4.4. Additional Concerns

4.4.1. A variety of roadside objects pose hazards for vehicles departing the roadway in the southbound direction of Route 17.

There were three crashes along the southbound Route 17 involving off road fixed objects. There are utility poles, signposts, and mailboxes all closely located near the curb that pose risks to vehicles departing the roadway. Two of the three crashes along southbound Route 17 were the result of left turning vehicles unexpectedly entering the lane in front of the through traveling vehicle. Figure 16 shows the roadside objects that also obstruct sight lines for vehicles exiting the driveway opposite to Sugar Hill Road.



Figure 16. Utility Poles Obstructing Sight Lines from Driveway Looking North of Intersection

Potential Safety Treatment(s): Access Management, Wider Edge Line

5. Potential Countermeasures

The following section summarizes potential countermeasures to address the issues identified through the RSA outlined in the previous section. When appropriate, the proposed countermeasure lists a crash reduction factor (CRF). A CRF is a multiplicative factor, based on documented safety research studies, used to compute the reduction in the expected number of crashes after implementing a given countermeasure at a specific site.[7] CRFs provide some indication of the potential benefit, or lack thereof, associated with

[7] American Association of State Highway and Transportation Officials. *Highway Safety Manual.* Washington, DC: American Association of State Highway and Transportation Officials, 2010.

specific countermeasures. Later in this report, there is a reference to the crash modification factor (CMF), which is the counter to a CRF, calculated as 1.0 minus the CRF.

This section also outlines the relative cost and implementation time frame for each potential countermeasure. Table 4 shows the approximate time frame for each implementation category (short, intermediate, long) as well as the cost range for each categorization (low, medium, high).

Table 4. Implementation Time Frame and Relative Cost for Potential Countermeasures

Implementation Time	
Short	Within 1 year
Intermediate	1 to 5 years
Long	Longer than 5 years

Cost	
Low	less than $150,000
Medium	$150,000 to $500,000
High	greater than $500,000

5.1. Intersection Design

5.1.1.Offset Right Turn Lane and Offset Stop Line

As discussed extensively in Section 4.1, sight distance challenges between vehicles on the Sugar Hill Road approach are a primary concern at the intersection. A potential countermeasure for correcting the Sugar Hill Road sight distance challenge is the introduction of an offset right turn lane for northbound Route 17 (Figure 17). This positive offset allows for the sight lines between drivers traveling northbound on Route 17 and vehicles turning from Sugar Hill Road to better see one another when a vehicle is utilizing the right turn lane. Furthermore, the removal of the northbound left turn lane for driveway on the west side of the intersection also helps better the sight lines by shifting the travel lanes to get the offset from the right turn lane and moving of the stop lines for Sugar Hill Road. For northbound vehicles needing to access the west side driveway, the next permitted U-turn is 1,000 feet downstream, with features an existing exclusive left turn lane. For vehicles exiting the west-side driveway at the intersection looking to travel north, the next available U-turn is 1,400 feet downstream, which also has an existing exclusive left turn lane.

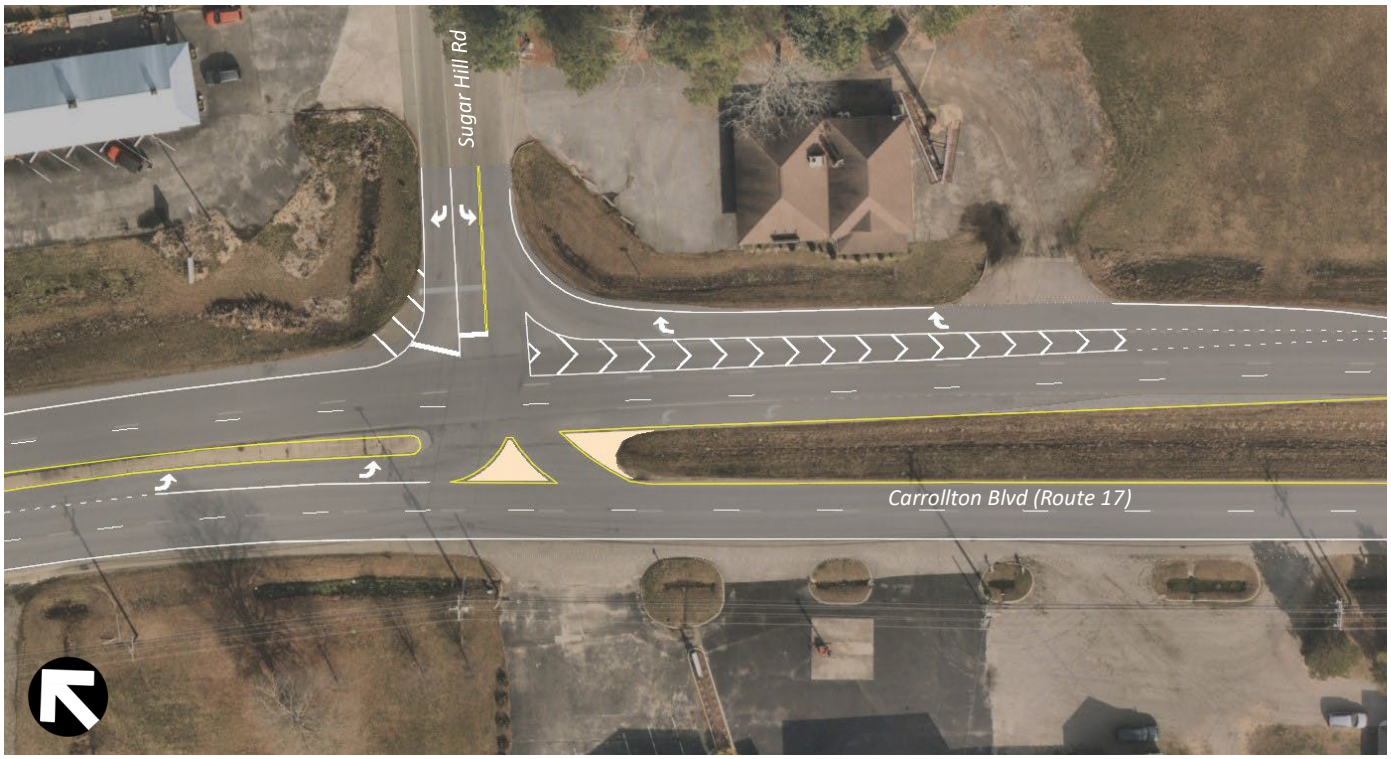


Figure 17. Offset Right Turn Lane Concept

The proposed stop line placement allows for drivers on the Sugar Hill Road approach to easily see northbound Route 17 vehicles even with a vehicle utilizing the right turn lane. By having offset stop lines on Sugar Hill Road, concurrent left and right turning vehicles can have non-conflicting lines of sight looking southbound (as demonstrated in Figure 18).



Figure 18. Offset Right Turn Lane Impacts on Sight Distance

Safety effects of the offset right turn lane have not been extensively studied. However, the recurrence of sight line challenges in the crash narratives, site observations, and crash patterns indicate that the right turn lane's current position relative to the speeds on Route 17 poses a concern. While there is no crash reduction factor for an offset right turn lane, results from recent studies have shown that intersections with offset right turn lanes may have lower crash rates than those with traditional right turn lanes or ones without.[8]

Alternatively, there is a crash reduction factor from NCHRP (National Cooperative Highway Research Program) Report 875 for improved sight distance, which mentions the potential for using offset right turn lanes.[9] The crash reduction potential is calculated through a formula using existing and improved sight distance. Based on the position of a vehicle entering the right turn lane at the same time a vehicle is following behind, the sight distance is drastically improved by an offset right turn lane, which as proposed, would have no sight line obstructions. The estimated crash reduction using the study guidance would be 55 percent for all crashes involving northbound vehicles and those turning from Sugar Hill Road.

Priority: High

[8] Khattak, A. and Kang, Y. *Offset Right-Turn Lanes on State Highway Systems*. Nebraska Transportation Center. 2018.
[9] Eccles, K, Himes, S., Peach, K., Gross, F., Porter, R.J., Gates, T.J., and Monsere. C. *Guidance for Evaluating the Safety Impacts of Intersection Sight Distance.* National Cooperative Highway Research Program, Report 875, Washington, D.C., 2018.

Cost: Medium

5.1.2.Turn Restrictions

The primary turning movements at the intersection involve left and right turns on and off Sugar Hill Road, while very limited vehicles are accessing the driveway on the west side of Route 17. Given the low number of turns involving the driveway, restricting left turns into and out of the driveway at the intersection would allow for geometric improvements that could help improve safety for the left turns on and off Sugar Hill Road. The reduction of the left turn lane into the driveway on the west side of the intersection also allows for the northbound Route 17 lanes to shift away from the right turn lane, allowing for the positive offset to improve sight distance between vehicles traveling northbound on Route 17 and those turning from Sugar Hill Road. It also reduces the number of potential conflict points at the intersection, including diverging conflicts from vehicles entering the northbound left turn lane, crossing conflicts for vehicles entering the intersection from the driveway, and merging conflicts for vehicles turning left onto northbound Route 17.

Additionally, the crash history at the intersection shows that drivers may struggle with finding a gap on Route 17 when entering from Sugar Hill Road. In addition to the improved sight distance in the northbound Route 17 gained by the offset right turn lane, the islands and median extensions allow for the channelization of the left turn from Sugar Hill Road onto Route 17 by allocating a space for drivers to confirm the gap in the southbound direction. This improvement could help reduce the angle crashes between the left turn from Sugar Hill Road and Route 17. This is primarily because of the ability for a driver to make a two-stage left turn if there is not enough time to merge onto Route 17 in front of through traveling southbound vehicles. The protected length of this slip lane would be roughly 25 feet, so heavy vehicles or those with trailers would be unable to make a two-stage left turn out of Sugar Hill Road. In addition, it is also possible that vehicles stopped in the slip lane may obstruct sight distance for left turning vehicles from southbound Route 17.

Lastly, the channelization of the left turn from southbound Route 17 and change in the stop line position for the Sugar Hill Road approach reduces the space and ease of U-turn maneuvers at the intersection. This discomfort and physical limitation may help reduce the number of vehicles making U-turns at the intersection, as supplemented with additional signage (as discussed in Section 5.3).

Priority: High
Cost: Low

Continuous Green T Intersection

Longer term, the intersection design could be modified to include a full Continuous Green T, also known as a Turbo T intersection. [10] The VDOT Arterial Preservation program conducted a study for Route 17 and identified the potential for a Green T installation at the intersection to help reduce the number of crashes involving left turns from Sugar Hill Road onto southbound Route 17. The geometric improvements discussed in the previous section have many of the same features and benefits of the Green T but does not require an acceleration lane. Without the installation of an acceleration lane, the median extension and channelizing island can be installed in phases, with a temporary demonstration using markings and flexible delineators, and a second phase for permanent installation using concrete. In the future, the full Green T with the acceleration lane may help mitigate any risk of sideswipe and rear end crashes for vehicles merging onto southbound Route 17. It should also be noted that a Continuous Green T design is not conducive to non-motorized crossings across the major road, meaning that this intersection could not feature crosswalks across Route 17 if the corridor has shared-use path. A previously developed concept of the Green T is shown in Figure 19.

[10] Virginia Department of Transportation. "Innovative Intersections and Interchanges". https://www.virginiadot.org/info/innovative_intersections_and_interchanges/cgt.asp

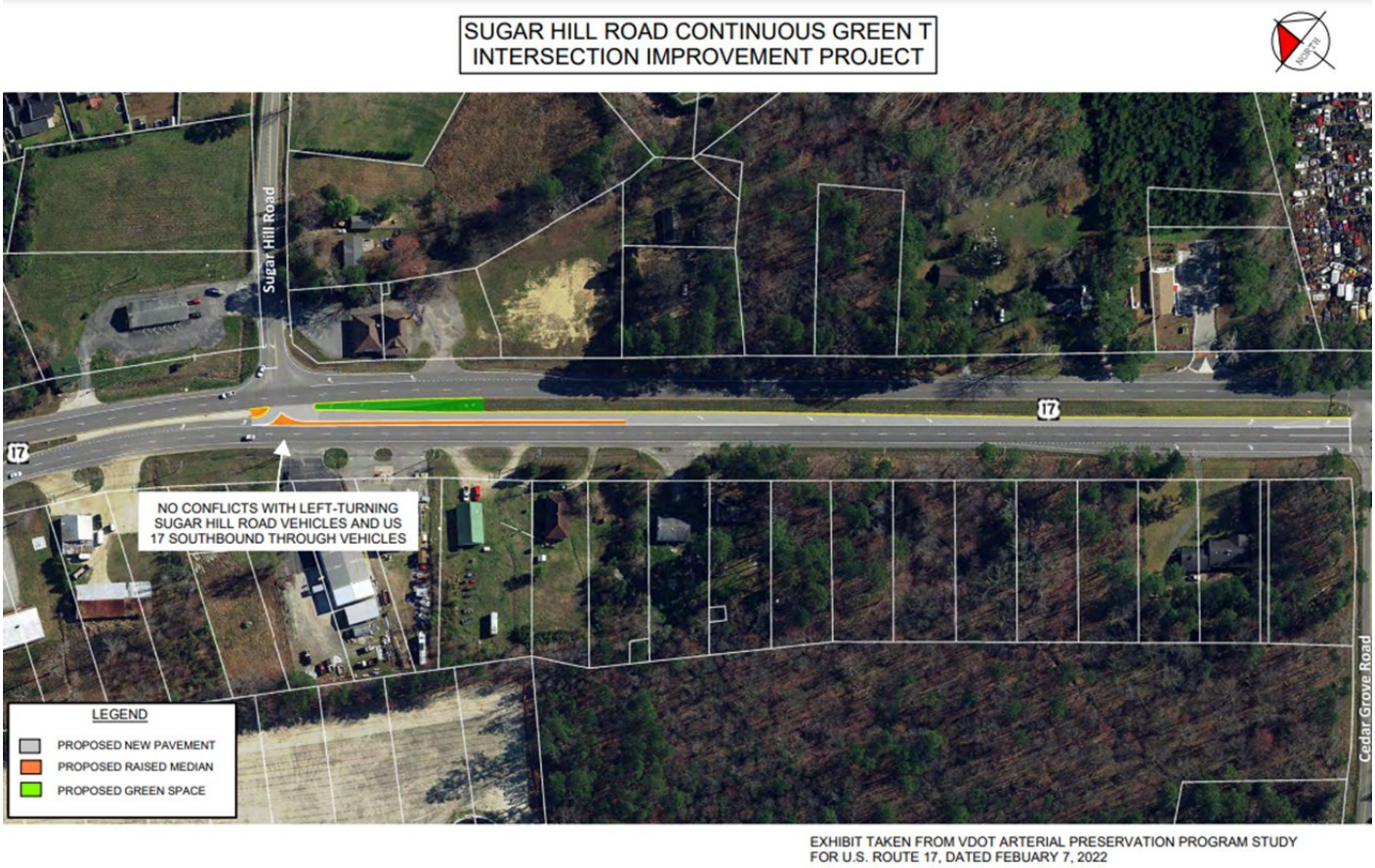


Figure 19. Continuous Green T Concept from Route 17 Arterial Preservation Study

Isle of Wight County applied for funding through the VDOT Smart Scale program in 2022 but was ultimately not awarded funding for the project. This is likely due to the high project cost of roughly $3.7 million and low reduction potential for total crashes (4.2 percent), despite the more significant reduction in fatal and injury crashes (15.4 percent).[11]

Priority: Medium
Cost: High

Restricted Crossing U-Turn Intersection

Because of the challenges with sight distance and the existing roadway geometry, an alternative intersection design or access management may help reduce crashes and improve intersection safety. One type of alternative intersection is a Restricted Crossing U-Turn (RCUT), which has been shown to reduce all crashes by 20 percent. An RCUT also greatly reduces the number of conflict points when compared to a traditional

[11] Wood, J. and Donnell, E.T. *Safety evaluation of continuous green T intersections: A propensity scores-genetic matching-potential outcomes approach*. Accident Analysis and Prevention, Vol. 93, (2016) pp. 1-13.

intersection (32 conflict points to 18 with RCUT design). Figure 20 shows the RCUT design and associated conflict points.

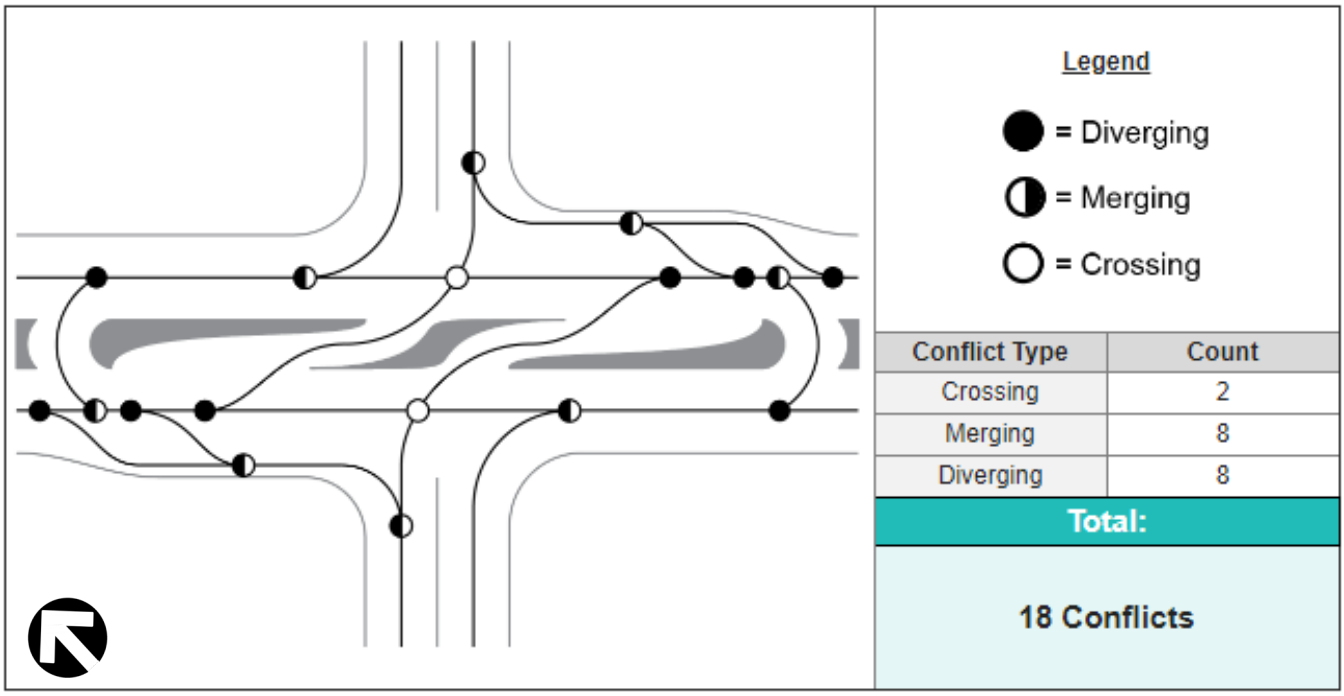


Figure 20. RCUT Intersection Design and Conflict Points (Source: VDOT)

Converting the intersection to an RCUT would allow all turning movements from Route 17 but would restrict Sugar Hill Road from making left turns onto southbound Route 17. Vehicles looking to enter southbound Route 17 would be required to make a U-turn roughly 1,000 feet north of Sugar Hill Road at Manor Drive. Additionally, vehicles looking to head northbound from the business driveway would need to make a U-turn 1,400 feet south at Cedar Grove Road. This intersection design would require further analysis of turning movements, vehicle types, and impacts to safety and operations of adjacent intersections. This safety countermeasure could be installed in the intermediate term if only including a narrow median with bollards, while full construction of concrete channelization could be installed long-term.

Priority: N/A
Cost: Medium (intermediate term), High (full construction)

5.1.3.Tightened Corner Radius for Right Turn onto Route 17

A tightened corner radius for the right turn from Sugar Hill Road onto northbound Route 17 is proposed in the intersection redesign. Tightening the turning radius can have beneficial traffic calming effects by slowing

turning speeds, improved visibility for drivers, and increasing driver yielding behavior.[12] By encouraging this lower speed turn, drivers may be more likely to make a complete stop at the stop line. As stated in the identified concerns, drivers consistently failed to stop when a gap in northbound traffic was present. By requiring them to slow down, drivers may not be able to enter northbound Route 17 as easily, thus increasing the likelihood of stopping. In addition to this countermeasure, intermittent enforcement may also contribute to driver compliance with the stop sign. Pavement markings are an alternative measure to tighten the turn radius to move the stop line forward for the right turn lane, but also allow for turning movements for larger vehicles.

Priority: Medium
Cost: Medium

5.1.4.Extended Turn Lane for Southbound Left from Route 17

Based on field observations, the left turn lane for southbound Route 17 can easily fill up with three or more vehicles, especially when they are larger or hauling a trailer. This left turn is also highest during the afternoon/evening peak hour (135 left turns onto Sugar Hill Road), which is when conflicting volumes on northbound Route 17 are highest (1,321 vehicles heading northbound). Considering the increase in conflicting volumes during the same time as peak left turning movements means that queues for the southbound left turn may extend past the current space that is designated. This is likely the result of the original design for the intersection, prior to the increase in trips generated by new housing developments off Sugar Hill Road. The traffic impact analysis for such housing developments would have predicted this increase in demand through traffic impact studies. Because of this challenge during peak hours, there is an opportunity to extend the southbound left turn lane back a distance allowable by drainage constraints.

Priority: Medium
Cost: Medium

5.1.5.Traffic Signal

Due to the nature of the intersection traffic volumes and crash history, the study team investigated several potential safety countermeasures. A traffic signal was posed as a potential alternative during the field observations, with intent of further investigating the feasibility and safety effects of a signal installation. Upon review of existing turning movement counts, minor road volumes from Sugar Hill Road throughout the course of the day are not typical of what would be required for a traffic signal. Furthermore, a signal at this intersection would not be compliant with the minimum signal spacing standards of the State. Per Table

[12] Fitzpatrick, K., Avelar, R., Pratt, M., Das, S., Lord, D. *Crash Modification Factor for Corner Radius, Right-Turn Speed, and Prediction of Pedestrian Crashes at Signalized Intersections*. Report No. FHWA-HRT-21-105. Federal Highway Administration. 2022.

2-2 in Appendix F of the VDOT RDM, the required signal spacing from the adjacent signals would be 2,640 feet. The adjacent signals to the north and south are roughly 1,400 feet and 1,900 feet from the study intersection, respectively. However, additional considerations such as crash history and potential safety impacts must also be reviewed.

In the 2009 version of the Manual on Uniform Traffic Control Devices (MUTCD), the crash history requirement for this intersection would have been five (5) crashes in a single year that could potentially be *correctable by a traffic signal* (left turn, angle crashes).[13] This arbitrary crash warrant had been in the MUTCD since the original release in 1935. In 2017, the MUTCD issued an Interim Approval (IA-19) for alternative signal warrants relating to the crash history driven by research documented in NCHRP Report 07-19, which VDOT has since adopted as the crash warrant for signalization through IIM-387.[14] Research used to develop the new crash warrants incorporate geometric features of the intersection, AADT, and speed, as well a single year and three-year crash history. The research report also mentions that multilane rural roads have much higher crash thresholds for signals than urban roads because "rural signalized intersections on multilane highways have a predicted average crash frequency that is about three times larger than that for rural stop-controlled intersections on multilane highways".[15] While this intersection is classified as "suburban", per the crash warrants, "rural" is defined as roadways with speeds greater than 40 mph or intersections located communities with populations less than 10,000. Crash thresholds for a rural three-leg intersection are listed below:

- 9 angle or pedestrian crashes in a single year; OR
- 6 fatal/injury angle or pedestrian crashes in a single year; OR
- 13 angle or pedestrian crashes in three years; OR
- 9 fatal/injury angle or pedestrian crashes in three years.

The intersection of Route 17 and Sugar Hill Road does not meet any of the required crash thresholds for signalization per IA-19. This is essential to note as research behind the warrant indicates that improper signalization of a highspeed multilane roadway may not result in safety benefits. Additionally, the installation of traffic signals has a well-documented data-driven history of an increase in rear end crashes, despite the potential reduction in angle crashes.[16] This must be considered when balancing the risk of each crash type, as this intersection has previously experienced a fatal rear end crash. Given the elevated speeds on Route 17, the risk of a severe crash involving a driver not expecting to stop for a red light may result in a

[13] Federal Highway Administration. *Manual on Uniform Traffic Control Devices.* Section 4C.08. Federal Highway Administration, Washington, D.C. 2009.
[14] Virginia Department of Transportation. *IIM TE-387 Signal Justification Reports (SJRs) For New and Reconstructed Signals*. Virginia Department of Transportation. 2019
[15] National Academies of Sciences, Engineering, and Medicine. *Crash Experience Warrant for Traffic Signals*. Washington, DC: The National Academies Press. 2014.
[16] National Academies of Sciences, Engineering, and Medicine. *Accident Modification Factors for Traffic Engineering and ITS Improvements*. Washington, DC: The National Academies Press. 2008.

rear end crash, whereas the same driver may opt to run the red light, which can result in a severe angle crash.

Ultimately, unwarranted traffic signals not only have impacts to operations, but they can result in an increase in crash rate and lead to driver disobedience with the signal.[17] Studies have also shown that the removal of unwarranted signals can lead to a decrease in all crashes (24 percent) and a significant decrease in severe injury crashes (53 percent).[18] Another study conducted by the University of Kentucky showed that total crashes increased at intersections where an unwarranted traffic signal was installed by 28.3 percent.[19] The same study also found that total crashes decreased by 42.9 percent when the study intersection met the criteria for crash warrant, but total crashes at intersections meeting non-crash warrant criteria (such as traffic volume) increased by 11.5 percent. While research into the effects of unwarranted traffic signals is limited, transportation agencies across the country have been investigating the impacts of removing unwarranted signals for safety. For this reason, justification of a traffic signal is an in-depth review of all intersection characteristics and must consider the effect on all road users and potential safety impacts, in addition to MUTCD signal warrant criteria. A signal at the intersection of Route 17 and Sugar Hill Road is not justified given the crash history, traffic volumes, and site conditions.

Priority: N/A
Cost: N/A

5.2. Speed Management for Route 17

As cited in Section 4.2.1, driver speeds are consistently higher than the posted 55 mph on Route 17. Because roadway features such as sign placement, turn lane length, intersection geometry, and signal timing are all designed based on the posted speed, ensuring that vehicles are operating at or near the speed limit is essential to safety. It must also be noted that posted speed limits are only part of the reason why people may drive at a certain speed. Factors such as roadway design, lane widths, signal spacing, adjacent land use, and visual cues all contribute to the speed that people feel comfortable driving. Because of the many variables that contribute to vehicle operating speeds, lowering the speed limit alone does not always result in people driving slower. In fact, lowering the posted speed alone can lead to an increase in total crashes and the severity of crashes.[20] Though lowering the posted speed 5 mph below the design speed can have reductions in total crashes and fatal and injury crashes, lowering the posted speed by 10 mph below the

---

[17] National Academies of Sciences, Engineering, and Medicine. *A Guide for Reducing Collisions at Signalized Intersections*. Washington, DC: The National Academies Press. 2004.
[18] National Academies of Sciences, Engineering, and Medicine. *Accident Modification Factors for Traffic Engineering and ITS Improvements*.
[19] Agent, K.R. and Green, E.R. *Crash history after installation of traffic signals: warranted vs. unwarranted*" University of Kentucky Transportation Research Center. 2008.
[20] Gayah, V.V., Donnell, E.T., Yu, Z., and Li., L. *Safety and operational impacts of setting speed limits below engineering recommendations*. Accident Analysis and Prevention, Vol. 121, pp. 43-52. 2018.

design speed can lead to a 42 percent increase in fatal and injury crashes.[21] The findings of the referenced study explained that this could be occurring as operating speed is heavily influenced by road design and visual cues. As a result, some drivers may see the speed reduction as arbitrary and continue operating at comfortable speeds, whereas others may drive at the posted speed limit. This increased differential in vehicle speeds could partially explain the increase in severe crashes.

For this reason, additional safety countermeasures must be employed for speed management given that the corridor has been designed for 55 mph. Speed management countermeasures can be employed to reduce the overall average and 85th percentile speeds closer to the design, or posted, speed. Additionally, intermittent enforcement may also help consistently reduce driver speeds on the corridor. This section addresses the variety of options that could be implemented in this section of Route 17. If, after additional speed management countermeasures are deployed, Isle of Wight County wishes to implement a speed reduction for this corridor segment, then an official request for a comprehensive speed study must be submitted to VDOT. This comprehensive speed study would consider the existing speed data as well as the road characteristics, roadside development, environment, crash analysis, and law enforcement data and input.

5.2.1.Optical Speed Bars or Transverse Markings

There are several options for pavement marking treatments that can be used to raise driver awareness of their driving speed. Both optical speed bar and transverse markings serve a similar purpose, which is to give drivers the perception that their speed is increasing. The intended result is that drivers will slow down on the approach to the change in the road condition, whether that be a horizontal curve, intersection, school zone, or change in speed limit. Studies show that the impacts on speed of optical speed bars or transverse markings are minor (1-2 mph for 85th percentile speeds), the impact was most significant on drivers traveling more than 10 mph and 15 mph over the speed limit.[22] This is an impactful effect, given that speeds significantly higher than the design speed require much more sight distance for drivers entering the major road. Higher speeds also can lead to more severe crashes. Figure 21 demonstrates optical speed bars pavement markings.

[21] Gayah, V.V., Donnell, E.T., Yu, Z., and Li., L.
[22] Hallmark, S. , Hawkins, N. and Knickerbocker, S. *Evaluation of Transverse Markings as a Speed Transition Zone Countermeasures in Small, Rural Communities*. Journal of Transportation Technologies, 11, 61-77. 2021.



Figure 21. Optical Speed Bar Markings on Roadway (Source: Virginia Center for Transportation Innovation and Research)

For a speed limit of 55 mph, FHWA design guidance recommends the placement of optical speed bars at least 300 feet before the intersection.[23] Given the challenges with sight lines at the intersection, optical speed bars or transverse markings should be placed prior to the distance needed for north and southbound to stop for vehicles entering the intersection from Sugar Hill Road (495 feet). The intention of this placement would encourage drivers to slow on the approach to the intersection, which may provide additional clearance time for vehicles turning left from Sugar Hill Road onto southbound Route 17. Both of these potential countermeasures are low-cost treatments that can have impacts on driver speed. Depending on the ease of implementation and maintenance needs, one of the three treatments may be better suited for Route 17 than the others. This study recommends the installation of one of the treatments in tandem with other speed management strategies.

Priority: Medium
Cost: Low

5.2.2.Speed Activated Warning Signs / Dynamic Speed Feedback Signs

A new safety countermeasure that is becoming increasingly popular are speed activated warning signs, also known as dynamic speed feedback signs. The most common speed feedback sign is one that automatically indicates driver speed, with a message saying "YOUR SPEED" underneath a posted speed limit sign. However, there are a variety of speed feedback signs that can be used for many different roadway

[23] Albin, Richard. *Low-Cost Treatments for Horizontal Curve Safety*, Report No FHWA-SA-15-084, Federal Highway Administration Office of Safety, Washington, D.C., 2016

conditions. Newer technology includes signs that provide messaging to drivers that are traveling a certain threshold over the posted or advisory speed. This is being used for approaches to horizontal curves, highway ramps, work zones, school zones, and more. Rather than having the sign activate for each approaching vehicle, a speed-based approach could emphasize the significance of the activation. In the study area scenario, the sign could be an intersection warning sign with an activation for drivers traveling greater than 65 mph. Specific messaging for this sign could be "SLOW DOWN", similar to the example in Figure 22.



Figure 22. Speed Activated Warning Sign (Source: Iowa State University Center for Transportation Research).

This safety countermeasure should only be installed if the Intersection Conflict Warning System, described in the following subsection, is not implemented. Both systems use innovative technology to warn approaching drivers of the same message, which is the intersection ahead. The advantage of this safety countermeasure is that it also has the speed feedback component as well.

Priority: Low
Cost: Medium

5.2.3.Intersection Conflict Warning System

As stated in the identified concerns, Sugar Hill Road may not be readily visible or apparent to drivers approaching the intersection. As a result, people driving on Route 17 approaching the intersection may not see or be aware of vehicles entering the intersection. One countermeasure that states have used to provide awareness for drivers on the major road is an Intersection Conflict Warning System (ICWS) as shown in Figure 23.



Figure 23.Route 17 and Kings Cove Way Dynamic Intersection Warning Sign (Source: Google Street View)

An ICWS is composed of warning signs on the major road approach with flashers, as well as detector loops on the minor road approach. This system is then activated when a vehicle on the minor road approach is detected at the stop line. The warning sign and flashing assembly for the major road approach is then activated to indicate the presence of a vehicle approaching on the minor roadway at the intersection. ICWS with the configuration as described when installed on a four-lane major road with a two-lane minor road intersection approach has demonstrated a potential reduction of 31 percent in total crashes and 24 percent in angle crashes.[24] As stated in the discussion of the speed activated warning sign, this countermeasure

[24] Himes, S., F. Gross, K. Eccles, and B. Persaud. *Multi-State Safety Evaluation of Intersection Conflict Warning Systems (ICWS)*. Presented at the 95th Annual Meeting of the Transportation Research Board, Paper No. 16-4225, Washington, D.C. 2016.

warns drivers of the intersection ahead, meaning that the ICWS should only be implemented without the installation of a speed activated sign.

Potential disadvantages include When the flashers are not activated, mainline vehicle speeds may increase, as drivers would not expect any vehicle to be entering the intersection ahead. The proposed installation would place vehicle detector loops on Sugar Hill Road, with considerations for placement in the driveway directly within the intersection and potentially in the median with the channelized left turn. With several other driveways in the immediate vicinity of Sugar Hill Road, vehicles traveling on Route 17 may not expect others to enter from these access points if the flashers are not activated.

Priority: High
Cost: Medium

5.2.4.Coordinate Adjacent Signals for Platooning

With the future Nike Park Extension traffic signal, the signals along this portion of Route 17 are planned to become coordinated, meaning that the two signals adjacent to the study intersection with operate in tandem. As a result, the coordinated signals may help improve safety at the intersection by creating a platooning effect in both directions. Platoons may also help with speed management along the corridor, as high-speed drivers are subject to travel at speeds similar to that of the group. Often times, the speed of the platoon is dictated by the vehicles at the front of the group when the signal changes to green. Recent studies have investigated the safety effects of signal coordination and found that there is potential for crash reduction on arterials, particularly a result of the speed management effects of platooning.[25]

Priority: Low
Cost: Low

5.3. Additional No U-Turn Signage for Route 17

Given the issues with driver non-compliance making U-turns at the intersection, additional signage may be needed. The existing No U-turn sign for the southbound left turn lane is located in the median behind where drivers would be stopping in the turn lane. While this sign is visible to southbound drivers, it is possible for drivers to miss on the approach. An additional No U-turn could be placed in the grass area of the opposing median to reinforce the message.

Furthermore, new geometric alignment of the intersection will require new No U-turn restrictions to be posted for northbound Route 17, as proposed islands and median extensions would prohibit such

[25] Yue, R., Yang, G., Zheng, Y. et al. *Effects of traffic signal coordination on the safety performance of urban arterials*. Computational Urban Science. 2, 3. 2022.

movement. In addition to the geometric changes and enhanced signage, intermittent enforcement may also help with driver compliance of the no U-turn restriction.

Priority: High
Cost: Low

5.4. Access Management Along Southbound Route 17

Intersections with one driveway on the receiving side of an intersection may have 33 percent more crashes, whereas intersections with two driveways on the receiving side may have 76 percent more crashes than intersections without.[26] The receiving side of southbound Route 17 has two driveways within 50 feet of the intersection and five driveways within 250 feet. While access must be maintained to each parcel along the roadway, 15322 Carrollton Boulevard, Dashiell Landscaping, currently has two driveways, one falling within 50 feet of the intersection. Given that this driveway is also closely located to the driveway for the adjacent parcel at 15314 Carrollton Boulevard, removing the 15322 Carrollton Boulevard access point nearest to the intersection and leaving the driveway roughly 100 feet from the intersection would reduce the potential conflict points for drivers on Route 17, as well as those turning left from Sugar Hill Road.

This reduction in access points could reduce risk of angle crashes for those vehicles exiting the driveway, rear end crashes for those entering the intersection or continuing south on Route 17, as well as overall potential conflicts that drivers must be aware of within the study area. Drivers may not know which driveway the vehicle in front of them may be accessing when indicating a turn. This uncertainty can be lessened by reducing the number of potential driveways closely spaced along the corridor.

Priority: Low
Cost: Medium

5.5. Pavement Marking Improvements

5.5.1.Wider Edge Line Pavement Marking for Route 17

Increasing edge line pavement marking width can help reduce all crashes on rural roadways by 17.5 percent and fatal and injury crashes by 36.5 crashes.[27] This countermeasure targets single vehicle, fixed object, nighttime, and wet crashes. This is primarily because wider edge lines increase driver visibility of the pavement markings, which can help during conditions when visibility may be limited, particularly at night and during inclement weather, which is when many roadway departure crashes occur. Since the study area

[26] Le, T. Q., Gross, F., Harmon, T, & Eccles, K. *Safety Evaluation of Corner Clearance at Signalized Intersections*. Report No. 18-03676, Federal Highway Administration, Washington, D.C. 2018.
[27] Park, E.S., Carlson, P.J., Porter, R.J., and Anderson, C.K. *Safety effects of wider edge lines on rural, two-lane highways*. Accident Analysis and Prevention Vol. 48, pp. 317-325. 2012.

does have an occurrence of roadway departure and fixed object crashes, a wider edge line on Route 17 could be an effective safety countermeasure.



Figure 24. Widened Edge Line along Roadway (Source: Texas Transportation Institute)

The standard installation of edge lines in Virginia is a normal solid line on non-freeway facilities, which constitutes a 4-inch edge line. However, a wide edge line, as defined as twice the width of a normal line, may be used for greater emphasis (Section 3B.06, Line 07).[28] The upgrade of an 8-inch edge line from a 4-inch edge line on Route 17 could be implemented through the VDOT repaving program. This low-cost countermeasure can have significant benefit-cost ratios when installed during roadway resurfacing.

Priority: Medium
Cost: Low

5.5.2.Refurbish Existing Pavement Markings

The existing pavement markings at the intersection vary in condition, ranging from poor to fair. Refurbishing existing pavement markings at the intersection would help driver visibility and awareness of lane designations and stopping locations. Sugar Hill Road is scheduled for repaving during Summer 2023, which provides an opportunity to refurbish existing markings on the approach. Proposed geometric improvements at the intersection would also require new or enhanced pavement markings.

Priority: High
Cost: Low

5.5.3.Install Raised Pavement Markers during Repaving of Route 17

Upon repaving of Route 17, raised pavement markers could be installed along the edge lines and lane lines to help delineate the roadway. This treatment is particularly effective on roadways without any lighting, as

[28] Virginia Department of Transportation. *2011 Virginia Supplement to MUTCD (Revision 1)*. Part 3, Markings Section 3B.06. Virginia Department of Transportation. 2014.

they provide driver guidance through the reflection from headlights. Raised pavement markers are effective in reducing nighttime crashes up to 31 percent and total crashes up to 25 percent on rural roads with an AADT of less than 20,000 VPD when paired with restriping.[29]

Priority: Medium
Cost: Low

5.6. Intersection Lighting

There is currently no lighting present at the intersection, nor along Route 17 between the James River Drawbridge and Suffolk. However, it was noted on site by representatives from the community that the intersection is very dark during night hours. There were three (3) night crashes, with one involving a deer, one involving a northbound U-turn and vehicle turning left from Sugar Hill Road, and another involving a northbound through vehicle and a left turning vehicle from Sugar Hill Road. Although there is not a pattern of nighttime crashes, the study team reviewed lighting as a potential safety countermeasure given the effectiveness in reducing crashes at rural intersections (32.6 percent reduction in angle crashes).[30]

Typical warranting criteria for uncontrolled intersections in rural and suburban areas includes traffic volume, nighttime crash rate or history, presence of pedestrians and bicyclists, and intersection geometry. However, neither Virginia nor Federal guidance currently have warranting criteria for lighting at a free-standing intersection. In this case, VDOT currently has criteria (IIM-TE-390) related to the installation of lighting on roadways, including at intersections and roundabouts. It states that lighting, similar to a traffic signal, must be warranted and justified.[31] Specifically, at uncontrolled intersections the guidance states that lighting may be considered and recommends using selection criteria outlined in the FHWA guide, *Design Criteria for Adaptive Roadway Lighting*.[32] Within the FHWA guide, it states that street lighting should be determined by a classification system including variables such as speed, AADT, median presence, intersection density, parking presence, pedestrian and bicyclist presence, ambient luminance, and roadway guidance. Using the criteria, this intersection is classified as an S5, which does not align with VDOT guidance to install lighting at S1 and S2 locations.

Lighting at the intersection may be considered as a future improvement depending on crash patterns and development of the surrounding land use. However, lighting improvements for the study area are not recommended currently.

---

[29] Sun, X. and Das. S. *Developing Louisiana Crash Reduction Factors*, Louisiana DOT Final Report, FHWA/LA.12/506, October 2013.
[30] Ye, X., Pendyala, R.M., Washington, S.P., Konduri, K., and Oh, J. *A Simultaneous Equations Model of Crash Frequency By Collision Type for Rural Intersections*. 87th Annual Meeting of the Transportation Research Board, TRB 2008 Annual Meeting CD-ROM. 2008.
[31] Virginia Department of Transportation. *IIM TE-390 Guidance on Light Emitting Diode (LED) Exterior Lighting*. Virginia Department of Transportation. 2019
[32] Gibbons, Ronald B. et al. *Design Criteria for Adaptive Roadway Lighting*. Report No. HRT-14-051, Federal Highway Administration, Washington, D.C. 2014.

Priority: N/A
Cost: High

6. Conclusions

The study team has taken into consideration the existing conditions, community feedback, and identified safety concerns at the site to develop a prioritized list of recommendations. To determine the benefit-cost ratio for each improvement, the CMF for each countermeasure must be identified using the Virginia List of Preferred CMFs and CMF Clearinghouse. Not all safety countermeasures had a CMF or reliable CMF, so potential benefits of such countermeasure are unable to be determined.

Table 5 outlines a prioritized list of the various countermeasures proposed in this study, along with each of the safety concerns that it addresses. The table also includes the time needed for implementation and cost of each countermeasure in relative terms.

Table 5. Summary of Recommended Safety Countermeasures and Associated CMFs, Implementation Time, and Cost

Time Needed to Implement	Countermeasure	Addresses Concern(s)	CMF	Cost	Unit
Short	Additional No U-Turn Signage for Route 17 (north and southbound)	Driver Noncompliance making U-Turns in Southbound Direction	0.949	$20,000	4 signs
Short	Refurbish Existing Pavement Markings	Worn Pavement Markings	0.75	$20,000	per project
Short	Optical Speed Bars or Transverse Markings	Sight Distance/Gap Acceptance, High Speeds	N/A	$50,000	2-lanes, each direction
Intermediate	Wider Edge Line Pavement Marking for Route 17	Roadside Hazards	0.825	$40,000	Additional cost per mile (4" to 8")
Intermediate	Raised Pavement Markers on Route 17 (with restriping)	Lighting	0.75	$110,000	per mile
Intermediate	Intersection Conflict Warning System	Sight Distance/Gap Acceptance	0.69*	$410,000	each direction
Intermediate	Coordinate Adjacent Signals for Platooning	Sight Distance/Gap Acceptance, High Speeds	N/A	$15,000	2 signals
Intermediate	Access Management Along Southbound Route 17	Noncompliant Access, Roadside Hazards	0.98~	$150,000	1 driveway
Intermediate	Geometric Improvements: Offset Right Turn Lane, Offset Stop Line, Tightened Corner Radius for Right Turn onto Route 17	Sight Distance/Gap Acceptance	0.45~	$320,000	per project
Long	Extend Left Turn Lane	Short Southbound Left Turn Lane	0.95	$1,050,000	per project
Long	Continuous Green T	Sight Distance/Gap Acceptance, High Speeds	0.96	$3,720,000	per project

Some high priority items will require additional time for implementation versus others. For example, the refurbishment of existing markings, installation of the additional no U-turn sign, and intersection conflict warning system are likely to be installed prior to the implementation of the offset right turn lane and geometric improvements. Such redesigns will require additional engineering and assembly of plans for construction. Similarly, medium priority countermeasures may also be able to be installed prior to intermediate term improvements.

Potential long-term improvements at the intersection could include the preferred redesign of the intersection to a full Continuous Green T, which would include an acceleration lane in addition to the proposed channelization discussed in Section 5.1. Another potential intersection design could be an RCUT, which would only allow left turns from Route 17, and no left turns from Sugar Hill Road or the driveway at 15314 Carrollton Boulevard. Both intersection designs should consider the long-term vision for the corridor, which may include a shared use path along Route 17. The Continuous Green T is not conducive to pedestrian crossings on the major road, while the RCUT may be confusing due to the geometry, which requires a diagonal crosswalk across the major road.

Next steps for this study include a formal response from the roadway owner, VDOT, with coordination from Isle of Wight County. This formal response will include a list of preferred alternatives of the several defined in this document, estimated costs, and delegation of the actions to each responsible party. It also includes an explanation on the feasibility and benefit/cost analysis of each of the recommendations proposed, including which safety countermeasures will move forward into implementation. Ultimately, the intent of these actions is to submit the short-term recommendations for funding through the VDOT HSIP program.