Wythe Creek - Cary's Chapel Intersection Study

HAMPTON ROADS
PLANNING DISTRICT COMMISSION

JUNE 2004

T04-06

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BRIAN MILLER	GRAPHIC TECHNICIAN II
RACHAEL V. PATCHETT	REPROGRAPHIC SUPERVISOR

WYTHE CREEK - CARY'S CHAPEL INTERSECTION STUDY

This report was included in the Work Program for Fiscal Year 2003-2004, which was approved by the Commission and the Metropolitan Planning Organization at their meetings of March 19, 2003.

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HAMPTON ROADS
PLANNING DISTRICT COMMISSION

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AUTHOR:
Keith M. Nichols

ORGANIZATION NAME, ADDRESS AND TELEPHONE
Hampton Roads Planning District Commission
723 Woodlake Drive
Chesapeake, Virginia 23320
(757) 420-8300
http://www.hrpdc.org

ABSTRACT

The intersection of Wythe Creek Road and Cary's Chapel Road is located in southern Poquoson, adjacent to its borders with both York County and the City of Hampton. Wythe Creek Road, a 2-lane arterial, provides the only direct access between the Cities of Poquoson and Hampton, while Cary's Chapel Road, a 2-lane collector, provides a shortcut between residential developments in eastern York County and Langley Air Force Base and NASA Langley. To the east of the intersection is the Shady Oaks Mobile Home Park, which includes approximately 150 homes, a convenience store, and a seafood market. The intersection currently operates under two-way stop control on the Cary's Chapel Road and Shady Oaks Park approaches. Safety is a concern due to limited sight distance caused by a bridge immediately to the south of the intersection. Congestion is also a concern at the intersection, particularly during the morning peak period. The City of Poquoson has requested that the Hampton Roads Planning District Commission (HRPDC) examine alternatives to improve safety and reduce congestion at this intersection.

ACKNOWLEDGMENTS

This report was prepared by the Hampton Roads Planning District Commission (HRPDC) in cooperation with the U.S. Department of Transportation (USDOT), the Federal Highway Administration (FHWA), the Virginia Department of Transportation (VDOT), and the City of Poquoson, Virginia. The contents of this report reflect the views of the staff of the Hampton Roads Area Metropolitan Planning Organization (MPO). The MPO staff is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the FHWA, VDOT, or HRPDC. This report does not constitute a standard, specification, or regulation. FHWA or VDOT acceptance of this report as evidence of fulfillment of the objectives of this planning study does not constitute endorsement/approval of the need for any recommended improvements nor does it constitute approval of their location and design or a commitment to fund any such improvements. Additional project level environmental impact assessments and/or studies of alternatives may be necessary.

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INTRODUCTION

The intersection of Wythe Creek Road and Cary's Chapel Road is located in southern Poquoson, adjacent to its borders with both York County and the City of Hampton. Wythe Creek Road, a 2-lane arterial, provides the only direct access between the Cities of Poquoson and Hampton, while Cary's Chapel Road, a 2-lane collector, provides a shortcut between residential developments in eastern York County and Langley Air Force Base and NASA Langley. To the east of the intersection is the Shady Oaks Mobile Home Park, which includes approximately 150 homes, a convenience store, and a seafood market (**Figure 1**). The intersection currently operates under two-way stop control on the Cary's Chapel Road and Shady Oaks Park approaches.

Safety is a concern due to limited sight distance caused by a bridge immediately to the south of the intersection. Congestion is also a concern at the intersection, particularly during the morning peak period. The City of Poquoson has requested that the Hampton Roads Planning District Commission (HRPDC) examine alternatives to improve safety and reduce congestion at this intersection.

Previous studies have been completed that analyzed both safety and capacity at the intersection of Wythe Creek Road and Cary's Chapel Road. In 1996, HRPDC completed the Poquoson Level of Service and Transportation Improvement Study[1]. In this study, a signal warrant analysis determined that a signal was warranted at this intersection, but raised concerns about turn bay storage space. In 2001, the Kubilins Transportation Group, Inc. completed a signal warrant analysis for this intersection[2]. In the study, installation of a traffic signal was recommended based on the limited sight distance at the intersection.

There is currently $325,000 of Regional STP and $90,000 of Statewide STP funding allocated for installation of a traffic signal at this intersection as part of the Congestion Relief program. Capacity improvements to Wythe Creek Road, however, are not included in the 2026 Regional Transportation Plan.

FIGURE 1 – Aerial View of Wythe Creek Road and Cary's Chapel Road

1 HRPDC, "Poquoson Level of Service and Transportation Improvement Study ", March 1996.

2 Kubilins Transportation Group, Inc., "Traffic Signal Warrant Analysis and Safety Evaluation – Wythe Creek Road and Cary's Chapel Road", 2001.

EXISTING CONDITIONS

This section will detail data that was collected for this study, including traffic counts, sight distance measurements, crash data, and speed data.

Traffic Counts

Table 1 provides average weekday traffic counts for approaches to the intersection of Wythe Creek Road and Cary's Chapel Road. Wythe Creek Road, a 2-lane arterial, carries over 16,000 vehicles per weekday to the south of Cary's Chapel Road and nearly 14,000 vehicles per weekday to the north of the intersection. Cary's Chapel Road, a 2-lane collector, carries 4,500 vehicles each weekday. It is estimated that 1,200 to 1,400 vehicles per day enter and exit the Shady Oaks neighborhood to the east of the intersection.

Traffic volumes entering the intersection from all four approaches only grew an average of 0.3% annually between 1994 and 2001. This is due to little change in traffic volumes on Wythe Creek Road during this time period.

TABLE 1 – Historical Weekday Traffic Volumes Near Wythe Creek Road and Cary's Chapel Road

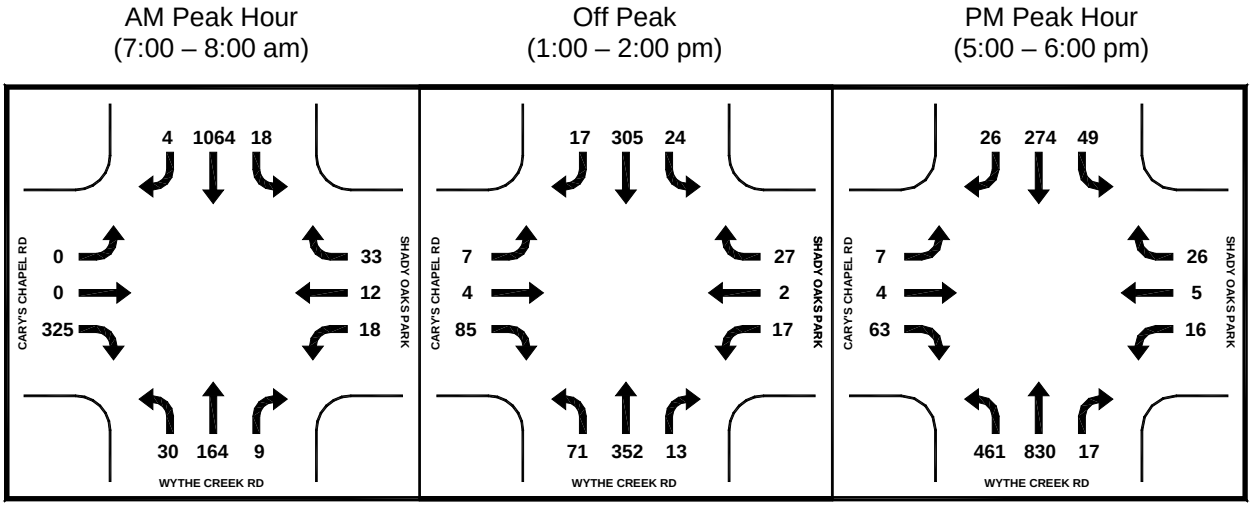
		Weekday Traffic Volumes		
Facility	**Location**	**1994**	**1998**	**2001**
Wythe Creek Rd	North of Cary's Chapel Rd	13,558	13,093	13,991
Wythe Creek Rd	South of Cary's Chapel Rd	16,617	16,269	16,598
Cary's Chapel Rd	West of Wythe Creek Rd	4,148	4,348	4,460

Source: Virginia Department of Transportation (VDOT).

Figure 2 includes turning movement counts for the morning peak hour (7:00 - 8:00 am), an off-peak hour (1:00 – 2:00 pm), and the afternoon peak hour (5:00 – 6:00 pm) for the year 2004. These turning movement counts were estimated based on 2001 turning movement counts taken by the Kubilins Transportation Group, Inc. for their signal warrant study.

The primary movements during the morning peak hour are through movements on southbound Wythe Creek Road and right-turn movements from eastbound Cary's Chapel Road. During the afternoon peak hour, northbound through and left-turn movements from Wythe Creek Road are the primary movements.

FIGURE 2 – 2004 Turning Movement Counts at the Intersection of Wythe Creek Road and Cary's Chapel Road



Sight Distance

The study conducted by Kubilins Transportation Group, Inc. recorded sight distances from the minor approaches to Wythe Creek Road. Sight distance data was collected from an automobile that was stopped at the stopbar on Cary's Chapel Road and at the end of the entrance to the Shady Oaks neighborhood. The sight distance measurements from the study were:

- From Cary's Chapel Road to northbound Wythe Creek Road traffic – 320 feet
- From Cary's Chapel Road to southbound Wythe Creek Road traffic – 335 feet
- From Shady Oaks to northbound Wythe Creek Road traffic – 200 feet
- From Shady Oaks to southbound Wythe Creek Road traffic - unlimited

Sight distance requirements and deficiencies are addressed further in the Analysis portion of the report.

Crash Data

As part of this study, crash reports for this intersection were collected from the Poquoson Police Department for the years 2000 to 2003. There were twenty crashes in the vicinity of the intersection during this four-year period, resulting in nine injuries and no fatalities. Further study of the crash data is included in the Analysis portion of this report.

The Cary's Chapel Road approach backs up during the morning peak hour.

Travel Speeds

Kubilins Transportation Group, Inc. also collected travel speeds as part of their study. Speeds were collected in each direction along Wythe Creek Road in the vicinity of Cary's Chapel Road during the morning and afternoon peak periods (**Table 2**).

To determine the prevailing travel speeds, the 85th percentile measured speed is used. The only occasion when the 85th percentile speed was above the posted speed limit of 40 mph was in the southbound direction during the afternoon peak period. Based on this data, it does not appear that speeding is prevalent during the peak travel periods.

TABLE 2 – 85th Percentile Travel Speeds on Wythe Creek Road at Cary's Chapel Road

Direction	Time of Day	85th Percentile Speed
Northbound	Morning Peak	40 mph
Northbound	Afternoon Peak	35 mph
Southbound	Morning Peak	35 mph
Southbound	Afternoon Peak	42 mph

Source: Kubilins Transportation Group, Inc.

Condition Diagram

Figure 3 on page 4 shows the roadway geometry, topography, and land use in the vicinity of the intersection of Wythe Creek Road and Cary's Chapel Road. Observed deficiencies are noted in the condition diagram as well.

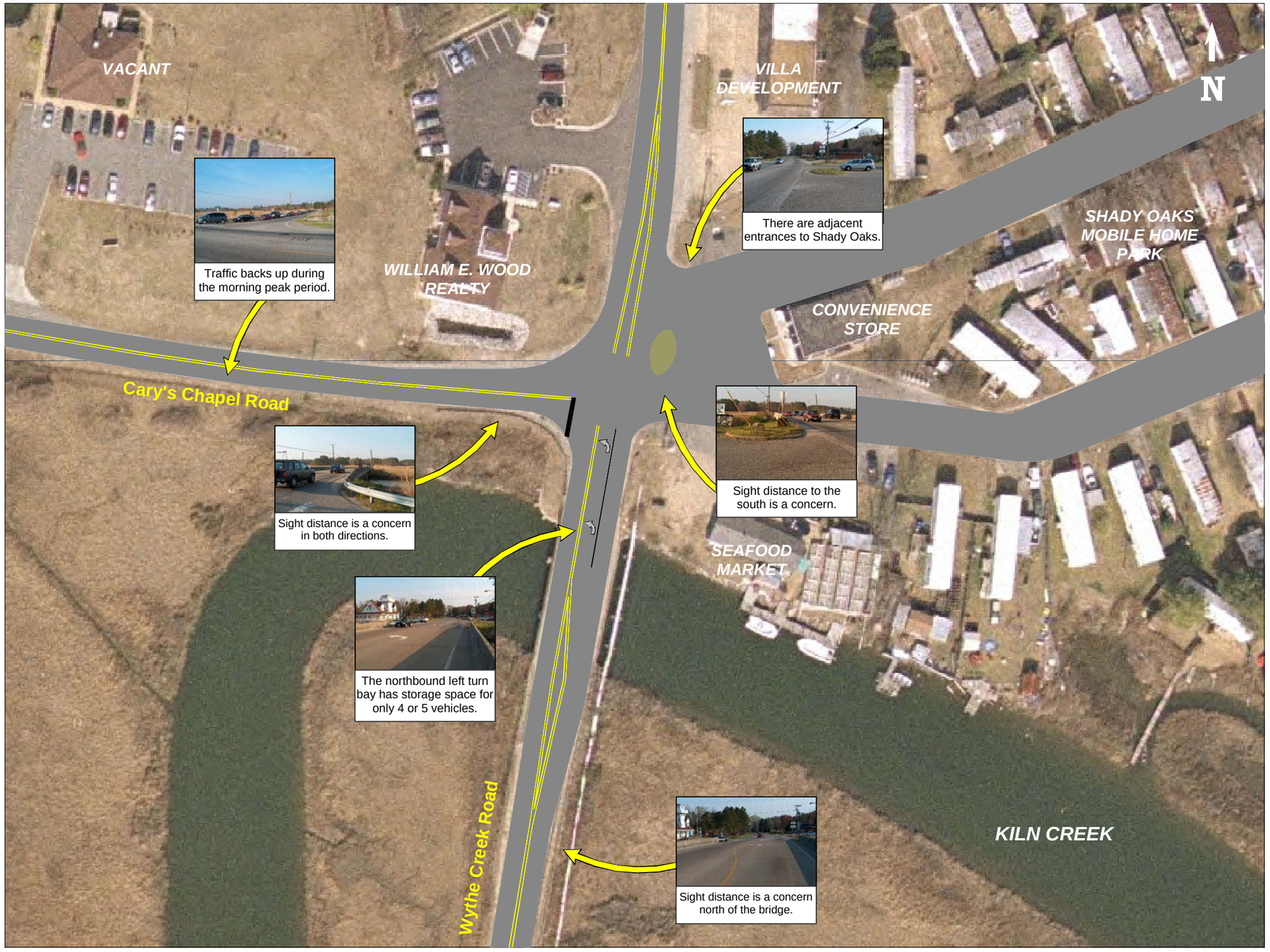


FIGURE 3

Roadway Geometry, Topography, and Land Use

Wythe Creek Road at Cary's Chapel Road

Scale: 1 inch equals approximately 67 feet.

Prepared by: Hampton Roads Planning District Commission, April 2004.

ANALYSIS

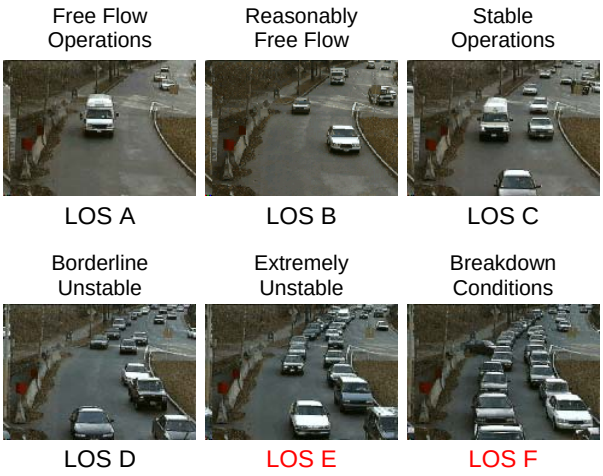
This section provides further analysis of existing conditions including congestion, sight distance, and safety at the intersection of Wythe Creek Road and Cary's Chapel Road.

Congestion Analysis

Highway Capacity Software (HCS)[3] was used to analyze the existing congestion levels of the intersection, as well as the alternatives that are included in the Alternative Analysis section. HCS calculates the control delay (which is defined as the delay resulting from slowing and stopping on intersection approaches) and levels-of-service based on the methodologies used in the 2000 edition of the Highway Capacity Manual. Levels-of-service are letter grades that are assigned to traffic movements based on the amount of delay experienced by each driver (**Figure 4**). Level-of-service A is considered the best operating condition with a control delay of less than 10 seconds per vehicle. Level-of-service F is considered the worst operating condition with control delays greater than 50 seconds per vehicle at unsignalized intersections or 80 seconds per vehicle at signalized intersections (**Table 3**).

Figure 5 contains levels-of-service by movement for the morning peak hour (7:00 – 8:00 am), an off peak hour (1:00 – 2:00 pm), and the afternoon peak hour (5:00 – 6:00 pm). The control delay

FIGURE 4 – Levels-of-Service for Roadways



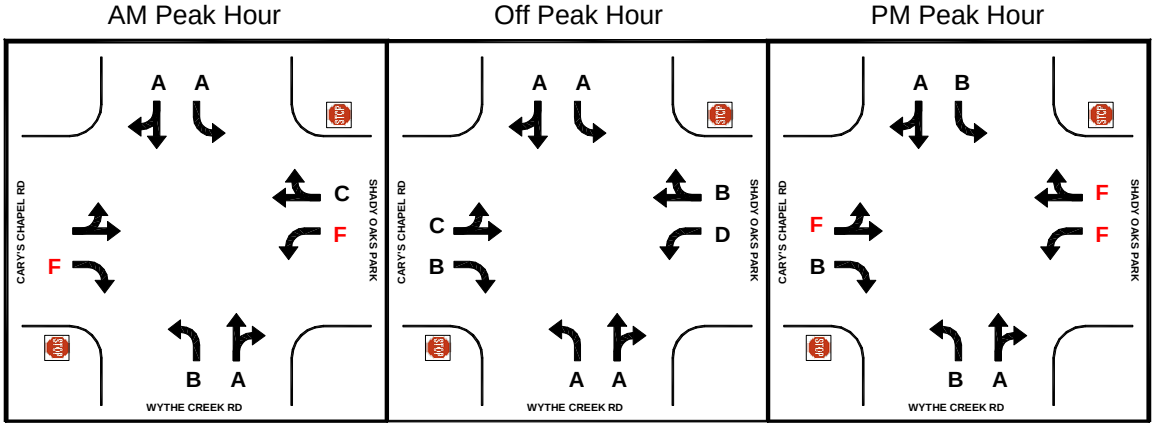
Picture source: Bureau of Transportation Statistics and the MIT Center for Transportation Studies

TABLE 3 – Levels-of-Service by Control Delay

LOS	Unsignalized Intersections Control Delay (sec/veh)	Signalized Intersections Control Delay (sec/veh)
A	< 10	< 10
B	10.1 - 15.0	10.1 - 20.0
C	15.1 - 25.0	20.1 - 35.0
D	25.1 - 35.0	35.1 - 55.0
E	35.1 - 50.0	55.1 - 80.0
F	> 50	> 80

Source: Highway Capacity Manual 2000.

FIGURE 5 – Existing Levels-of-Service by Movement



3 Highway Capacity Software, Version 4.1d, McTrans Center.

for each movement at the intersection is also included in **Appendix A**.

Although users of Wythe Creek Road currently experience no delay at the intersection, users on the minor approaches experience excessive delay during the morning and afternoon peak hours. HCS calculates the average control delay for users turning right from Cary's Chapel Road onto Wythe Creek Road to be 3 minutes and 45 seconds per vehicle during the morning peak hour. Delay for users making left turns leaving the Shady Oaks neighborhood during both the morning and afternoon peak hours are large and in some cases incalculable.

Sight Distance

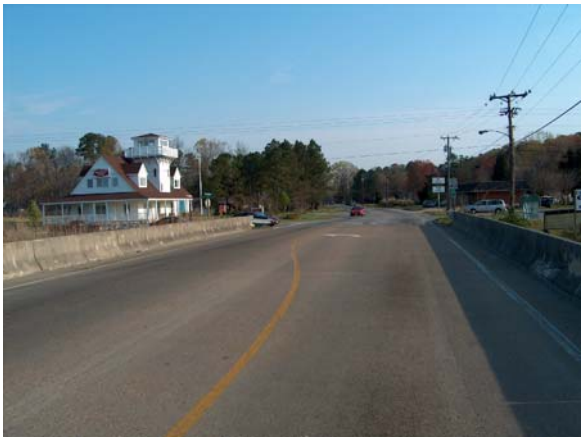
As stated earlier in this report, sight distance is greatly limited by the bridge just to the south of the intersection of Wythe Creek Road and Cary's Chapel Road. Measured sight distances of particular concern are:

- From Cary's Chapel Road to northbound Wythe Creek Road traffic – 320 feet
- From Cary's Chapel Road to southbound Wythe Creek Road traffic – 335 feet
- From Shady Oaks to northbound Wythe Creek Road traffic – 200 feet

Table 4 shows the sight distances that are recommended for passenger cars making either movements across or onto a two-lane roadway from a stop. Assuming that the design speed of Wythe Creek Road is equal to the posted speed limit of 40 miles per hour, the required sight distances from the minor approaches are 445 feet for left turns and 385 feet for crossing movements and right turns.

Figure 6 on page 7 incorporates the existing sight distances with the sight distances that are recommended for the three movements that were previously listed. In each case, the existing sight distance does not meet the recommended sight distance. Of particular concern are the left turns and through movements from Cary's Chapel Road as well as all movements out of the Shady Oaks neighborhood. In both instances, the existing sight distances are considerably below the required sight distances due to the bridge railings.

In order to assure adequate sight distance for the left turns from Cary's Chapel Road, the design speed of Wythe Creek Road would need to be 30 miles per hour. For movements from Shady Oaks Park, the design speed of Wythe Creek Road would need to be 20 miles per hour. Due to these values, **adjusting speeds to resolve sight distance concerns at this intersection will not be considered a viable option in this study.**



Sight distance is a concern for the minor approaches to the north of the bridge.

TABLE 4 – Design Intersection Sight Distances for Turns Made Onto or Across Two-Lane Highways from a Stop

	Design Intersection Sight Distance for Passenger Cars	
Design Speed	**Left Turns**	**Through Movements and Right Turns**
15 mph	170'	145'
20 mph	225'	195'
25 mph	280'	240'
30 mph	335'	290'
35 mph	390'	335'
40 mph	**445'**	**385'**
45 mph	500'	430'
50 mph	555'	480'
55 mph	610'	530'
60 mph	665'	575'
65 mph	720'	625'
70 mph	775'	670'
75 mph	830'	720'
80 mph	885'	765'

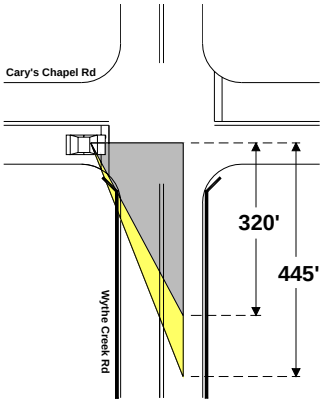
Source: American Association of State Highway and Transportation Officials, "A Policy on Geometric Design of Highways and Streets", 2001.

FIGURE 6 – Existing and Recommended Sight Distances at the Intersection of Wythe Creek Road and Cary's Chapel Road

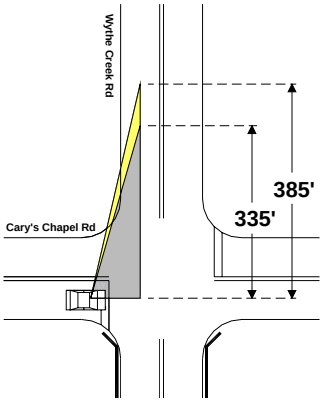
Existing Sight Distance

Recommended Sight Distance

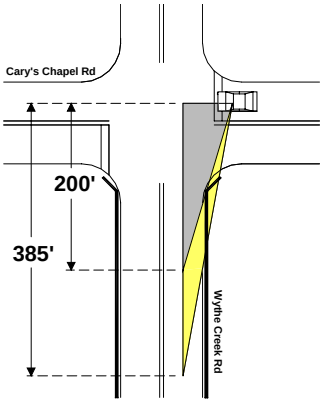
From Cary's Chapel Road to Northbound Wythe Creek Road Traffic



From Cary's Chapel Road to Southbound Wythe Creek Road Traffic



From Shady Oaks Park to Northbound Wythe Creek Road Traffic



Sources: Kubilins Transportation Group, Inc., American Association of State Highway and Transportation Officials.

Crashes

With limited sight distance at the intersection of Wythe Creek Road and Cary's Chapel Road, safety is a concern. As stated earlier in this study, there were twenty crashes in the vicinity of the intersection during the four-year period from 2000 to 2003, resulting in nine injuries and no fatalities. A collision diagram for the intersection of Wythe Creek Road and Cary's Chapel Road for these years is shown in **Figure 7** on page 8.

Of the crashes and injuries that occurred at the intersection between 2000 and 2003, five crashes and three injuries were the result of traffic leaving the Shady Oaks neighborhood making contact with vehicles traveling northbound on Wythe Creek Road. This is particularly concerning since the Shady Oaks neighborhood approach only carries 3% to 4% of the total intersection volume. Providing further proof that speeding is not a problem approaching this intersection, none of these crashes was the result of excessive speed.

The next most prevalent crash type was rear-end collisions on the Cary's Chapel Road approach. There were three such crashes between 2000 and 2003, resulting in no injuries. All of these crashes involved vehicles making right turns onto Wythe Creek Road, and two of the crashes occurred during the morning peak period.

Of the twenty crashes that occurred at the intersection, six of those crashes can be directly related to the sight distance concerns that were addressed previously in this report. In addition, sight distance limitations may have been a factor in some of the remaining crashes. The congestion that exists during the peak travel periods has undoubtedly led to crashes at the intersection as well, since twelve of the twenty crashes occurred during the morning or afternoon peak periods.

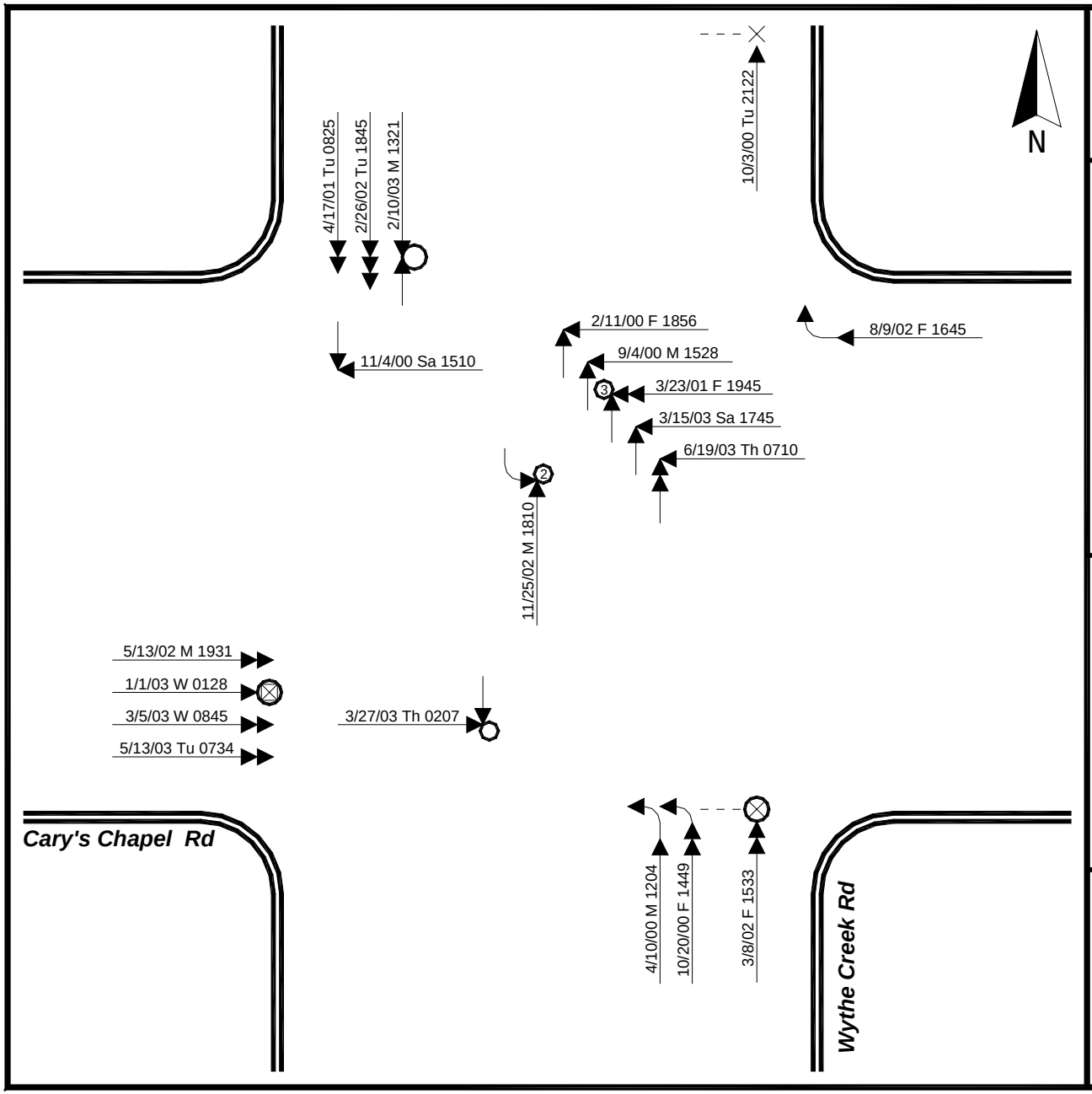


FIGURE 7

COLLISION DIAGRAM

Wythe Creek Rd at Cary's Chapel Rd
City of Poquoson

Analysis includes crashes occurring in the vicinity of the intersection from 2000 to 2003.

NO. OF CRASHES PER YEAR	**5.0**
Property Damage Only	**3.5**
Crashes with Injuries	**1.5**
Crashes with Fatalities	**0.0**
NO. OF INJURIES PER YEAR	**2.25**
NO. OF FATALITIES PER YEAR	**0.0**

LEGEND

Crash date — 3/5/03 W 0845 — Number of arrowheads represents the number of vehicles involved in the crash
Crash day of week — Crash time of day

- Moving Vehicle
- Backing Vehicle
- Parked Vehicle
- Pedestrian
- Animal
- Fixed Object
- Fatal Crash
- Injury Crash (If multiple injuries, number is shown)

COLLISION TYPE

- Rear End
- Head On
- Right Turn
- Left Turn
- Right Angle
- Sideswipe

ALTERNATIVE ANALYSIS

The previous section detailed the congestion and safety concerns that exist at the intersection of Wythe Creek Road and Cary's Chapel Road. Of particular concern are the right-angle crashes that occur between northbound Wythe Creek Road traffic and traffic exiting the Shady Oaks neighborhood. Congestion on the minor approaches during the morning and afternoon peak hours is also a concern.

Any alternatives that are considered should address both safety and congestion issues. **Table 5** details possible countermeasures to address right-angle collisions due to restricted sight distance, while **Table 6** lists countermeasures that address congestion at unsignalized intersections.

Any alternatives that are considered should also take into account that this intersection is adjacent to the city limits, and Wythe Creek Road serves as one of only two primary entrances to the City of Poquoson. Aesthetic concerns may play a bigger role at this location than at other similar intersections.

Selecting Viable Alternatives

The following alternatives from Tables 5 and 6 are considered viable methods of addressing safety and/or congestion concerns at this intersection:

- Install warning/advisory signage
- Add or improve alternate routes, or encourage traffic diversion
- Remove sight obstructions
- Prohibit turns
- Relocate intersection
- Add (or lengthen) turn bays
- Add capacity to the major/minor road
- Channelize intersection
- Adjust signal timing/modify signal coordination at upstream signals
- Convert to multi-way stop control
- Convert to roundabout
- Convert to traffic signal control

Each alternative listed above is analyzed in detail in this section. **Table 8** on page 18 includes descriptions, cost estimates, and pros and cons of each of these alternatives.

TABLE 5 – Crash Pattern Countermeasures for Right-Angle Collisions at Unsignalized Intersections

Observed Problem	Possible Countermeasures
Right-angle collisions at unsignalized intersections due to restricted sight distance	- Install warning signs - Install stop signs - Install yield signs - Install roundabout - Reduce speed limit if justified by spot speed study - Restict parking near corners - Remove sight obstructions - Install signals - Install/improve street lighting - Channelize intersection - Relocate intersection

Source: Institute of Transportation Engineers, "Traffic Engineering Handbook", 1999.

TABLE 6 – Countermeasures to Address Congestion at Unsignalized Intersections

Observed Problem	Possible Countermeasures
Delay	- Convert to yield control - Convert to multi-way stop control - Convert to roundabout - Convert to traffic signal - Add capacity to the major or minor road - Add (or lengthen) turn bays - Add or improve alternate routes - Relocate intersection - Prohibit left turns - Employ calming techniques to encourage traffic diversion - Adjust signal timing at upstream signals - Modify signal coordination - Add advisory signing - Prohibit on-street parking

Source: Transportation Research Board, "NCHRP Report 457 – Engineering Study Guide for Evaluating Intersection Improvements", 2001.

Install Warning/Advisory Signage

The purpose of installing warning signage is to alert the driver that there is an intersection ahead and traffic could be entering from hidden approaches.

This can be accomplished using various types of signage, from the simple to the quite sophisticated. Simple warning signs such as the common yellow diamond sign with the crossroad symbol and a flashing beacon can alert drivers to the intersection ahead. Rumble strips used in conjunction with these signs can further alert drivers to the hidden intersection. A more complex example from North Carolina (pictured below) uses flashing beacons over the intersection to alert drivers when vehicles are entering from the minor approaches.

The primary benefit of installing warning signage is to alert drivers to an unexpected situation. However, due to the topography of the Poquoson area, the roadway network includes mostly local traffic. Most users of Wythe Creek Road are local residents who are familiar with the intersection and the area, and as such are likely aware of the sight distance problems that exist at the intersection.

Warning signage used in North Carolina to alert drivers when vehicles are entering the intersection from minor approaches.

Installing warning signage does not resolve the sight distance problem but rather alerts drivers to the problem. Installing warning signage also does not address the congestion problems during the peak hours.

Add or Improve Alternate Routes, or Encourage Traffic Diversion

The purpose of this alternative is to reduce the volume of traffic that passes through the intersection. Two methods are available to decrease the amount of traffic at a particular location. Transportation demand management alternatives (including increased transit usage, ridesharing and vanpooling, diverting traffic to off-peak time periods, telecommuting, etc.) aim to reduce transportation system demand with methods that generally do not require capital improvements. Transportation systems management alternatives (traffic diversion to alternate routes, optimizing and coordinating traffic signals, various ITS initiatives, etc.) aim to improve the existing transportation system efficiency by making better use of the entire transportation system through short-term and generally low cost projects.

There are few viable alternate routes available at this location. The route between the intersection of Wythe Creek Road/Armistead Avenue and the intersection of Cary's Chapel Road/Victory Boulevard without using Wythe Creek Road is over two miles longer and includes additional signals. If traffic were restricted in some way from Cary's Chapel Road, the logical alternative would be to use the intersection of Wythe Creek Road and Victory Boulevard, which already is Poquoson's busiest intersection.

Any transportation demand management or transportation systems management alternatives, which may or may not significantly improve congestion at the intersection, would definitely not address the safety concerns related to the sight distance problems at the bridge.

Remove Sight Obstructions

As stated earlier in this report, three movements are affected by sight obstructions:

- From Cary's Chapel Road to northbound Wythe Creek Road traffic
- From Cary's Chapel Road to southbound Wythe Creek Road traffic
- From Shady Oaks to northbound Wythe Creek Road traffic

The obstruction affecting traffic turning right from Cary's Chapel Road to southbound Wythe Creek Road is landscaping that can be easily removed. The obstructions affecting the other two movements, however, are railings of the bridge. The existing bridge railings are constructed of reinforced concrete and appear similar to jersey barriers (see picture below). In order to remove the sight obstructions, the replaced bridge railings must allow visibility between Wythe Creek Road and the minor approaches.

The cost of improving the bridge railing is high. In addition, at least one lane of the bridge will need to be closed and traffic control will need to be implemented during the construction period. **This alternative also has no affect on the congestion that occurs at the intersection during the peak hours.**

The cost of improving the bridge's railing to improve sight distance is significant.

Prohibit Turns

Another way to improve the safety of the intersection is to prohibit the movements that lead to safety conflicts. For this to be a viable alternative, however, feasible alternate routes must be available.

Optimally, all movements that are unsafe due to limited sight distance would be prohibited in this alternative. This would include all movements from both Cary's Chapel Road and the Shady Oaks neighborhood. Assuming that the landscaping that affects sight distance to the north of Cary's Chapel Road is removed, movements with sight distances affected by the bridge railings would still need to be prohibited. These movements include:

- Left turns and through movements from the Cary's Chapel Road approach.
- All movements from the Shady Oaks neighborhood approach.

Prohibiting left turns and through movements from the Cary's Chapel Road approach may be a viable alternative since these volumes are low. But even if only right turns are allowed from the Shady Oaks approach, 385 feet of sight distance would still be necessary to safely make these movements. **Since both entrances to Shady Oaks are well within this 385-foot threshold, prohibiting turns is not a viable alternative.**

Relocate Intersection

While removing the obstructions is one option to solving the sight distance problem, another possiblity is to relocate the minor approaches away from the sight obstructions.

With the current sight distances, both the Cary's Chapel Road and the Shady Oaks neighborhood approaches would have to be relocated to locations north of the intersection that provide acceptable sight distance. Even if only right turns are allowed from Cary's Chapel Road after removing the landscaping, the Shady Oaks neighborhood approach would still need to be relocated. Right-of-way and construction costs would be significant and possibly politically difficult. **Relocating the roadway also has little affect on the congestion that occurs at the intersection during the peak hours.**

Add (or Lengthen) Turn Bays

Inadequate turn bay length can greatly affect both the safety and operation of intersection approaches. Without adequate turn bay storage and deceleration length, vehicles can affect the flow of the through lanes.

The Cary's Chapel Road approach does not have a turn bay but rather a flared approach. A turn bay, however, is not necessary due to the low volume of through and left-turning vehicles. Although four crashes have occurred over the last four years on this approach, all of these crashes involved either fixed objects or drivers making right-turn movements.

The southbound Wythe Creek Road approach has no marked left-turn bay but there is a small storage area where left-turning vehicles are removed from through traffic. Although the lack of a marked turn bay affects safety (two rear-end crashes have occurred on this approach over the last four years), the capacity of the approach is not significantly affected by these turning vehicles.

There is a short left-turn bay provided for northbound Wythe Creek Road traffic approaching the intersection. With a length of about 100 feet, there is storage area for only four or five vehicles, and no deceleration area is provided. This has caused a minor safety problem, with two rear-end crashes occurring in the northbound left-turn bay over the last four years. According to the VDOT Road Design Manual[4], the left-turn bays at an unsignalized intersection should be of a certain length based on advancing and opposing traffic volumes, operating speeds, and the percentage of left-turning traffic. These values are then analyzed using various graphs (included in **Appendix B**) to determine the recommended length of the turn bay. For the intersection of Wythe Creek Road at Cary's Chapel Road, the northbound left-turn bay should be at least 300 feet when the percentage of left turns for an approach is 30% and at least 350 feet with 40% left turns. Since 35% of all northbound traffic turns left onto Cary's Chapel Road during the afternoon peak hour, interpolation provides a recommended northbound left-turn bay length of 325 feet.

The left-turn bay from northbound Wythe Creek Road to Cary's Chapel Road does not meet recommended standards.

Although the length of the northbound left-turn bay does not meet recommended standards, **improving the turn bays will have little to no affect on either existing congestion levels or concerns related to sight distance at the intersection.** However, any alternative that changes the traffic control devices at the intersection may also require adding or lengthening turn bays.

Add Capacity to the Major/Minor Road

Widening Wythe Creek Road to 5 lanes between Alphus Street and Semple Farm Road has been discussed in the past. The project has even been included in previous regional long range transportation plans[5].

Plans for capacity improvements to Wythe Creek Road, however, are not included in the 2026 Regional Transportation Plan. If such a project were accepted into the next long range transportation plan, **it would take at least a decade to implement.** Such a project, which would cost in the tens of millions of dollars, would also have to compete with other projects regionwide for scarce transportation funds. In addition, environmental concerns could also plague the project with the amount of wetlands along Wythe Creek Road.

4 VDOT, "Road Design Manual", 2003.

5 HRPDC, "Hampton Roads 2021 Regional Transportation Plan ", July 2001.

Channelize Intersection

Although intersection channelization usually refers to pavement markings and raised islands that help direct traffic through the intersection, in this study channelizing refers to consolidating the entrances to the Shady Oaks neighborhood and channelizing the traffic to one entrance.

There are currently two entrances to the Shady Oaks neighborhood spaced less than 50 feet apart, with the southern entrance aligned with Cary's Chapel Road. Pavement in front of the convenience store connects the two entrances.

By consolidating the entrances to the Shady Oaks neighborhood, safety at the intersection should be slightly improved. Although the northern entrance has better sight distance to the south than the southern entrance, closing the southern entrance would result in a skewed alignment with Cary's Chapel Road. This would lead to other safety concerns, particularly with northbound left-turning traffic not observing traffic making left-turns out of the Shady Oaks neighborhood.

This alternative, however, does not address the safety concerns related to the sight distance to the south of the intersection, nor does it address the peak hour congestion.

There are two closely spaced entrances to the Shady Oaks neighborhood.

Adjust Signal Timing/Modify Signal Coordination at Upstream Signals

Adjusting signal timings and modifying signal coordination at upstream signals can affect traffic movement on the major road by moving traffic through uninterrupted vehicle platoons. Unsignalized intersections in the vicinity of coordinated signals are affected by the size and arrival of these platoons. However, the effect of upstream signals decreases as the distance between it and the analyzed intersection increases.

The nearest signalized intersection to the north is Victory Boulevard/Little Florida Road, a little more than a mile from Cary's Chapel Road. To the south, the nearest signalized intersection is Voyager Drive/Steam Plant entrance, which is approximately 3,000 feet to the south. The minor approaches carry about 1% of the total daily traffic at this intersection, so Wythe Creek Road has nearly all of the green time. The next closest signal to the south, an entrance to NASA, is approximately 4,200 feet from Cary's Chapel Road.

Currently these signals are operating under time-based coordination, although the city of Hampton plans to connect these signals together in the near future. Even though traffic can back up significantly from the NASA entrance during the morning peak hour, these signals have little to no affect on the arrival of vehicles at the intersection of Wythe Creek Road and Cary's Chapel Road. According to the Highway Capacity Manual (HCM)[6], there is little platoon effect for distances greater than 1,300 feet from a signalized intersection. As stated above, there are no signals within 1,300 feet of the intersection of Wythe Creek Road and Cary's Chapel Road. Even if the intersection of Wythe Creek Road and Cary's Chapel Road were signalized, there would not likely be platoons between intersections.

Any attempts to affect traffic by adjusting signal timing or coordination at upstream signals would have little affect on the intersection of Wythe Creek Road and Cary's Chapel Road, regardless of the traffic control in place.

6 Transportation Research Board, "Highway Capacity Manual", 2000.

Convert to Multi-way Stop Control

Multi-way stop control is generally used where the traffic volumes on intersecting roads are high enough to create conflicts and the traffic volumes on each approach are approximately equal. Depending on the types of crashes that are occurring at the intersection, multi-way stop control can also reduce the number and severity of crashes.

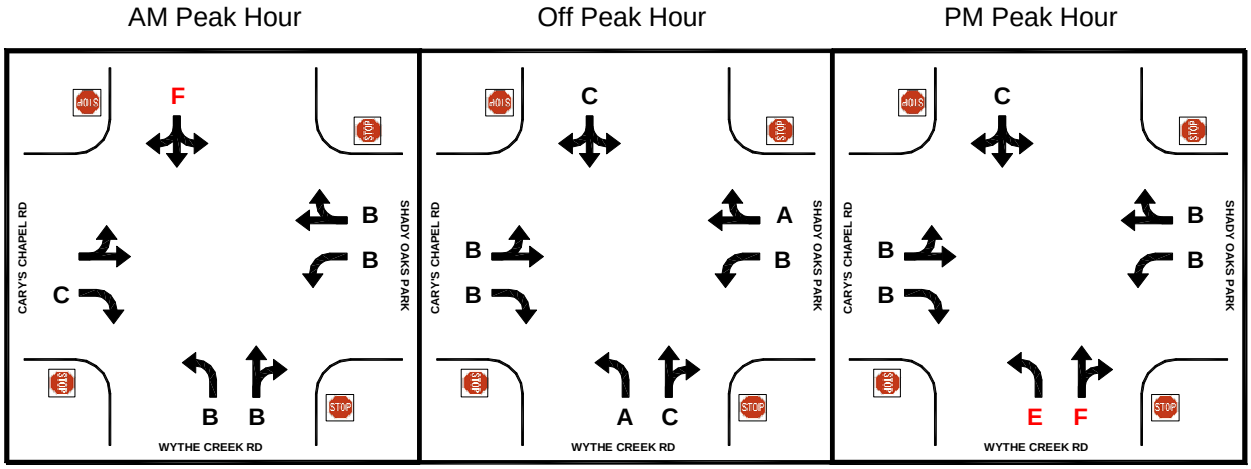
The 2003 version of the Manual on Uniform Traffic Control Devices (MUTCD)[7] includes criteria to consider within an engineering study for a multi-way stop control installation. The criteria includes:

- Where traffic control signals are justified, multi-way stops can be used as an interim measure.
- A safety problem, with five or more reported crashes in a 12-month period that can be corrected by a multi-way stop installation.
- Minimum vehicular, pedestrian, and/or bicycle volumes.
- The need to control left-turn conflicts.
- The need to control vehicle/pedestrian conflicts near locations with high pedestrian volumes.
- Locations where a road user, after stopping, cannot see conflicting traffic and is not able to safely negotiate the intersection unless conflicting cross traffic is also required to stop.
- An intersection of two residential collector streets of similar design and operating characteristics.

The intersection of Wythe Creek Road and Cary's Chapel Road does not meet most of these criteria for installation of multi-way stop control, including the minimum volumes on the minor street approaches. However, the intersection is a location where road users, after stopping, cannot see conflicting traffic. Installing multi-way stop control would alleviate this problem.

Highway Capacity Software (HCS) was used to analyze the congestion levels at the intersection if multi-way stop control were implemented. **Figure 8** shows the results by movement for the morning peak hour, an off peak hour, and the afternoon peak hour. **Significant delays result under this alternative along the dominant direction of Wythe Creek Road during both peak hours.** During the morning peak hour, traffic in the southbound direction would experience a control delay of over 460 seconds per vehicle according to HCS. During the afternoon peak hour, the control delay is over 250 seconds per vehicle for northbound through traffic.

FIGURE 8 – Multi-way Stop Control Alternative – Levels-of-Service by Movement



7 Federal Highway Administration, "Manual on Uniform Traffic Control Devices", 2003 edition.

Convert to Roundabout

Roundabouts are circular intersections with specific design and traffic control features that include yield control for traffic entering the intersection, channelized approaches, and geometric curvature to ensure slow speeds on the circulatory roadway. Although common in Europe, roundabouts have only recently gained popularity in the United States.

The primary benefits of roundabouts include:

- Reduced frequency and severity of certain crash types (i.e. right-angle crashes) due to lower speeds and fewer conflict points.
- Typically less delay than stop controlled intersections.
- Less delay than signalized intersections when traffic volumes are below the capacity of the roundabout.
- Can be aesthetically pleasing.

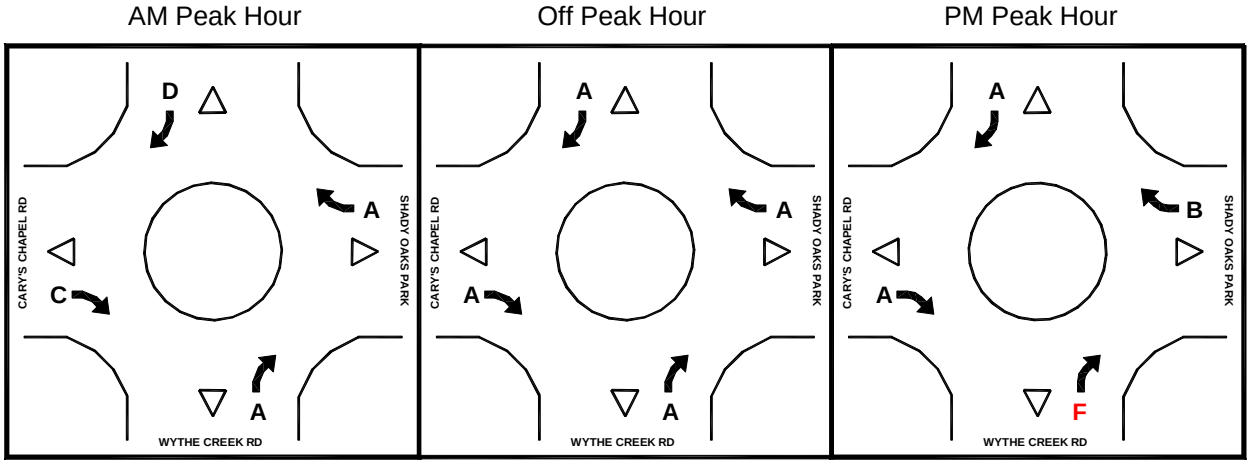
Roundabouts also have characteristics that may exclude them from being a viable alternative. Roundabouts may not operate at acceptable conditions if the major-street volumes are significantly higher than the minor-street volumes. Roundabouts may also require right-of-way acquisition, and may not be easily transversed by large vehicles such as trucks, buses, and fire trucks. Public acceptance of roundabouts has also been challenging in some areas.

Roundabout
Source: Ourston Roundabout Engineering.

The proximity of the bridge and wetlands would require the roundabout be offset to the north of the present intersection. This would require the purchase of additional right-of-way as well as additional construction, thereby significantly increasing the cost of implementation.

Highway Capacity Software (HCS) was used to analyze the congestion levels at the intersection if a roundabout was constructed. HCS calculated the capacity of each approach to the roundabout, and delay and levels-of-service were produced using equations from a roundabout guide released by the Federal Highway Administration (FHWA)[8]. **Congestion during the afternoon peak hour would result if a roundabout were constructed**, with a prohibitive control delay of 145 seconds per vehicle for northbound users.

FIGURE 9 – Roundabout Alternative – Levels-of-Service by Movement



8 FHWA, "Roundabouts: An Informational Guide", 2000.

Convert to Traffic Signal Control

When properly designed and operated, traffic signals can provide a valuable traffic control device for controlling movements at certain intersections. The benefits of installing a traffic signal include:

- More orderly traffic movement.
- Increased intersection capacity.
- Continuous movement of traffic along the through route.
- Reduced frequency of certain types of crashes, particularly severe right-angle crashes.
- Reduced delay to minor vehicular movements by interrupting heavy traffic on the major streets.

Installing traffic signals may also produce the following disadvantages, particularly if the signal is not properly designed and operated:

- Additional delay to all traffic movements, particularly during non-peak travel periods.
- Increased frequency of certain types of crashes, particularly rear-end crashes.
- Increased diversion of traffic through adjacent neighborhoods.
- Noncompliance of the traffic control device.

The 2003 version of the Manual on Uniform Traffic Control Devices (MUTCD) details the methodology of traffic control signal needs studies, which help evaluate the need for the installation of a traffic signal. There are eight warrants that describe the conditions where the installation of a traffic signal should improve intersection safety and/or operations. The eight signal warrants are:

1) Eight-Hour Vehicular Volume
2) Four-Hour Vehicular Volume
3) Peak Hour Volume
4) Pedestrian Volume
5) School Crossing
6) Coordinated Signal System
7) Crash Experience
8) Roadway Network

A signal may be considered for installation if any of these eight warrants is satisfied. The satisfaction of a traffic signal warrant, however, does not mean the installation of a signal is required. A traffic signal should not be installed unless further study indicates that the signal will improve the overall safety and/or operation of the intersection.

Of these eight warrants, only Warrants 1, 2, 3, and 7 are applicable to the intersection of Wythe Creek Road and Cary's Chapel Road. Pedestrian volumes are low and there are no schools in the vicinity of the intersection. The intersection is also not within a coordinated signal system nor is this the intersection of two major routes.

A signal warrant analysis was performed for the remaining four warrants and is included in **Appendix C**. The results of the analysis are included in **Table 7**.

TABLE 7 – Signal Warrant Analysis Results for Wythe Creek Road at Cary's Chapel Road

Warrant	Warrant Name	Warrant Satisfied?
Warrant 1	Eight-hour vehicular volume	YES
Warrant 2	Four-hour vehicular volume	YES
Warrant 3	Peak hour volume	YES
Warrant 7	Crash Experience	NO

Since three of the eight warrants for installation of a traffic signal were satisfied, this alternative was further analyzed to study its effects on safety and congestion.

The safety concerns related to sight distance will be resolved with the installation of a traffic signal, since the signal will provide protected phases for these turning movements. This should alleviate most of the severe right-angle crashes that occur at the intersection, although the number of rear-end crashes on Wythe Creek Road is likely to increase due to additional stops.

To determine the traffic signal's affect on congestion at the intersection, optimal signal timings and phasings had to be determined. The software package Synchro[9] was used to establish optimal signal timings and phasings. It was

9 Synchro, Version 6, Trafficware Corportation.

determined that a three-phase traffic signal, which includes a protected-permitted northbound left-turn phase, is optimal. These timings were then entered into HCS to calculate delay and levels-of-service for the morning peak hour, the off peak hour, and the afternoon peak hour at the signalized intersection. These results are shown in **Figure 10**.

None of the movements at the intersection experience a level-of-service F throughout the day under signal control, although left-turn movements from Shady Oaks would still experience an unacceptable LOS E. While the effects on delay on Wythe Creek Road through movements would be detrimental, the lowest level-of-service for any of the through movements would be LOS C.

During the off peak periods, the delay at the intersection slightly increases under signal control, from the existing 3.1 seconds per vehicle up to 10.9 seconds per vehicle. This is due to the minor delay created by the signal on Wythe Creek Road. According to HCS, the minor movements at the intersection will experience similar delays regardless of whether the intersection is under stop or signal control during the off peak periods, so long as the traffic signal operates under actuated control.

Although there are slight delay increases during the off peak periods, flashing mode should not be implemented at any time at this intersection. While it is VDOT's policy not to permit flash mode at intersections that warrant traffic signals, this is particularly important at this intersection due to the sight distance limitations. NCHRP Report 457 also has guidance regarding when to use flash mode. According to their recommendations, traffic volumes are too high on Wythe Creek Road between the morning and afternoon peak hours to warrant flash mode during this period.

Although the northbound left-turn bay does not currently meet standards for an unsignalized intersection, it would also not meet standards if a traffic signal were installed. The northbound left-turn bay should accommodate the 95th percentile queue for the longest queue expected during one of the peak hours at a signalized intersection. For the northbound left-turn movement, HCS calculates the 95th percentile queue will be approximately 9 vehicles (225 feet) during the afternoon peak hour if a signal is installed. In this same scenario, the 95th percentile queue length for the northbound through movements is calculated to be about 20 vehicles (500 feet), which may also be accounted for when lengthening the left-turn bay.

If the aesthetics of a traffic signal located at the city limits is a concern, alternative traffic signal designs can be considered. Various communities around the country, including Virginia Beach's oceanfront area, have installed traffic signals with unique designs that add to the aesthetics of the area. It is expected, however, that these unique designs would result in higher construction and maintenance costs.

FIGURE 10 – Signalized Alternative – Levels-of-Service by Movement

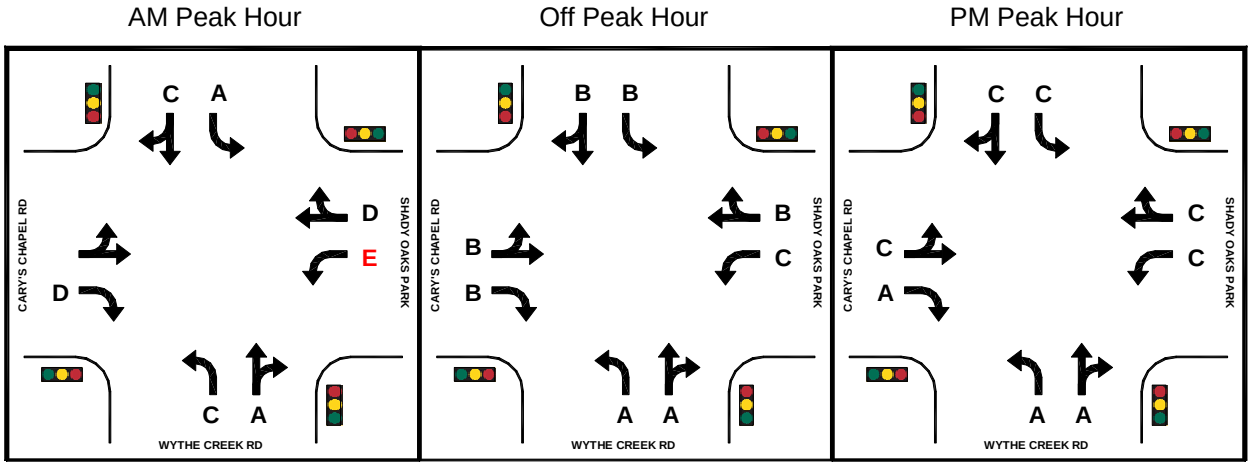


TABLE 8 – Descriptions, Cost Estimates, and Pros and Cons of Each Alternative for Wythe Creek Road at Cary's Chapel Road

Alternative	Cost	Pros	Cons	Relieves Congestion?	Improves Safety?
Install warning/advisory signage	Low (varies by method)	- Alerts drivers that vehicles could be entering from hidden approaches	- Mostly local traffic uses the intersection, so most users are familiar with the intersection - Does not resolve the sight distance problem - Does not resolve the congestion problem	✗	√
Add or improve alternate routes, or encourage traffic diversion	Low (varies by method)	- Could resolve congestion problems if successfully implemented	- Difficult to successfully implement - Few viable alternative routes are available - Does not resolve the sight distance problem	√	✗
Remove sight obstructions	$150,000	- Resolves the sight distance problem	- Does not resolve the congestion problem - High construction costs - Traffic affected during the construction period - Special type of bridge railing would be required to allow increased sight distance	✗	✓
Prohibit turns	Very Low	- Prohibits the movements that lead to safety conflicts	- All turns from the Shady Oaks approach lead to safety conflicts - Does not resolve the congestion problem	✗	√
Relocate intersection	Very High (varies by method)	- Resolves the sight distance problem	- Both minor approaches would have to be relocated - High construction and right-of-way costs - Does not resolve the congestion problem	✗	✓
Add (or lengthen) turn bays	Medium	-The northbound left-turn bay does not have adequate length for storage and deceleration	- Does not resolve the congestion problem - Does not resolve the sight distance problem	✗	√

LEGEND

Costs are planning level estimates provided by The City of Poquoson or VDOT.

✗ **Does not improve congestion or safety**

√ **Minimally improves congestion or safety**

√ **Partially improves congestion or safety**

✓ **Sufficiently improves congestion or safety**

Alternative	Cost	Pros	Cons	Relieves Congestion?	Improves Safety?
Add capacity to the major or minor road	$20 million (from Alphus St in Poquoson to Semple Farm Rd in Hampton	- Resolves the sight distance problem	- Such a project would take over a decade to implement - High construction and right-of-way costs - Competes with other projects regionwide for funding - Does not entirely resolve the congestion problem	√	✓
Channelize intersection	Low	- Should resolve safety concerns related to adjacent entrances and a skewed intersection	- Does not resolve the congestion problem - Does not resolve the sight distance problem	✗	√
Adjust signal timing/modify signal coordination at upstream signals	Low		- This intersection is too far from the nearest signal to be affected by vehicle platooning - Does not resolve the congestion problem - Does not resolve the sight distance problem	✗	✗
Convert to multi-way stop control	Very Low	- Low cost - Resolves the sight distance problem - Results in fewer right-angle crashes - Lowered crash severity	- Leads to significant delay on Wythe Creek Road during the peak hours - Would result in more rear-end crashes on Wythe Creek Road	✗	✓
Convert to roundabout	$250,000 - $500,000	- Reduces travel speeds at the intersection - Resolves the sight distance problem - Lowered crash severity - Can be an aesthetically pleasing entrance to the city	- Leads to congestion in the northbound direction during the afternoon peak hour - May not be easily transversed by trucks and emergency vehicles - High construction & right-of-way costs	✗	✓
Convert to traffic signal control	$325,000	- Resolves the sight distance problem - Resolves the congestion problem - Results in fewer right-angle crashes	- Will slightly increase delay at the intersection during the off peak hours - May lead to an increase in rear-end crashes on Wythe Creek Road - Requires the northbound turn bay to be lengthened - Aesthetic concerns	✓	✓

LEGEND

Costs are planning level estimates provided by The City of Poquoson or VDOT.

✗ **Does not improve congestion or safety**

√ **Minimally improves congestion or safety**

√ **Partially improves congestion or safety**

✓ **Sufficiently improves congestion or safety**

CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis completed for this report, the following conclusions can be made concerning the intersection of Wythe Creek Road and Cary's Chapel Road:

- Sight distance is a concern at this intersection. The primary culprits are the railings from the bridge located immediately south of the intersection.
- Safety is a problem due to the limited sight distance. Twenty crashes occurred in the vicinity of the intersection between 2000 and 2003, with six of those crashes directly related to the sight distance problems caused by the bridge.
- Congestion is also a problem on the minor approaches of the intersection. Each approach experiences LOS F during both the morning and afternoon peak hours.
- Speeding is not a concern on Wythe Creek Road near the intersection.
- The northbound left-turn bay on Wythe Creek Road is not sufficient for queuing area and deceleration length.
- The adjacent entrances to the Shady Oaks neighborhood are also a safety concern.

Twelve alternatives were analyzed for their affects on both safety and congestion at the intersection of Wythe Creek Road and Cary's Chapel Road. Of these twelve, the following alternatives sufficiently improved either the safety or congestion problems:

- Remove sight obstructions – Safety
- Relocate intersection – Safety
- Add capacity to the major road - Safety
- Convert to multi-way stop control – Safety
- Convert to roundabout - Safety
- Convert to traffic signal control – Congestion and Safety

Although converting the intersection to either multi-way stop control or a roundabout would sufficiently improve safety, these alternatives should not be considered due to their adverse effect on congestion at the intersection.

The following recommendations are made based on the findings of this report:

- Install a three-phase traffic signal at the intersection of Wythe Creek Road and Cary's Chapel Road. This will resolve both the congestion and safety issues at the intersection. As stated earlier in this report, there is funding programmed for the installation of a signal at this intersection.
- Remove the landscaping that is limiting sight distance from Cary's Chapel Road to the north.
- Lengthen the northbound left-turn bay on Wythe Creek Road to accommodate vehicles that will queue as a result of a traffic signal.
- Consolidate the entrances to the Shady Oaks neighborhood.

Appendix A

Control Delay and Levels-of-Service by Movement for Each Alternative

Wythe Creek Road at Cary's Chapel Road

Control Delay and Levels-of-Service by Movement for Each Alternative

AM Peak Hour
7:00 - 8:00 am

Alternative		Wythe Creek Rd Northbound				Wythe Creek Rd Southbound				Cary's Chapel Rd Eastbound				Shady Oaks Park Westbound				Intersection
		Left Turn	Through	Right Turn	Approach	Left Turn	Through	Right Turn	Approach	Left Turn	Through	Right Turn	Approach	Left Turn	Through	Right Turn	Approach	
	Volume	30	164	9	203	18	1064	4	1086	0	0	325	325	18	12	33	63	1677
	Adj. Flow Rate	32	173	9	214	19	1120	4	1143	0	0	342	342	19	13	35	66	1765
2-way stop (existing)	Control Delay (sec/veh)	11.1	0		1.7	7.6	0		0.1	N/A		225.2	225.2	*	16.6		*	*
	LOS	B	A		A	A	A		A			F	F	F	C		F	
4-way stop	Control Delay (sec/veh)	10.6	13.2		12.8	461.1			461.1	N/A		18.6	18.6	11.4	10.8		11.0	304.8
	LOS	B	B		B	F			F			C	C	B	B		B	F
Roundabout	Control Delay (sec/veh)				3.5				29.4				24.6				3.6	24.4
	LOS				A				D				C				A	C
Signal	Control Delay (sec/veh)	21.7	3.2		5.9	6.2	32.4		32.0	N/A		49.8	49.8	55.2	36.9		42.1	32.7
	LOS	C	A		A	A	C		C			D	D	E	D		D	C

* Capacity for the westbound movement is calculated to be 0 veh/hr by HCS, making delay calculations impossible.

Off Peak Hour
1:00 - 2:00 pm

Alternative		Wythe Creek Rd Northbound				Wythe Creek Rd Southbound				Cary's Chapel Rd Eastbound				Shady Oaks Park Westbound				Intersection
		Left Turn	Through	Right Turn	Approach	Left Turn	Through	Right Turn	Approach	Left Turn	Through	Right Turn	Approach	Left Turn	Through	Right Turn	Approach	
	Volume	71	352	13	436	24	305	17	346	7	4	85	96	17	2	27	46	924
	Adj. Flow Rate	84	414	15	513	28	359	20	407	8	5	100	113	20	2	32	54	1087
2-way stop (existing)	Control Delay (sec/veh)	8.3	0		1.4	8.2	0		0.6	24.6		11.2	12.7	30.7	11.7		18.6	3.1
	LOS	A	A		A	A	A		A	C		B	B	D	B		C	A
4-way stop	Control Delay (sec/veh)	9.7	17.9		16.6	17.6			17.6	10.2		10.3	10.2	10.6	9.5		9.9	16.0
	LOS	A	C		C	C			C	B		B	B	B	A		A	C
Roundabout	Control Delay (sec/veh)				5.1				4.8				4.5				4.6	4.9
	LOS				A				A				A				A	A
Signal	Control Delay (sec/veh)	6.0	6.7		6.6	10.8	15.1		14.8	18.7		11.4	12.2	22.1	19.3		20.4	10.9
	LOS	A	A		A	B	B		B	B		B	B	C	B		C	B

PM Peak Hour
5:00 - 6:00 pm

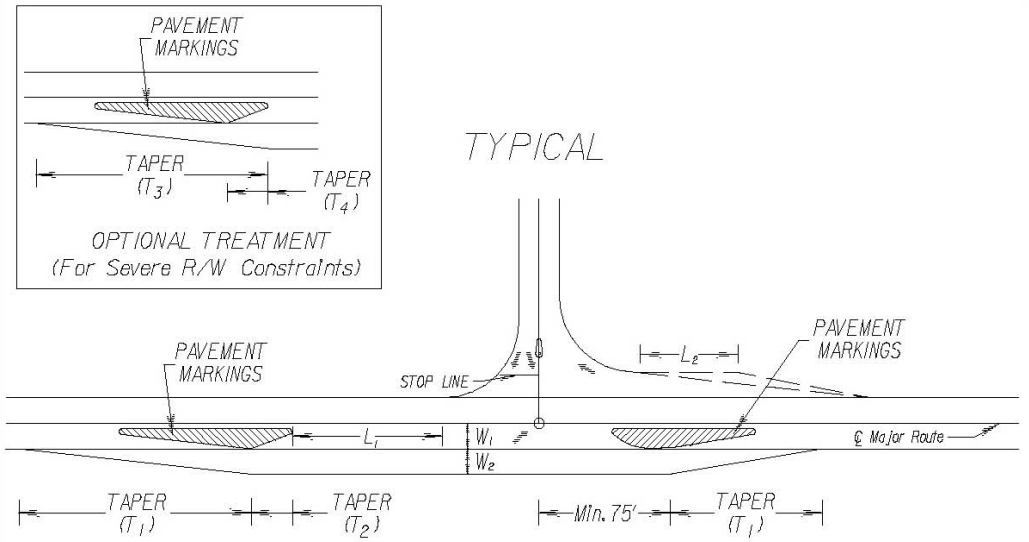
Alternative		Wythe Creek Rd Northbound				Wythe Creek Rd Southbound				Cary's Chapel Rd Eastbound				Shady Oaks Park Westbound				Intersection
		Left Turn	Through	Right Turn	Approach	Left Turn	Through	Right Turn	Approach	Left Turn	Through	Right Turn	Approach	Left Turn	Through	Right Turn	Approach	
	Volume	461	830	17	1308	49	274	26	349	7	4	63	74	16	5	26	47	1778
	Adj. Flow Rate	542	976	20	1539	58	322	31	411	8	5	74	87	19	6	31	55	2092
2-way stop (existing)	Control Delay (sec/veh)	10.4	0		3.7	10.6	0		1.5	1130		10.7	166.9	1468	85.9		555.2	24.6
	LOS	B	A		A	B	A		A	F		B	F	F	F		F	C
4-way stop	Control Delay (sec/veh)	41.1	256.2		180.4	19.6			19.6	11.0		11.0	11.0	11.4	10.5		10.8	137.5
	LOS	E	F		F	C			C	B		B	B	B	B		B	F
Roundabout	Control Delay (sec/veh)				144.6				9.3				4.4				12.4	108.7
	LOS				F				A				A				B	F
Signal	Control Delay (sec/veh)	8.6	8.1		8.3	21.6	23.8		23.5	25.6		7.1	9.8	26.6	27.9		27.5	11.8
	LOS	A	A		A	C	C		C	C		A	A	C	C		C	B

Appendix B

Recommended Northbound Left-Turn Bay Length Analysis

Wythe Creek Road at Cary's Chapel Road

Source: VDOT Road Design Manual



TAPER LENGTH (ft.)	DESIGN SPEED, S (mph)			
	30	40	50	60
T_1	200	325	600	725
T_2	100	200	200	200

TAPER LENGTH (ft.)	DESIGN SPEED, S (mph)			
	30	40	50	60
T_3	200	550	600	725
T_4	100	200	200	200

Notes:

1. L_1 - Length of storage lane to be determined by figures C-1-1.2 through C-1-1.19 by capacity analysis for Left-Turn Storage. Minimum Length = 100'.
2. L_2 - Length of storage lane to be as needed to maintain speed and provide smooth traffic operations.
3. Design speed is the preferred criteria, but operating speed or speed limits may be used if applicable, i.e., adding lanes to existing facilities.
4. Storage lanes are controlled by the turning radius begin point.
5. W_1 - Same as through lane.
   W_2 - Through lane pavement width.

PASSING / LEFT TURN LANE ON TWO - LANE HIGHWAY

FIGURE C-1-1.20

C-5.3

WARRANT FOR LEFT-TURN STORAGE LANES ON TWO-LANE HIGHWAYS

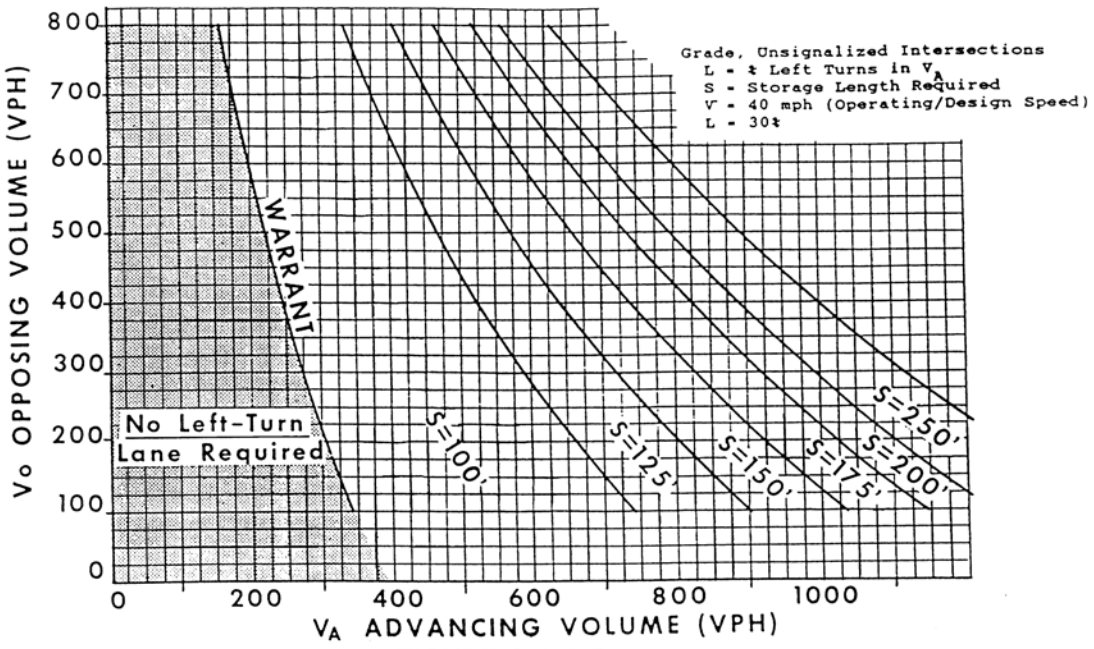


FIGURE C-1-1.6

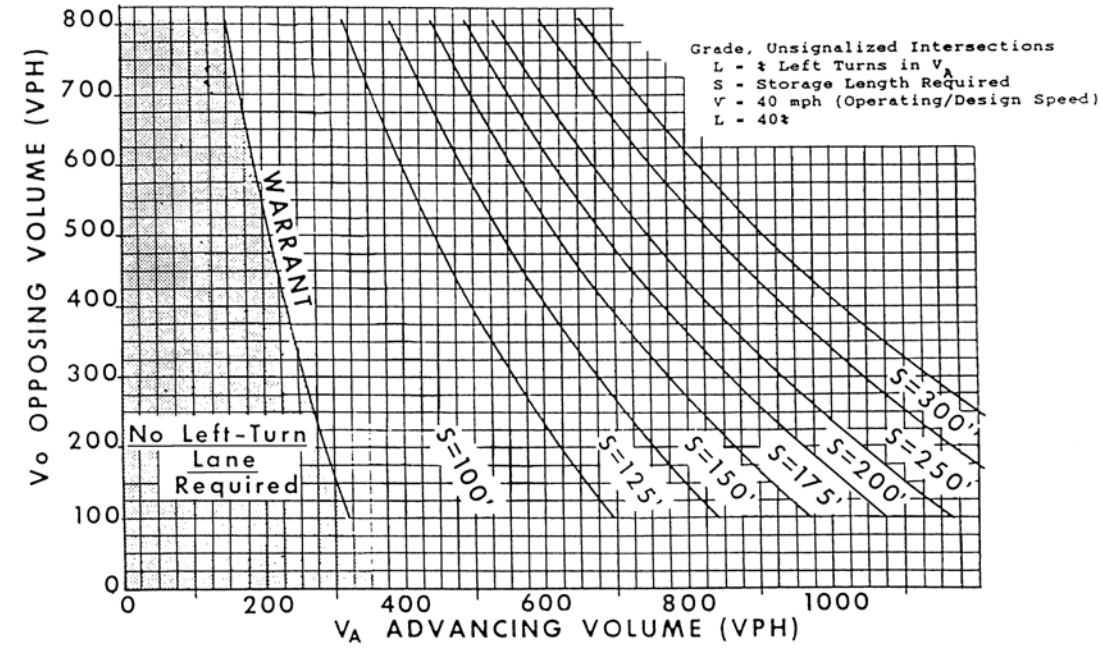


FIGURE C-1-1.7

Appendix C

Traffic Control Signal Needs Study
Warrants 1, 2, 3, and 7

Wythe Creek Road at Cary's Chapel Road

TRAFFIC CONTROL SIGNAL NEEDS STUDIES
WARRANT 1 - EIGHT-HOUR VEHICULAR VOLUME

Warrant 1 is satisfied when one of the following conditions exist for each of any 8 hours of an average day:

A) The vehicles per hour given in both of the 100% columns (70% columns if the posted or 85th percentile speed on the major street exceeds 40 mph) of Condition A in Table 4C-1 exist

B) The vehicles per hour given in both of the 100% columns (70% columns if the posted or 85th percentile speed on the major street exceeds 40 mph) of Condition B in Table 4C-1 exist

C) The vehicles per hour given in both of the 80% columns (56% columns if the posted or 85th percentile speed on the major street exceeds 40 mph) of both Conditions A and B in Table 4C-1 exist

Date: 3/25/2004
By: Keith Nichols
Agency: HRPDC
Date of Count: 2004

LOCATION City of Poquoson

Major Street: Wythe Creek Rd

Minor Street: Cary's Chapel Rd

Major Street Approach Lanes: 1
Major Street Posted Speed: 40 MPH
Major Street 85th % Speed: < 40 MPH

Minor Street Approach Lanes: 1
Minor Street Posted Speed: 25 MPH

Time of Day	Major Street Two-Way Volume	Minor Street Highest Approach Volume	MINIMUM VEHICULAR VOLUMES (Based on Number of Lanes and Approach Speeds)							
			CONDITION A		CONDITION B		COMBINATION OF CONDITION A AND CONDITION B			
			Minimum Vehicular Volume		Interruption of Continuous Traffic		Minimum Vehicular Volume		Interruption of Continuous Traffic	
			Major Two-Way Volume	Minor Highest Approach Volume	Major Two-Way Volume	Minor Highest Approach Volume	Major Two-Way Volume	Minor Highest Approach Volume	Major Two-Way Volume	Minor Highest Approach Volume
			500	150	750	75	400	120	600	60
12:00 - 1:00 am	0	0								
1:00 - 2:00 am	0	0								
2:00 - 3:00 am	0	0								
3:00 - 4:00 am	0	0								
4:00 - 5:00 am	0	0								
5:00 - 6:00 am	0	0								
6:00 - 7:00 am	766	235	X	X	X	X	X	X	X	X
7:00 - 8:00 am	1251	315	X	X	X	X	X	X	X	X
8:00 - 9:00 am	753	284	X	X	X	X	X	X	X	X
9:00 - 10:00 am	590	125	X			X	X	X		X
10:00 - 11:00 am	567	85	X			X	X			X
11:00 - 12:00 pm	962	105	X		X	X	X		X	X
12:00 - 1:00 pm	1017	109	X		X	X	X		X	X
1:00 - 2:00 pm	760	93	X		X	X	X		X	X
2:00 - 3:00 pm	771	84	X		X	X	X		X	X
3:00 - 4:00 pm	1096	75	X		X	X	X		X	X
4:00 - 5:00 pm	1433	57	X		X		X		X	
5:00 - 6:00 pm	1607	72	X		X		X		X	X
6:00 - 7:00 pm	971	83	X		X	X	X		X	X
7:00 - 8:00 pm	0	0								
8:00 - 9:00 pm	0	0								
9:00 - 10:00 pm	0	0								
10:00 - 11:00 pm	0	0								
11:00 - 12:00 am	0	0								
NUMBER OF HOURS CONDITION IS MET			3		9		3			
CONDITION COMPLIANCE			NO		YES		NO			
ARE THE CONDITIONS OF WARRANT 1 SATISFIED?					YES					

Table 4C-1. Warrant 1, Eight-Hour Vehicular Volume

Condition A—Minimum Vehicular Volume

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1	1	500	400	350	280	150	120	105	84
2 or more	1	600	480	420	336	150	120	105	84
2 or more	2 or more	600	480	420	336	200	160	140	112
1	2 or more	500	400	350	280	200	160	140	112

Condition B—Interruption of Continuous Traffic

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1	1	750	600	525	420	75	60	53	42
2 or more	1	900	720	630	504	75	60	53	42
2 or more	2 or more	900	720	630	504	100	80	70	56
1	2 or more	750	600	525	420	100	80	70	56

[a] Basic minimum hourly volume.
[b] Used for combination of Conditions A and B after adequate trial of other remedial measures.
[c] May be used when the major-street speed exceeds 70 km/h or exceeds 40 mph or in an isolated community with a population of less than 10,000.
[d] May be used for combination of Conditions A and B after adequate trial of other remedial measures when the major-street speed exceeds 70 km/h or exceeds 40 mph or in an isolated community with a population of less than 10,000.

Source: Manual of Traffic Control Devices 2003 Edition

TRAFFIC CONTROL SIGNAL NEEDS STUDIES
WARRANT 2 - FOUR-HOUR VEHICULAR VOLUME & WARRANT 3 - PEAK HOUR VOLUME

LOCATION: City of Poquoson Major Street: Wythe Creek Rd Minor Street: Cary's Chapel Rd

Date: 3/25/2004
By: Keith Nichols
Agency: HRPDC
Date of Count: 2004

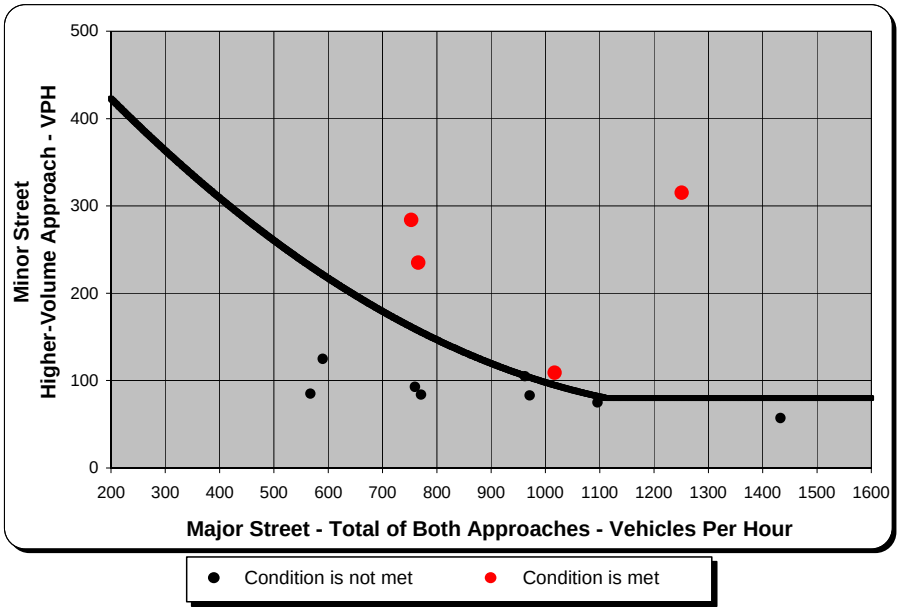
Major Street Approach Lanes: 1
Major Street Posted Speed: 40 MPH
Major Street 85th % Speed: < 40 MPH

Minor Street Approach Lanes: 1
Minor Street Posted Speed: 25 MPH

Source: Manual of Traffic Control Devices 2003 Edition

WARRANT 2 - FOUR-HOUR VEHICULAR VOLUME

Warrant 2 is satisfied when, for each of any four hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both appraoches) and the corresponding vehicles per hour on the higher-volume minor-street approach all fall above the applicable curve in Figure 4C-1 for the existing combination of approach lanes.



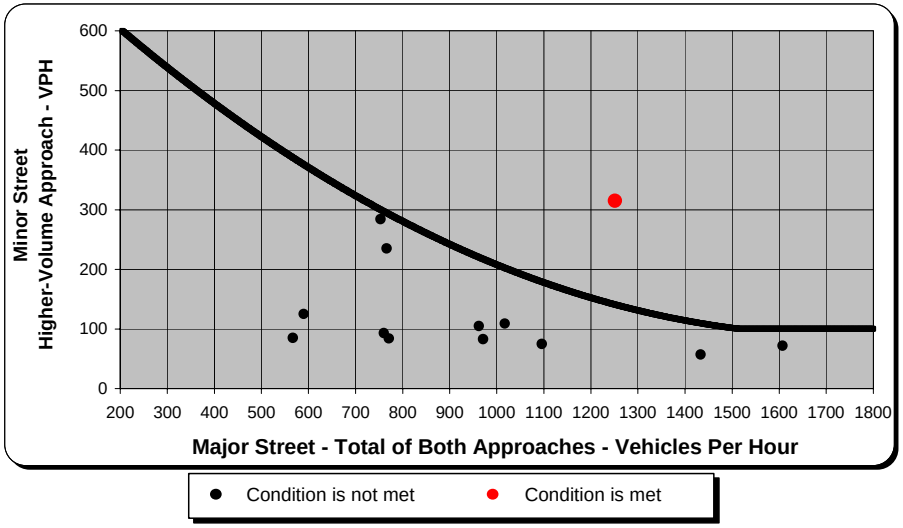
NUMBER OF HOURS CONDITION IS MET	4
ARE THE CONDITIONS OF WARRANT 2 SATISFIED?	**YES**

WARRANT 3 - PEAK HOUR VOLUME

This warrant shall be applied only in unusual cases where facilities attract or discharge large number of vehicles period of time. Warrant 3 is satisfied when either of the following two are met:

A) All three of the following conditions exist for the same hour: The total stopped delay experienced by the traffic on one minor approach equals/exceeds 4 vehicle-hours for a one-lane approach or 5 veh-hours for a two lane approach, AND the volume on the same approach equals or exceeds 100 veh/hr for one lane of traffic or 150 veh/hr for two lanes, AND the total entering volume during the hour equals/exceeds 650 veh/hr for 3-leg intersections or 800 veh/hr for 4-leg intersections.

B) The plotted point representing the vehicles per hour on the major street and the correspoinding vehicles per hour on the minor-street approach for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4C-3.



IS CONDITION A MET?	**YES**	IS CONDITION B MET?	**YES**
ARE THE CONDITIONS OF WARRANT 3 SATISFIED?	**YES**		

TRAFFIC CONTROL SIGNAL NEEDS STUDIES
WARRANT 7- CRASH EXPERIENCE

LOCATION: City of Poquoson Major Street: Wythe Creek Rd Minor Street: Cary's Chapel Rd

Date: 3/25/2004
By: Keith Nichols
Agency: HRPDC
Date of Count: 2004

Major Street Approach Lanes: 1
Major Street Posted Speed: 40 MPH
Major Street 85th % Speed: < 40 MPH

Minor Street Approach Lanes: 1
Minor Street Posted Speed: 25 MPH

Source: Manual of Traffic Control Devices 2003 Edition

WARRANT 7 - CRASH EXPERIENCE

Warrant 7 is satisfied when an engineering study finds that all three of the following criteria are met:

A) Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency.
B) Five or more reported crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period, with each crash exceeding the applicable requirements for a reportable crash.
C) For each of any 8 hours of an average day, the vehicles per hour given in both of the 80 percent columns of Condition A or Condition B in Warrant 1 exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not less than 80 percent of the requirements specified in Warrant 4.

Total Crashes that occurred within a 12-month period that are correctible by a traffic control signal: **3**

IS CONDITION A MET? **YES**

IS CONDITION B MET? **NO**

IS CONDITION C MET? **YES**

ARE THE CONDITIONS OF WARRANT 7 SATISFIED? **NO**