet) and object height equivalent to the taillight height of a passenger car (2.0 feet) for the eastbound and westbound Parmenter Road approaches to the intersection. **Table 4** presents a summary of the

COLLISION DIAGRAM

STUDY AREA Parmenter Road at Pine Hill Road

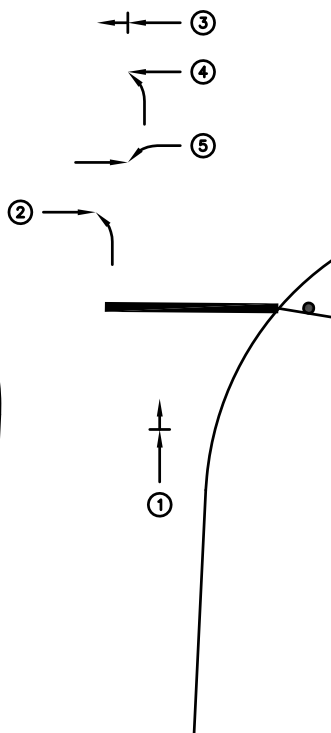
PERIOD 2011-2015 **FROM** JANUARY 2011 **TO** AUGUST 2015

CITY Southborough, MA **PREPARED BY** MLH



Parmenter Road
STREET NAME

Pine Hill Road
STREET NAME



CRASH SUMMARY JANUARY 2011 TO AUGUST 2015¹

| Crash (#) | Date | Collision (Type) | Time | Severity | Roadway Conditions |
|---|-------------------|------------------|-------|----------------------|--------------------|
| <i>Parmenter Road at Pine Hill Road</i> | | | | | |
| 1 | July 13, 2011 | Rear End | 13:15 | Property Damage Only | Dry |
| 2 | March 5, 2014 | Angle | 17:28 | Property Damage Only | Dry |
| 3 | October 7, 2014 | Rear End | 16:45 | Property Damage Only | Dry |
| 4 | February 16, 2015 | Angle | 15:56 | Property Damage Only | Slush |
| 5 | June 11, 2015 | Angle | 08:32 | Personal Injury | Dry |

¹Source: Town of Southborough Police Department Records

NUMBER OF CRASHES

4 PROPERTY DAMAGE ONLY

1 INJURY OR FATAL

5 TOTAL ACCIDENTS

SYMBOLS

| | |
|-----|-----------------------|
| → | MOVING VEHICLES |
| →→→ | BACKING VEHICLES |
| — | NON-INVOLVED VEHICLES |
| X | PEDESTRIAN |
| ▬ | PARKED VEHICLE |
| □ | FIXED OBJECT |
| • | FATAL ACCIDENT |
| ○ | INJURY ACCIDENT |

TYPES OF COLLISIONS

| | |
|-----|----------------|
| →→ | REAR END |
| →→→ | HEAD ON |
| →→ | SIDE SWIPE |
| →→ | OUT OF CONTROL |
| →→ | LEFT TURN |
| →→ | RIGHT ANGLE |

Figure 3

available SSD for the Parmenter Road approaches to Pine Hill Road and AASHTO's recommended SSD for the regulatory and observed travel speeds.

TABLE 4
STOPPING SIGHT DISTANCE SUMMARY
PARMENTER ROAD APPROACH TO PINE HILL ROAD

| <u>Approach/ Travel Direction</u> | <u>Available SSD</u> | <u>AASHTO Recommended¹</u> | | |
|---------------------------------------|----------------------|---|---|--|
| | | <u>Regulatory Speed²</u> | <u>Average Travel Speed³</u> | <u>85th Percentile Travel Speed⁴</u> |
| <i>Eastbound</i> | 250± Feet | 180 Feet ² | 200 Feet | 215 Feet |
| <i>Westbound</i> | 365± Feet | 205 Feet | 195 Feet | 235 Feet |

¹ Recommended sight distance based on AASHTO, A Policy on Geometric Design of Highways and Streets. Based on driver height of eye of 3.5 feet to object height of 2.0 feet and adjustments for roadway grade were applicable.

² Regulatory Speed Limit based on prima facie is 30 mph.

³ Average Speed is 32 mph EB and 29 mph WB.

⁴ 85th Percentile travel speed is 34 mph EB and 33 mph WB

As summarized in **Table 4**, analysis results indicate that the existing available sight lines exceed AASHTO's recommended SSD criteria for both travel directions along Parmenter Road based on the regulatory speed limit and the measured 85th percentile travel speeds. MDM notes the limiting factor in the eastbound direction is an existing vertical crest curve along Parmenter Road.

Intersection Sight Distance

Clear sight lines provide sufficient sight distance for a stopped driver on a minor-road approach to depart from the intersection and enter or cross the major road. As stated under AASHTO's Intersection Sight Distance (ISD) considerations, "...If the available sight distance for an entering ...vehicle is at least equal to the appropriate stopping sight distance for the major road, then drivers have sufficient sight distance to avoid collisions...To enhance traffic operations, intersection sight distances that exceed stopping sight distances are desirable along the major road." AASHTO's ISD criteria are defined into several "cases". In this case the intersection is under STOP signal control and the ISD in question relates to the ability to turn left or turn right from Pine Hill Road.

Available ISD was estimated in the field using AASHTO standards for driver's eye (3.5 feet), object height (3.5 feet) and decision point (11.0 feet from the edge of travel way) for the eastbound and westbound directions along Parmenter Road. **Table 5** presents a summary of the available ISD for the departure from Pine Hill Road and AASHTO's recommended ISD for the regulatory speed limit and observed travel speeds.

TABLE 5
INTERSECTION SIGHT DISTANCE SUMMARY
PINE HILL ROAD DEPARTURE TO PARMENTER ROAD

| Approach/ Travel Direction | Available ISD | AASHTO Minimum ¹ | | AASHTO Ideal ¹ |
|-------------------------------|---------------|----------------------------------|--|----------------------------------|
| | | Regulatory Speed ² | 85 th Percentile Observed Speed ³ | Regulatory Speed ² |
| <i>Looking East</i> | 410± Feet | 205 Feet | 235 Feet | 335 Feet |
| <i>Looking West</i> | 50± Feet | 180 Feet | 215 Feet | 290 Feet |

¹Recommended sight distance based on AASHTO, A Policy on Geometric Design of Highways and Streets. Based on driver height of eye of 3.5 feet and an object height of 3.5 feet and adjustments for roadway grade if required. Minimum value as noted represents SSD per AASHTO guidance.

²Prima facie speed = 30 mph.

³85th Percentile travel speed is 34 mph EB and 33 mph WB

The results of the ISD analysis presented in **Table 5** indicate that the available sight line looking east from Pine Hill Road onto Parmenter Road exceed both the minimum and ideal sight line recommendations from AASHTO based on the regulatory speed and 85th percentile speed. The available sight line looking to the west from Pine Hill Road onto Parmenter Road currently do not satisfy even the minimum recommended sight line requirement for the regulatory speed limit due to existing roadside obstructions in close proximity to the travel way including trees, stone walls, and the existing ground embankment.

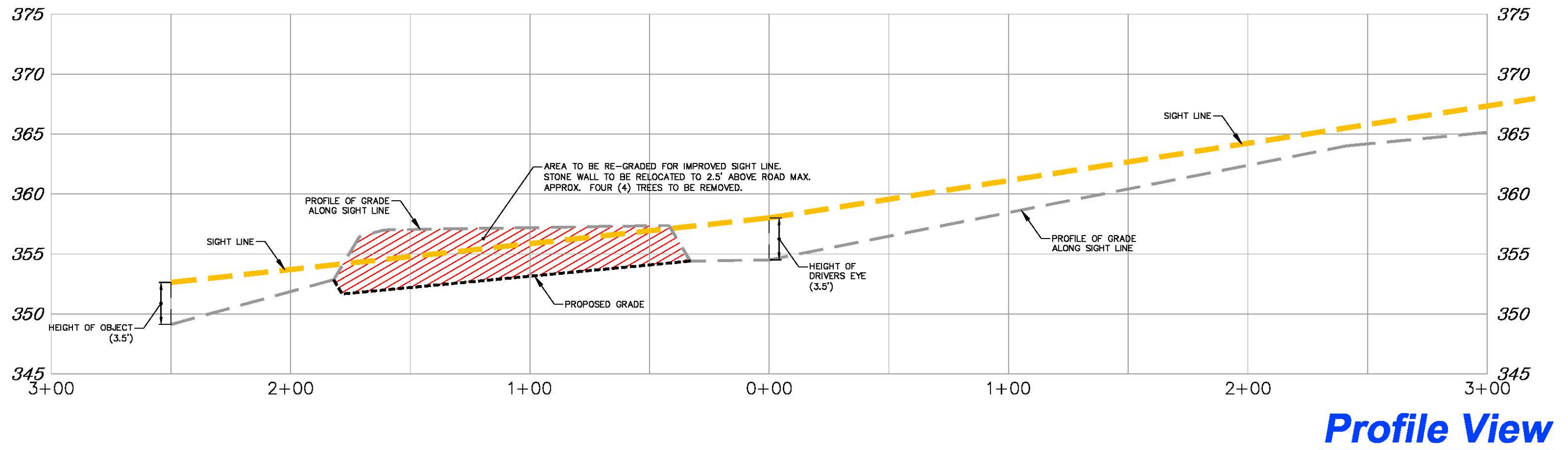
A review of the existing features within the sight line looking to the west from Pine Hill Road onto Parmenter Road indicates that to maximize the available sight line the area should be re-graded within the sight line triangle, the stone wall should be removed and reset to a maximum height of 2.5 feet above the adjacent roadway grade and approximately four (4) trees should be removed. With said improvements the sight line looking to the west from Pine Hill Road onto Parmenter Road can be maximized to approximately 250 feet, as shown in **Figure 4**, which correlates to a design speed of approximately 25 mph.

MDM recommends that in the future the sight lines should continue to be maintained and that any new plantings (shrubs, bushes) or physical landscape features to be located within the driveway sight lines should also be maintained at a height of 2.5 feet or less above the adjacent existing roadway grade to ensure unobstructed lines of sight.



NOTES

1. THIS PLAN INTENDED FOR DISCUSSION PURPOSES ONLY; IT IS NOT FOR CONSTRUCTION.
2. FINAL DESIGN IS SUBJECT TO ADDITIONAL FIELD SURVEY BY OTHERS.
3. PROPERTY LINES AND ACCESS LINE LOCATIONS ARE APPROXIMATE ONLY.
4. BASE PLAN PROVIDED BY MASSGIS DATA.



MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers

28 Lord Road, Suite 280
Marlborough, MA 01752

DWG No. 845 Concept Plan (9-11-2015).dwg

Date: September 2015
Project No. 845

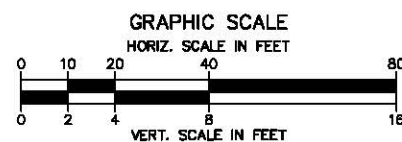


Figure 4
Intersection Sight Distance

OPERATIONS ANALYSIS

This section provides an overview of operational analysis methodology and an assessment of intersection operations under Baseline conditions.

Analysis Methodology

Intersection capacity analyses are presented in this section for the Baseline traffic-volume conditions. Capacity analyses, conducted in accordance with EEA/MassDOT guidelines, provide an index of how well the roadway facilities serve the traffic demands placed upon them. The operational results provide the basis for recommended access and roadway improvements in the following section.

Capacity analysis of intersections is developed using the Synchro® computer software, which implements the methods of the 2010 Highway Capacity Manual (HCM). The resulting analysis presents a level-of-service (LOS) designation for individual intersection movements. The LOS is a letter designation that provides a qualitative measure of operating conditions based on several factors including roadway geometry, speeds, ambient traffic volumes, traffic controls, and driver characteristics. Since the LOS of a traffic facility is a function of the traffic flows placed upon it, such a facility may operate at a wide range of LOS, depending on the time of day, day of week, or period of year. A range of six levels of service are defined on the basis of average delay, ranging from LOS A (the least delay) to LOS F (delays greater than 50 seconds for unsignalized movements). The specific control delays and associated LOS designations are presented in the **Attachments**.

Analysis Results

Level-of-Service (LOS) analyses were conducted for the Baseline conditions for the study intersection. The results of the intersection capacity are summarized below in **Table 6**. Detailed analysis results are presented in the **Attachments**.

TABLE 6
INTERSECTION CAPACITY ANALYSIS RESULTS
PARMENTER ROAD AT PINE HILL ROAD

| Intersection | Approach | 2015 Baseline | | |
|-------------------------------------|-------------|------------------|--------------------|------------------|
| | | v/c ¹ | Delay ² | LOS ³ |
| <i>Weekday Morning Peak Hour</i> | | | | |
| Parmenter Road at Pine Hill Road | Eastbound | 0.00 | <5 | A |
| | Westbound | 0.08 | <5 | A |
| | NB L/R Exit | 0.13 | 12 | B |
| <i>Weekday Evening Peak Hour</i> | | | | |
| Parmenter Road at Pine Hill Road | Eastbound | 0.00 | <5 | A |
| | Westbound | 0.02 | <5 | A |
| | NB L/R Exit | 0.31 | 12 | B |

¹Volume-to-capacity ratio

²Average control delay per vehicle (in seconds)

³Level of service

As summarized in **Table 6**, the northbound Pine Hill Road approach to Parmenter Road which is under “STOP” sign control operates at level of service (LOS) B or better with minimal delay. Mainline travel along Parmenter Road currently operates unimpeded with minimal delay.

ALL-WAY STOP WARRANT

The applicability of a multi-way stop control at the intersection of Parmenter Road and Pine Hill Road were reviewed based on criteria outlined in the Manual on Uniform Traffic Control Devices (MUTCD) with *Section 2B.07 Multi-Way Stop Applications* provided in the **Attachments** for reference purposes. The following considerations outlined in the MUTCD were reviewed, need for temporary traffic control, reported crashes, minimum volumes, the need to control left turn conflicts, the need to control high pedestrian volumes, sight line restrictions, and if all-way stop control would improve operations.

Upon review of the criteria outlined in the MUTCD, the following criteria are not satisfied for an all-way stop warrant:

- Need for temporary traffic control (not applicable)
- Reported crashes (less than 5 crashes in a single year)
- Minimum volumes over 8 hours of a day (less than 300 vehicles per hour (vph) major street approaches and less than 200 combined pedestrian/bike/vehicular units per hour for the same 8 hours)
- The need to control vehicle/pedestrian conflicts near locations that generate high pedestrian volumes.

However, the following criteria are satisfied for an all-way stop warrant:

- The need to control left turn conflicts (sight line is currently 50 feet looking west)
- Locations where a road user, after stopping, cannot see conflicting traffic and is not able to negotiate the intersection unless conflicting cross traffic is also required to stop.
- An intersection of two residential neighborhood collector (through) streets of similar design and operating characteristics where multi-way stop control would improve traffic operational characteristics of the intersection.

It is the opinion of MDM that an all-way stop control is not desirable nor strongly supported at the intersection of Parmenter Road and Pine Hill Road given the low traffic volumes and ability to first try other remedial measures such as outlined under *Recommendations* which are specifically designed to reduce travel speeds, reduce vehicular conflicts, enhance intersection visibility and enhance sight lines. Should this set of remedial measures fail to enhance visibility and safety then an all-way STOP control may be considered.

SUMMARY OF TRAFFIC and SAFETY ISSUES

The safety and operations evaluation for the intersection of Parmenter Road and Pine Hill Road indicated the following traffic and safety issues as outlined in **Figure 5**:

- Parmenter Road is classified as rolling terrain with both vertical and horizontal curves with roadside obstructions in close proximity to the travel way including vegetation, trees and stone walls.
- While yellow centerlines and single white edge lines are provided in the adjacent communities no pavement markings within the Town of Southborough were evident at the time of this evaluation.
- Roadside vegetation along Parmenter Road impairs visibility to existing signage.
- Stopping sight distance (SSD) along Parmenter Road approaching Pine Hill Road from the west is limited to 250 feet by a vertical crest curve.
- Intersection sight distance (ISD) looking west from Pine Hill Road onto Parmenter Road is severely limited to only 50± feet by an embankment, stone wall, vegetation, and several large trees.
- The “STOP” sign on the Pine Hill northbound approach to Parmenter Road is blocked by vegetation. Said vegetation also impairs ISD looking to the east onto Parmenter Road from a STOP position further from the edge of travel way. A “STOP” line on the Pine Hill Road approach to Parmenter Road is also worn or no existent.
- The right turn corner radius from Parmenter Road to Pine Hill Road is restrictive.

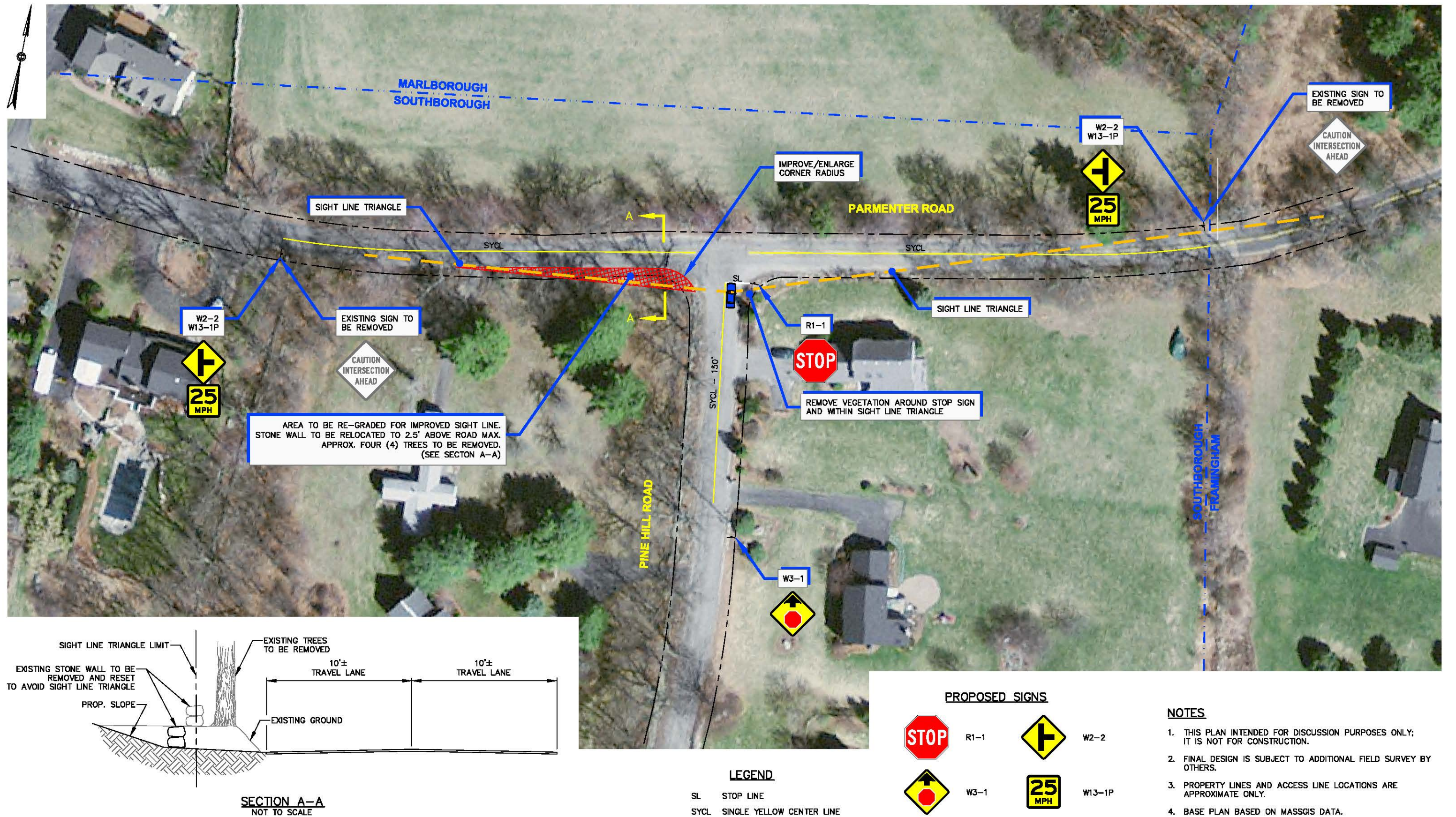
In summary, there are several existing traffic and safety issues at the intersection which should be addressed. Potential roadway and intersection improvements are identified under *Recommendations* that have been designed to address the existing traffic operations and safety issues within the study area.



RECOMMENDATIONS AND CONCLUSIONS

MDM recommends the following design elements as summarized in **Figure 6** which will enhance traffic operations and safety within the Town of Southborough along Parmenter Road and at the intersection of Parmenter Road and Pine Hill Road:

- A yellow centerline should be installed along Parmenter Road consistent with markings currently provided in the adjacent communities of Marlborough and Framingham. The resulting roadway cross section would consist of two 10± foot travel lanes (one lane in each direction).
- A yellow centerline should be installed along the last 150 feet of Pine Hill Road approaching Parmenter Road.
- A “STOP” line and new “STOP” sign should be installed on the Pine Hill Road approach to Parmenter Road. The vegetation blocking the view of the STOP sign should be removed to enhance visibility of the sign as well as sight line triangle for vehicles looking east onto Parmenter Road from Pine Hill Road. To enhance the visibility of the “STOP” condition a “STOP sign ahead” warning sign (graphic W3-1) should be installed along Pine Hill Road.
- Existing roadside vegetation along Parmenter Road within the Town of Southborough should be trimmed as needed to enhance roadway and signage visibility.
- To maximize the available sight line looking west from Pine Hill Road onto Parmenter Road the area within the sight line triangle should be regraded, the stone wall should be removed and reset to a maximum height of 2.5 feet above the adjacent roadway grade and approximately four (4) trees should be removed. With said improvements the sight line (ISD) looking to the west from Pine Hill Road onto Parmenter Road can be maximized to approximately 250 feet which correlates to a design speed of approximately 25 mph.
- The two “Caution Intersection Ahead” signs on the Parmenter Road approaches to Pine Hill Road should be removed. The Signs should be replaced with “Advanced Intersection Warning” signs (graphic W2-2) with supplemental “25 mph” advisory speed plaques (W13-1P). The 25 mph designation for the advisory speed plaque is based on the available ISD of 250 feet as cited above. Likewise, the new signage should be placed approximately 250 feet from the intersection.
- The right turn corner radius from Parmenter Road onto Pine Hill Road should be enlarged to enhance operations and to provide a tangent curve.



Conclusions

In summary, there are several existing traffic and safety issues at the intersection of Parmenter Road and Pine Hill Road which should be addressed. Recommended roadway and intersection improvements have been identified under *Recommendations* that have been designed to address the existing traffic operations and safety issues within the study area. With the recommended improvements in place traffic operations and safety will be enhanced within the Town of Southborough along Parmenter Road and at the intersection of Parmenter Road and Pine Hill Road.