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To: West Tisbury Board of Selectmen
From: MVC Staff
Date: April 15, 2010
Re: **Design Alternatives for the Intersection of State Road and Old County Road in West Tisbury**

At the request of the Town of West Tisbury, the Martha's Vineyard Commission carried out a traffic study of the intersection of Old County Road and State Road. The aim was to assess current traffic conditions including average daily traffic data and crash history, to identify alternatives for intersection reconfiguration, and to analyze these alternatives from various points of view including a level of service analysis.

The Martha's Vineyard Joint Transportation Committee had requested that the Massachusetts Department of Transportation (MassDOT) look at the possibility of redesigning the intersection. Last year, MassDOT District 5 Project Development Section prepared concept plans for two alternative modifications. Both options were for a simpler "T"-intersection, located further west (up-Island), with and without a left-turn lane on State Road. The West Tisbury Board of Selectmen had concerns about these proposals and asked the MVC to explore other alternatives.

1. Study Area

The project site is located on the northeast quadrant in West Tisbury, roughly one-mile from the Tisbury town line. In the site vicinity, speed limits of 40 mph are posted along the eastbound and westbound approaches of State Road and on the southbound approach of Old County Road. A speed limit of 25 mph is posted on the Old County Road northbound approach, just prior to reaching the intersection. There are no sidewalks on either side of either roadway.

2. Existing Conditions

2.1 Geometry: Old County Road intersects State Road at an acute angle rather than a 90-degree angle. Combined with the current intersection design, this creates an awkward geometry that raises several safety issues. The northern end of Old County Road splits into two 2-way segments for up-Island and down-Island traffic, separated by a small triangular area marked by hatching on the pavement. This is somewhat similar to some other intersections on the Island where the end of a road splits around a vegetated island. Here the vegetated island separates the entire intersection from a paved area that is used only for parking fire trucks that are filling their tanks from an adjacent water pump.



- 2.2 Peak Hour Traffic Volumes:** Manual turning movement counts were conducted at the existing intersection. The traffic count was conducted during the typical weekday morning peak traffic period (7:00-9:00 a.m.) and afternoon peak traffic period (4:00-6:00 p.m.). At the unsignalized intersection of State Road and Old County Road, the morning peak hour occurred from 7:45 to 8:45 a.m. and carried a total volume of approximately 1,367 vehicles. The afternoon peak hour occurred from 4:00 to 5:00 p.m. and carried a total volume of approximately 1,843 vehicles. Future traffic conditions were also evaluated using the moderate growth rate of 17%.
- 2.3 Sight Distances:** The minimum required sight distance – the length of road visible for a driver – for a road with a posted speed limit of 40 mph is 305 feet. The existing sight distance for vehicles turning from Old County Road onto State Road looking left is over 700 feet, while the sight distance looking right is 650 feet, which are both more than the required minimum. However, what is more critical is the visibility of eastbound vehicles on State Road from westbound vehicles making a left turn onto Old County Road, and vice versa. Since there is a curve in State Road at the approximate location of the intersection, the visibility between eastbound and westbound vehicles on State Road is reduced. This limits the time to react, particularly for non-regular users. Presently, westbound vehicles on State Road turning left onto Old County Road start making the turn

at a location east of the curve, where they cannot see the eastbound vehicles on State Road.

Eliminating the eastern segment of the end of Old County Road would effectively move the intersection to the west of the curve in State Road, thereby increasing the sight distance for left-turning vehicles. Moving the intersection further to the west would increase this sight distance even more. With a T intersection, the westbound vehicles turning onto Old County Road will have to slow down considerably, if not stop. Locating this intersection where left-turning cars can clearly see the eastbound traffic on State Road means that drivers can clearly see approaching vehicles. This is the main reason for considering a change to the intersection design. This issue could be looked at in more detail if the decision is made to pursue action.

2.4 Accident History: The accident history of the study area intersection was evaluated to identify any safety deficiencies and to determine if the location experiences a higher than average accident rate. The accident data was obtained from MassDOT records for the three most recent years available (2005-2007). The MassDOT Crash Rate Worksheet was used to calculate accident rates in accidents per million vehicles entering each intersection. These rates are compared to Statewide and MassDOT District average rates by intersection type. The intersection of State Road and Old County Road experienced a total of 4 accidents over the three year period, or 1.33 accidents per year. This results in an intersection crash rate of 0.34, which is lower than the average state-wide rate of 0.87 and the District 5 average of 0.66 for unsignalized intersections. Although the accident rate has been low, there is a concern that the limited sight distance between vehicles heading in opposite directions on State Road could someday result in a head-on crash.

2.5 Vegetation: The main concern about vegetation is the presence of trees in the island, of which there are seven. (They are numbered counter-clockwise starting from the Christmas tree.) The canopies of trees 2 to 5, located closer to Old County Road, intermingle. Trees 6 and 7 are a bit separate from the first group and are located closer to State Road.

- Tree 1 is a healthy spruce tree about 8-10 feet tall. It is decorated as a Christmas tree in the holiday season. This tree is small enough to transplant.
- Tree 2, closest to Old County Road along the fire lane, is a healthy beech tree about 30'-35' tall.
- Tree 3 is a white pine in fair shape, about 30 feet tall.
- Tree 4 is another white pine that is about 20 feet tall that is wedged in between the larger pine and a bigger oak and thus not particularly robust.
- Tree 5 is a double stemmed oak about 35 feet tall. One of the stems appears to be in better health than the other but it is hard to tell for sure in the winter.
- Tree 6 is a small, healthy oak about 20 feet tall.
- Tree 7 is a healthy oak that is about 40 feet tall. Its canopy reaches over the State Road layout.

3. Alternatives – Description and Analysis

There are two main reasons to consider modifying the intersection design.

- From a safety point of view, the fact that vehicles turning left from State Road onto Old County Road can make this turn without slowing down raises concern that this conflict might someday lead to a crash. Though the intersection accident rate is relatively low, the consequences of a potential head-on crash at relatively high speeds are such that an intervention may be warranted. The main aim would be to come up with a design that requires vehicles to slow down before making the turn.
- From a landscape point of view, the present configuration has a considerable amount of pavement and it would be desirable to reduce the amount of paved roadway. It would also be desirable to preserve all or as many as possible of the existing large trees, especially those in the island just west of the intersection. It might be preferable to sacrifice some trees in the interest of improving safety, in that new trees could be planted in different locations.

The main questions that the alternatives analysis addressed are:

- Whether a left-hand turn lane on State Road is warranted,
- Where the T-intersection should be located,
- What the dimensional requirements should be, and
- Whether a left-hand turn on Old County Road is warranted.

This analysis will help with the basic question, of whether there is a redesign of the intersection that is sufficiently superior to the existing situation that warrants proceeding.

2.1 Possibility of Left-Turn Lane on State Road: The two geometric design alternatives provided by MassDOT each create a “T” intersection.

- Alternative A does not have a left-turn lane on State Road. It does propose a wider shoulder on the north side of the intersection that could allow vehicles heading west on State Road to slowly pass vehicles that are stopped on State Road waiting to turn onto Old County Road.
- Alternative B proposes a dedicated turning lane which separates turning traffic from the through traffic flow.

The Commission used traffic modeling software to estimate the level of service and average delay with both options, based on current traffic levels and with the projected increase in traffic. This modeling was based on a simple T-intersection with and without a turning lane.¹

The level of service analysis, described in more detail in appendix 1, indicates that the average intersection delay for Alternative A (no turning lane) is currently 6.8 seconds during the morning peak hour and 5.6 seconds in the afternoon peak, and with projected traffic growth would go up to 9.6 and 8.0 seconds respectively.

The addition of the turning lane would only reduce the overall average intersection delay by about half a second, namely to 6.4 and 5.2 seconds today, and 9.2 and 7.5 seconds

¹ *The traffic analysis software does not permit analyzing the impact of changing the detailed geometry of the intersection to a T, which would lead to vehicles heading west on State Road having to slow down to make the left turn onto Old County Road. Nor does it allow estimating the impact of vehicles using the shoulder to pass stopped vehicles, and offered with option A.*

with the projected growth. With or without a left-turn lane, vehicles turning left onto Old County Road will have to wait an average of 9.1 seconds. With a left-turn lane, westbound vehicles on State Road would have no delay at all; and without the left-turn lane, would have an average delay of less than 2 seconds.

Based on MassDOT criteria, the analysis shows that a left turn lane can be considered at this location but is not required. Given the desirability of maintaining the two-lane character of the Island's main roads and the minimal decrease in delay that a left-turn lane would offer, it would not appear worthwhile pursuing this option, and it was not studied further.

2.2 Location of T-Intersection: The next question is where the T-intersection is best located in order to optimize the two goals of improving safety and improving the landscape character. In all cases, the design is based on creating a right-angled intersection. Four options were analyzed (from west to east).

- Option 1: Fire Lane: Generally in the lane presently used by fire trucks, providing additional shoulder width for use by fire trucks.
- Option 2: MassDOT: West of the existing intersection, in the alignment proposed by MassDOT.
- Option 3: East of Trees: Just east of the trees in the island.
- Option 4: Existing Location: In the existing location of the up-Island segment.

Moving the intersection west of the curve in State Road would maximize the visibility of eastbound vehicles on State Road for vehicles turning left from State Road onto Old County Road. Moving it even farther to the west would further increase sight distances, would result in an easier turn for eastbound vehicles on State Road turning right onto Old County Road, and would provide a longer road segment perpendicular to State Road. However, moving it to the west also reduces or eliminates the possibility of preserving the existing trees. In all cases, the total amount of pavement is reduced because the area that is currently asphalted and that is re-vegetated is greater than the area of vegetation that is paved.

The following sketches are based on current dimensional requirements and no left turn lane on Old County Road. The sketches are intended to illustrate several alternative concepts, but are not accurate design proposals.



Option 1: Fire Lane

Advantages

- Maximizes sight distance for vehicles turning left from State Road onto Old County Road by locating the intersection west of the curve in State Road.
- Minimizes the overall extent of asphalt, by allowing a single paved area with a wide shoulder to serve as the road and as the fire truck water supply area.

Disadvantages

- Would appear to result in elimination of all major trees in the island.



Option 2: MassDOT

Note that this sketch is based on the intersection location proposed by MassDOT, but the dimensional requirements are tighter as explained in the next section.

Advantages

- Second best option for maximizing sight distance for left-turning vehicles by locating the intersection in the curve on State Road.

Disadvantages

- Eliminates most of the trees in the island.
- Doesn't allow for combining road and fire truck lane.



Option 3: East of Trees

Note that the exact location of this option would depend on what MassDOT accepts as the minimal dimensional requirements with respect to the setback from existing trees and shoulder width.

A variation of this option would involve moving tree 1 (the Christmas tree) to the southeast corner of the intersection, which would allow the roadway to be located farther to the west.

Advantages

- Increased sight distance for left-turning vehicles compared to the current situation. Preserves all the trees in the island.

Disadvantages

- Doesn't allow for combining road and fire truck lane.



Option 4: Existing Location

This option involves keeping the western segment at the end of Old County Road. The eastern segment would be re-vegetated.

Advantages

- Increase in sight distance compared to the existing situation by eliminating the segment that had allowed left turns to the east of the curve, but not as great as the other options.
- No change to vegetated island including trees.
- Presumably lowest cost in that only the southeast corner needs to be modified.

Disadvantages

- Doesn't allow for combining road and fire truck lane.

2.3 Dimensional Requirements: For each of these locations, there are possible variations with respect to several aspects of the specific intersection geometry could vary, including the tightness of the curves, the width of shoulders, and the width of the cleared roadside area. Presently, the curve to the southwest of the intersection is relatively tight (radius of about thirty feet), but buses and trucks seem to be able to manage it without difficulty. The shoulders and the cleared area (i.e. from the edge of asphalt to trees or other obstructions) are relatively narrow, similar to most of the Island's road network.

The idea of widening lanes, shoulders, and cleared areas beside the road might be counterproductive. On Martha's Vineyard, the experience has been that those roads that have the largest dimensions, those that most closely respect the FHWA standards, have the highest number of serious accidents rather than the lowest. This is perhaps because the wide-open, highway-like roadway encourages people to speed up. Traffic calming techniques suggest that tighter geometries are far more effective than posted speed limits in encouraging drivers to slow down. In the coming year, the Martha's Vineyard Commission will be analyzing accident statistics on the Island to see whether this perception is backed up by facts.

If MassDOT rebuilds the intersection, it might have to apply different minimal requirements, resulting in wider curves, shoulders, and cleared areas, even though the existing situation appears to be satisfactory. This is a key question that will have to be discussed with MassDOT. The above sketches are based on a relatively tight geometry, similar to the existing situation in order to reduce the expanse of asphalt and to preserve more trees, namely: an approximately 30-foot radius for curves, an 8-foot cleared area beside the road, and a 3½-foot shoulder.

To illustrate the difference, below is the original design for option 2 as drawn by the MassDOT (Option 2b) which has a more expansive geometry.



2.4 Possibility of Left-Turn Lane on Old County Road: The level of service analysis showed that the introduction of a left-turn lane on State Road would not have a significant impact on delays on State Road. However, it shows that the delay for vehicles turning onto State Road from the north end of Old County Road is already more than 19 seconds and is projected to increase to 29 seconds.



4. Conclusions and Recommendations

- 1) There appears to be no reason to pursue a left-turn lane on State Road and it is recommended that this possibility be dropped.
- 2) The introduction of a short left-turn lane at the end of Old County Road could be useful and it is suggested that this possibility be explored.
- 3) As for the location of the T-intersection, the two options that appear to be the most promising are:
 - Option 1, which maximizes the sight distance, but would apparently eliminate all the existing trees in the island,
 - Option 3, which moves the road as far to the west as possible without impacting the trees.

For both these options, it is suggested that we meet MassDOT to see what minimal dimensional requirements might be acceptable in the roadway design, and we could more precisely determine the sight lines with the most promising options.

- 4) If MassDOT is obliged to impose large dimensional requirements on the redesigned intersection, and if the sight lines with option 4 are adequate, it might be preferable to leave the intersection as it is.
- 5) It might be useful to do a mock up of a T intersection to see how it operates. This could be done by using cones to simulate option 4. It should be recognized, however, that people are often uncomfortable at first about any change, so receiving some negative comments should not, in itself, put an end to the project if the Board of Selectmen feel that the advantages outweigh the disadvantages.
- 6) Even though sight distances are adequate for the posted speed limits, the elimination of a few trees on the westbound approach could give travelers heading westbound on State Road even more distance to safely determine the gap needed in order to safely make a left hand turn onto Old County Road.
- 7) If these efforts do not produce a satisfactory conclusion, it might be worthwhile conducting a Road Safety Audit, through the MassDOT Highway Safety Improvement Program (HSIP), though these are normally reserved for higher accident locations.

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Appendix 1: Level of Service Analysis

Level of Service Criteria: Level of Service (LOS) is a term used to describe the quality of the traffic flow on a roadway facility at a particular point in time. It is an aggregate measure of travel delay, travel speed, congestion, driver discomfort, convenience, and safety based on a comparison of roadway system capacity to roadway system travel demand. Operating levels of service are reported on a scale of A to F, with LOS A representing the best operating conditions with little or no delay to motorists, and LOS F representing the worst operating conditions with long delays and traffic demands sometimes exceeding roadway capacity.

Intersection operating levels of service are calculated following procedures defined in the *2000 Highway Capacity Manual*, published by the Transportation Research Board. For signalized and unsignalized intersections, the operating level of service is based on travel delays. Delays can be measured in the field but generally are calculated as a function of traffic volume; peaking characteristic of traffic flow; percentage of heavy vehicles in the traffic stream; type of traffic control; number of travel lanes and lane use; intersection approach grades; pedestrian activity; and, signal timing, phasing, and progression where applicable. The specific criteria applied per the *2000 Highway Capacity Manual* are summarized in Table 1.

Table 1 Intersection Level of Service Criteria

Level of Service	Average Delay per Vehicle (Seconds)	
	Signalized Intersections	Unsignalized Intersections
A	<10.0	<10.0
B	10.1 to 20.0	10.1 to 15.0
C	20.1 to 35.0	15.1 to 25.0
D	35.1 to 55.0	25.1 to 35.0
E	55.1 to 80.0	35.1 to 50.0
F	>80.0	>50.0

Source: *Highway Capacity Manual*, Special Report 209, Fourth Edition, Transportation Research Board, National Research Council, Washington, DC, 2000.

The calculated average delay per vehicle for signalized intersections applies to all vehicles entering the intersection and under control of the traffic signal. For unsignalized intersections, it is assumed that through movements on the main street have the right-of-way and are not delayed by side street traffic. Consequently, the average delay values in Table 1 for unsignalized intersections apply only to the minor street intersection approaches or to left turns from the major street into the minor street which must yield to oncoming traffic. For this study, the SYNCHRO software was used to analyze peak hour operations.

Intersection Operating Conditions: Martha's Vineyard Commission completed a level of service analysis for the study area intersection. Field observations were made to determine traffic controls and intersection geometry. Martha's Vineyard Commission analyzed several scenarios. Each scenario uses the existing traffic volumes, while the future scenarios applied a 17% growth

rate to them, as mentioned above. Tables 2-3 below provide a summary of the level of service analysis.

As shown in Table 2, the intersection currently operates at Level of Service (LOS) B or better during the morning and afternoon peak periods. The future no build conditions assume that no mitigation measures are in place. Future traffic growth traveling through this intersection will experience nominal increases in delay (approximately 2.4 to 2.8 seconds). Westbound travelers will not experience long delays. Northbound lefts are projected to see an increase in upwards of 10 seconds of delay or LOS D or better, which will have a negligible impact on traffic operations.

Table 2		Without Left-Turn Lane on State Road Level of Service Summary					
Intersection	Peak Hour	Existing Conditions			Future No-Build Conditions		
		LOS	Delay	V/C	LOS	Delay	V/C
	a.m.	A	6.8		B	9.6	
	p.m.	B	5.6		C	8.0	
State Road WB	a.m.	A	3.5	0.12	A	3.8	0.14
	p.m.	A	4.1	0.14	A	4.6	0.18
Old County Road NB	a.m.	C	18.1	0.50	D	27.5	0.68
	p.m.	C	19.1	0.47	D	29.6	0.66
Delay = Average delay (seconds per vehicle) V/C = Volume-to-capacity ratio LOS = Level of Service							

MassDOT Alternative B proposes a dedicated turning lane which separates turning traffic from the through traffic flow. As shown in Table 3, if a left turn lane was present today; all approaches currently operate at Level of Service (LOS) A during the morning and afternoon peak periods. Future traffic growth traveling through this intersection will result in nominal increases in delay (approximately 2.3 to 2.8 seconds). Northbound lefts onto State Road will experience an increase in delay of 10 seconds. These delays will have negligible impact on traffic operations.

Table 3		With Left-Turn Lane on State Road Level of Service Summary					
Intersection	Peak Hour	Existing Build Conditions with Left-Turn Lane			Future Build Conditions with Left-Turn Lane		
		LOS	Delay	V/C	LOS	Delay	V/C
State Road WB	a.m.	A	6.4		A	9.2	
	p.m.	A	5.2		B	7.5	
Old County Road NB	a.m.	A	8.1	0.12	A	8.3	0.14
	p.m.	A	8.7	0.14	A	9.1	0.18
Old County Road NB	a.m.	C	18.1	0.50	D	27.5	0.68
	p.m.	C	19.1	0.47	D	29.6	0.66

Delay = Average delay (seconds per vehicle)
V/C = Volume-to-capacity ratio
LOS = Level of Service