



ROAD SAFETY AUDITS

COURTHOUSE HIGHWAY AND FOURSQUARE
ROAD / SCOTTS FACTORY ROAD
SMITHFIELD, VIRGINIA

July 2024



Table of Contents

- Table of Contents.....2
- Acronyms3
- Applicable Guidance and Standards.....4
 - 1. Introduction.....5
 - 1.1. Study Purpose5
 - 1.2. Study Area.....5
 - 1.3. RSA Details.....6
 - 1.4. RSA Attendees.....6
 - 2. Existing Conditions7
 - 2.1. Study Area Characteristics7
 - 2.2. Past and Ongoing VDOT Initiatives.....10
 - 2.3. Crash History.....12
 - 2.4. Traffic Data15
 - 3. Prompt Questions17
 - 4. Identified Concerns.....20
 - 4.1. Sight Distance Concerns.....20
 - 4.2. Operational / Driver Behavior Concerns.....22
 - 4.3. Signing, Pavement Marking, and Lighting Concerns25
 - 5. Potential Countermeasures27
 - 5.1. Tier 1 Countermeasures.....27
 - 5.2. Tier 2 Countermeasures.....31
 - 5.3. Tier 3 Countermeasures.....36
 - 5.4. Other Intersection Countermeasures41
 - 5.5. Treatments reviewed but not currently recommended.....42
 - 6. Conclusions.....46
- Appendix A – Turning Movement Data48

Acronyms

AADT – annual average daily traffic

AASHTO – American Association of State Highway and Transportation Officials

ATR – automated traffic recorder

CMF – crash modification factor

CRF – crash reduction factor

FHWA – Federal Highway Administration

HSM – Highway Safety Manual

IIM – Instructional and Informational Memoranda

LOS – level of service

MPH – miles per hour

MUTCD – Manual on Uniform Traffic Control Devices for Streets and Highways

NCHRP – National Cooperative Highway Research Panel

PRT – perception reaction time

RSA – road safety audit

RDM – Road Design Manual

TIA – traffic impact analysis

TMC – turning movement counts

TOSAM – Traffic Operations and Safety Analysis Manual

VDOT – Virginia Department of Transportation

VPD – vehicles per day

Applicable Guidance and Standards

AASHTO Policy on Geometric Design of Highways and Streets, 2018

<https://store.transportation.org/item/collectiondetail/180>

AASHTO Highway Safety Manual (HSM), 2010

<https://www.highwaysafetymanual.org/>

Manual on Uniform Traffic Control Devices (MUTCD), 2009

<https://mutcd.fhwa.dot.gov/>

MUTCD Interim Approval for Optional Use of an Alternative Signal Warrant 7 – Crash Experience (IA-19)

https://mutcd.fhwa.dot.gov/resources/interim_approval/ia19/index.htm

VDOT IIM-TE-387 Signal Justification Reports (SJRs) For New and Reconstructed Signals

https://www.virginiadot.org/business/resources/iim/te-387_signal_justification_reports.pdf

VDOT IIM-TE-390 Guidance on Light Emitting Diode (LED) Exterior Lighting

https://www.virginiadot.org/business/resources/IIM/TE-390_LED_Lighting.pdf

VDOT Road Design Manual

<https://www.virginiadot.org/business/locdes/rdmanual-index.asp>

VDOT Supplement to the MUTCD (Version 1)

https://www.virginiadot.org/business/virginia_mutcd_supplement.asp

1. Introduction

1.1. Study Purpose

This report summarizes the findings of a Road Safety Audit (RSA) for the intersection of Courthouse Highway (Route 258) and Foursquare Road/Scotts Factory Road (Route 620). The purpose of the study is to identify safety risks and develop potential improvements to address the safety of all road users.

The study team has compiled this report to evaluate potential safety enhancements and understand trade-offs for potential treatments. Safety improvement countermeasures outlined in this report may not all be feasible; thus, engineering assessments and additional field evaluations are needed to determine implementation needs. The evaluation focuses on a prioritized list of safety improvements and includes the identification of implementation time frame, dependency on other countermeasures/factors, potential benefits, and potential constraints or challenges.

1.2. Study Area

The study area consists of the intersection of Courthouse Highway (Route 258) and Foursquare Road/Scotts Factory Road (Route 620), situated in Isle of Wight County, Virginia. For the purposes of this report, Foursquare Road/Scotts Factory Road is oriented northwest-southeast but is referred to as an east-west road, while Courthouse Highway is oriented southwest-northeast but will be referred to as a north-south road. An overview of the study area is shown in Figure 1.



Figure 1. Overview of Study Area

1.3. RSA Details

To identify potential safety improvements, the project team held an RSA, which included data analysis, a field review, and post field review analysis. The study team conducted the RSA field review on Tuesday, March 26, 2024, from 1:00 pm to 3:00 pm. The site conditions were cloudy, dry, and cool (roughly 50° F).

1.4. RSA Attendees

- Nathan Milaszewski (VDOT)
- Glenn Hott (VDOT)
- Matthew Davenport (VDOT)
- George Bowman (VDOT)
- Jason Fowler (VDOT)
- Andy McLaughlin (VDOT)
- Julie Boswell (Isle of Wight County)
- Garry Windley (Isle of Wight)
- Jamie Oliver (Isle of Wight)
- Brian Carroll (Isle of Wight)
- Taylor Bonner (VHB)
- Kirsten Tynch (VHB)
- Azeez Lawal (VHB)

2. Existing Conditions

2.1. Study Area Characteristics

The study intersection is an unsignalized four-way intersection with a stop-controlled approach on both Foursquare Road/Scotts Factory Road (Route 620), and no traffic control on the Courthouse Highway/Route 258 approaches. Heading north on Courthouse Highway (Route 258), the roadway changes names to W Main Street at the Town of Smithfield jurisdictional line. Foursquare Road/Scotts Factory Road (Route 620) is classified as a rural major collector and features open ditches, no turn lanes, and variable shoulder widths, with speed limits of 45 mph on Scotts Factory Road and 55 mph on Foursquare Road for passenger vehicles and 45 mph on Foursquare Road for trucks. Courthouse Highway (Route 258), classified as a rural minor arterial, runs north-south and accommodates two lanes undivided with additional dedicated left and right turning lanes on both approaches of Courthouse Highway at the intersection, open ditches, varied width shoulders, and a uniform speed limit of 55 mph.

The land use in the area northeast and west of the study is rural and consists of agricultural and low-density residential land use. Southwest of the study intersection, land use is low density with residential developments and is classified as part of the South Hampton Roads subregion of the Hampton Roads area per 2010 U.S. Census data.¹ A major trip generator within the greater study area includes the Town of Smithfield, which generates trips by out-of-town drivers. Another major trip generator within the study area is Food Lion's nearby warehouse complex, which generates significant left-turning truck movements from eastbound Foursquare Road onto northbound Courthouse Highway and right-turning movements from southbound Courthouse Highway onto eastbound Foursquare Road. An overview of key characteristics of the study intersection are shown in Table 1 and shown in Figure 2.

¹ U.S. Census Bureau. "2010 Census Urban Area Reference Maps". Washington, D.C. 2010.
<https://www.census.gov/geographies/reference-maps/2010/geo/2010-census-urban-areas.html>

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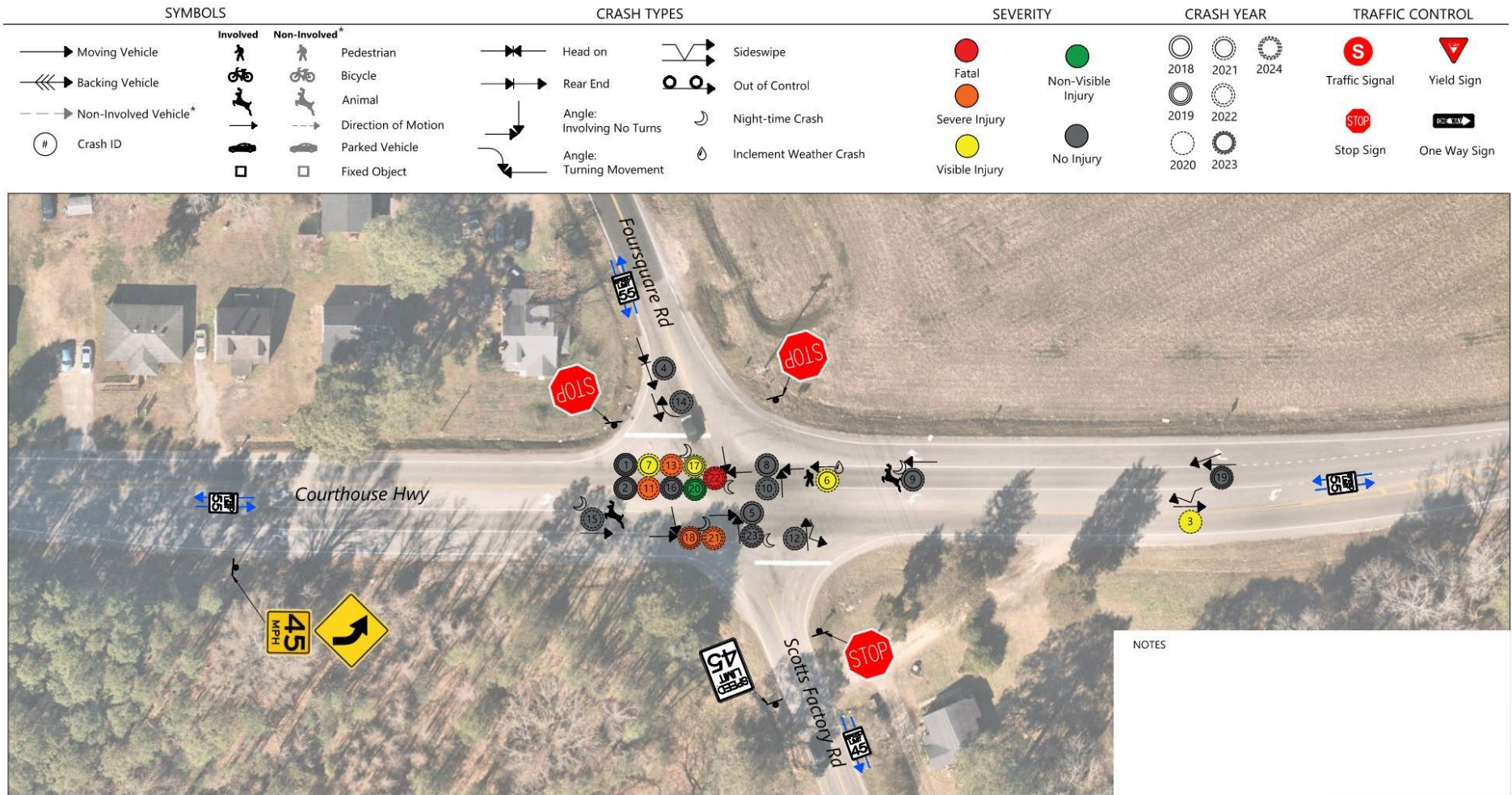
COURTHOUSE HIGHWAY AND FOURSQUARE ROAD / SCOTTS FACTORY ROAD

Table 1. Intersection Characteristics by Approach

Characteristics	Courthouse Highway (Route 258)	Foursquare Road/Scotts Factory Rd (Route 620)
Orientation	Northeast-Southwest	Northwest-Southeast
Functional Classification	Minor Arterial	Major Collector
Annual Average Daily Traffic (AADT) in 2021 (vehicles per day)	8,900	3,100 (Foursquare) 2,100 (Scotts Factory)
Speed Limit (miles per hour)	55 mph	55 mph (Foursquare, passenger cars) 45 mph (Foursquare, trucks) 45 mph (Scott Factory)
Number of Lanes	2 (one through lane in each direction)	2 (one through lane in each direction)
Lane Widths (feet)	12'	11'
Roadway Features	Left and right turn lanes on both approaches to the intersection. Edge lines present.	Stop ahead warning signs on Foursquare Road/Scotts Factory Road approaches. Edge lines present on Foursquare Road.
Distance from adjacent signalized intersections (feet)	Nearest signalized intersection is ~1.8 miles northeast at W Main Street and Bennis Church Boulevard	
Land Uses	Low-Density Residential and Agricultural	

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COURTHOUSE HIGHWAY AND FOURSQUARE ROAD / SCOTTS FACTORY ROAD



0 50 Feet

SOURCE: VDOT TRAFFIC ENGINEERING DIVISION
HIGHWAY SAFETY SECTION, VIRGINIA DEPARTMENT OF
MOTOR VEHICLES, NEARMAP.

LEGEND

→ Travel Direction

⬮ Sign Location

*"Non-Involved Vehicle" and other "Non-Involved" symbols represent vehicles and other representations that were not physically struck but caused other vehicles to crash

ROAD SAFETY AUDIT
EXISTING CONDITIONS/CRASH DIAGRAM
Intersection of US Rte 258 (Courthouse Hwy)
and Rte 620 (Foursquare Rd / Scotts Factory Rd)
Isle of Wight County, VA



April 2024

Figure 2. Existing Conditions Map and Crash Diagram

2.2. Past and Ongoing VDOT Initiatives

2.2.1. Intersection Turn Lane Improvements (UPC 58297)

Between 2016 and 2017, VDOT designed and constructed left and right-turn lanes on both approaches of Courthouse Highway at the Foursquare Road / Scotts Factory Road intersection. By adding these dedicated turn lanes, turning movements were separated from through-traveling traffic which can help reduce the risk of rear-end crashes caused by vehicles slowing down to turn left or right.

2.2.2. VDOT Highway Safety Improvement Program Application (2023)

As part of VDOT's Highway Safety Improvement Program (VHSIP), a proposal for an offset right turn lane for the southbound Courthouse Highway approach was put forth based on a request from Isle of Wight County in 2023. An offset right turn lane could serve as a potential countermeasure for correcting any challenges with right-turning vehicles obstructing sight lines. This positive offset allows for southbound through-traveling drivers and eastbound drivers stopped on Foursquare Road to better see one another when a vehicle is turning right, as the right turn lane is displaced out of the line of sight.

This proposal did not move forward with an official application for VHSIP funding since the cost-benefit ratio was not greater than 1. This is due to the lack of a crash reduction factor for an offset right turn lane and the CMF used for a benefit-cost analysis would equal 1, meaning the countermeasure has no safety effect though 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.² However, the proposal was not advanced to an application for funding under VHSIP.

2.2.3. Fatal Crash Review

This recently completed VDOT study focused on assessing the safety of the intersection at Foursquare Road/Scotts Factory Road and Courthouse Highway in Isle of Wight County. The analysis was initiated due to a citizen request, determining the necessity for additional traffic control devices at this rural intersection, as well as a recent fatal crash that occurred December 2023.

The VDOT study noted that current traffic control measures included stop signs, advanced warning signs, and pavement markings. Speed data from Courthouse Highway noted an 85th-percentile speed of 56.4 mph, while crash data spanning the last three years highlighted different types of incidents, sourced from VDOT's Roadway Network System and additional databases, noting some backlog in crash records due to data processing time. The field review revealed mixed land use in the surrounding areas, including agricultural activities (notably corn farming), residential developments, and wooded regions. The review

² Khattak, A. and Kang, Y. *Offset Right-Turn Lanes on State Highway Systems*. Nebraska Transportation Center. 2018.

VDOT ROAD SAFETY AUDITS

COURTHOUSE HIGHWAY AND FOURSQUARE ROAD / SCOTTS FACTORY ROAD

flagged concerns regarding faded stop bar pavement markings and obstructed sightlines primarily due to overgrown vegetation and cornstalks, which potentially affect visibility and intersection safety. A concept of improvements from the VDOT study is shown in Figure 3. In response to these findings, this RSA was commissioned to review the intersection's safety dynamics thoroughly.

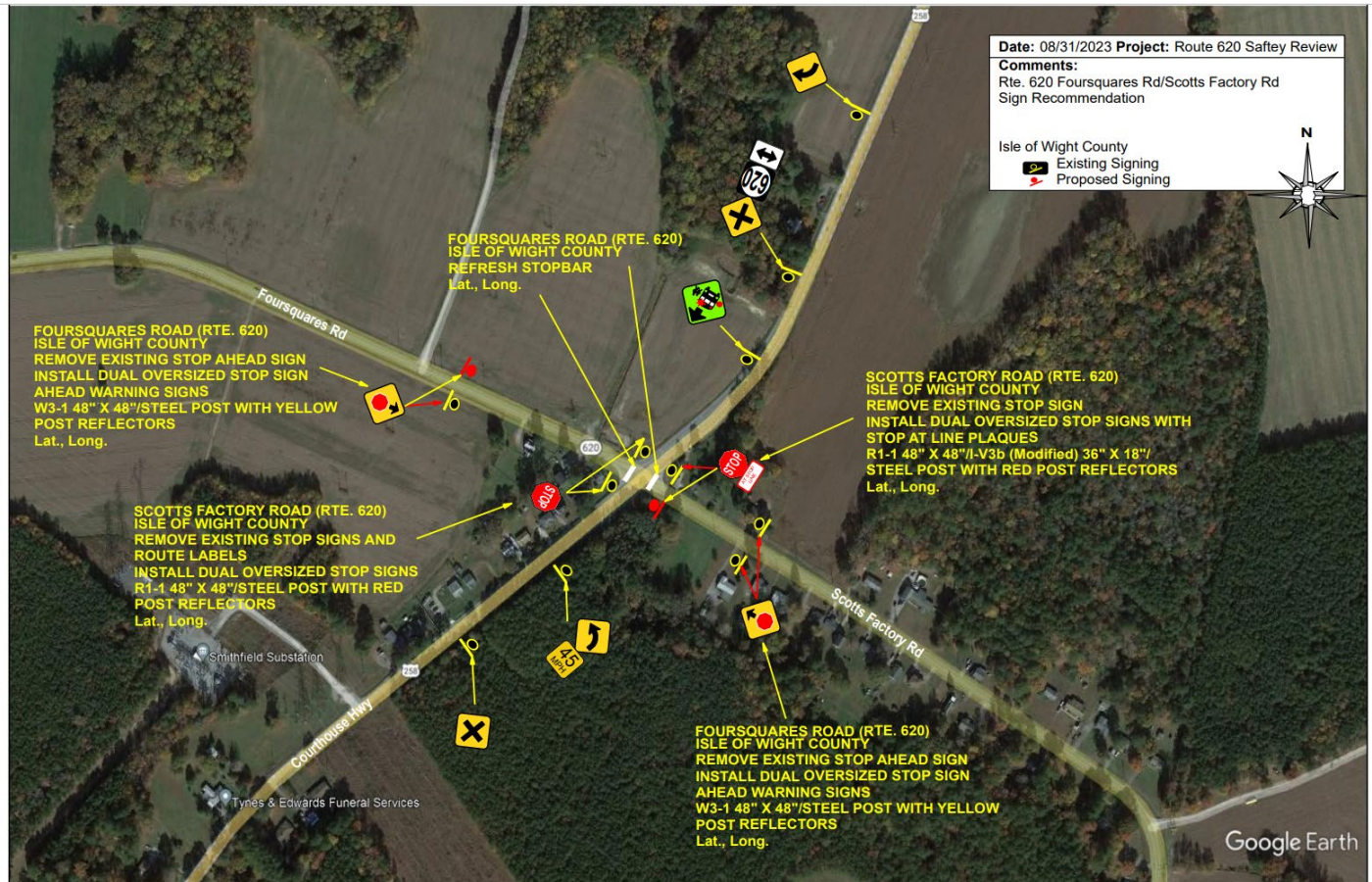


Figure 3. Proposed Sign Recommendations from VDOT Study

Based on this RSA, some of the VDOT study recommendations require adjustments (such as the stop ahead warning sign) in accordance with the MUTCD. For example, the "STOP AT LINE" plaque recommended in the VDOT study is not MUTCD compliant or included in the Virginia Supplement to the MUTCD, though the sign is referred to as a modified "END STATE MAINTENANCE" (I-V3b) sign.³ Lastly, the study recommended oversized 48" by 48" signs. The oversized stop signs and stop ahead warning signs have since been installed (May 16, 2024).

³ Virginia Department of Transportation. "VDOT Supplement to the MUTCD (Version 1)." Virginia Department of Transportation. 2012. https://www.virginiadot.org/business/virginia_mutcd_supplement.asp

2.2.4.VHSIP Two-Lane Rural Roads Systemic Initiative (2024)

VHSIP is undergoing a statewide systemic safety initiative on high-risk rural roads in 2024. This program utilizes systemic countermeasures, such as centerline and/or edgeline rumble strips, warning signs, pavement markings, and other roadway departure countermeasures that can be used to keep drivers on the road or help re-enter the road. As part of this initiative, Foursquare Road between Courthouse Highway and Comet Road (Route 652) was identified as a candidate location for centerline rumble strips.

2.3. Crash History

Through the RSA, it is crucial to examine all crashes to obtain a comprehensive understanding of how the intersection operates. Crash data was collected from January 2019 through January 2024 to obtain 5 full years of data for review and capture recent crashes. The most common crash type at the intersection was angle crashes, most often involving two through-traveling vehicles. There were two angle crashes involving northbound and westbound movements, two involving northbound and eastbound movements, and two involving southbound and eastbound movements. Most notably, there were nine angle crashes involving southbound and eastbound through movements. Figure 2 shows the collision diagram for crashes occurring at the intersection during the 5-year study period.

As shown in Figure 4, there was one fatal crash in 2023. This crash involved a vehicle traveling eastbound on Foursquare Road/Scotts Factory Road when it failed to stop before entering the intersection and struck another vehicle traveling south on Courthouse Highway, resulting in an angle crash.

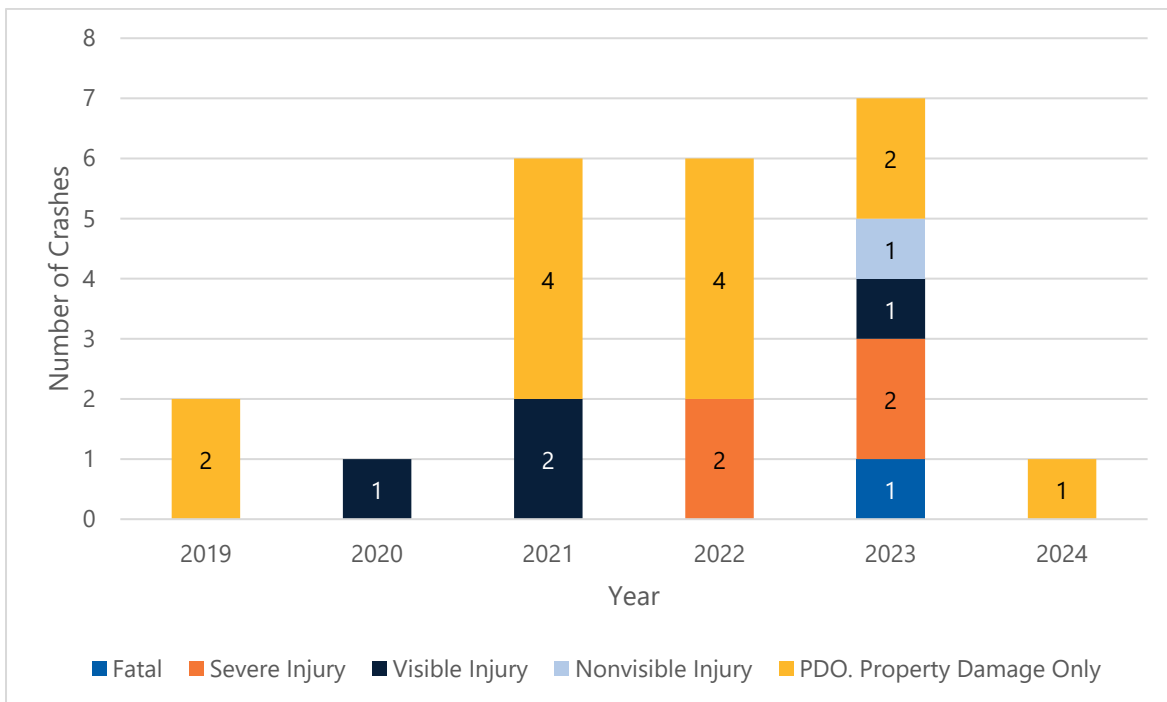


Figure 4. Crash Severity by Year in the Study Area (2018-2024)

Figure 5 shows that most crashes occurred during daylight conditions (17 of 23). Of the six non-daylight crashes, two involved deer collisions, three were angle collisions involving eastbound Foursquare Road, and one involved an angle collision with westbound Scotts Factory Road.

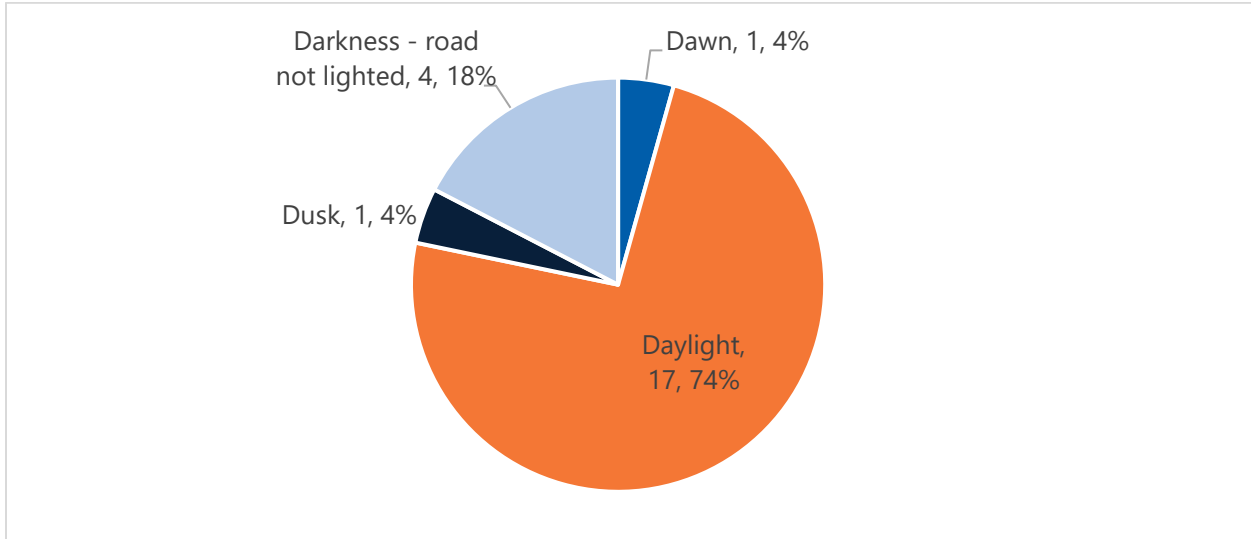


Figure 5. Crashes by Lighting Condition (2018-2024)

Figure 6 shows that nearly all the crashes occurred in clear/cloudy weather conditions, with only one occurring during misty conditions.

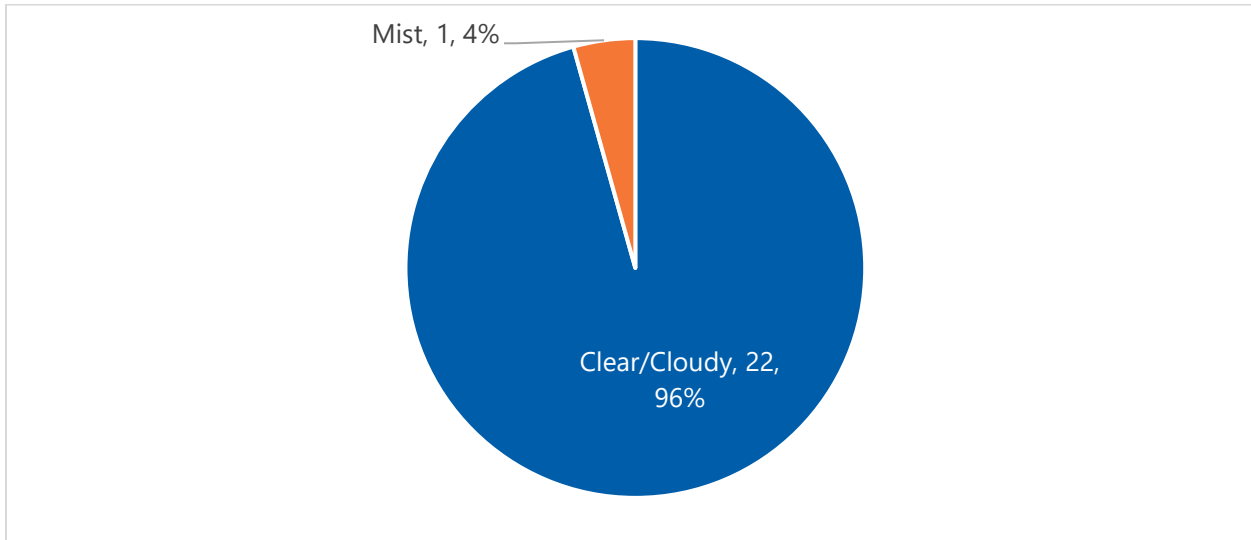


Figure 6. Crashes by Weather Condition (2018-2024)

Aside from the two deer-related crashes that occurred in the evening (between 6:00 and 9:00 pm), all other crashes took place between the hours of 6:00 am and 6:00 pm. All the rear end crashes occurred between the hours of 11:00 am to 5:00 pm as shown in Figure 7.

VDOT ROAD SAFETY AUDITS

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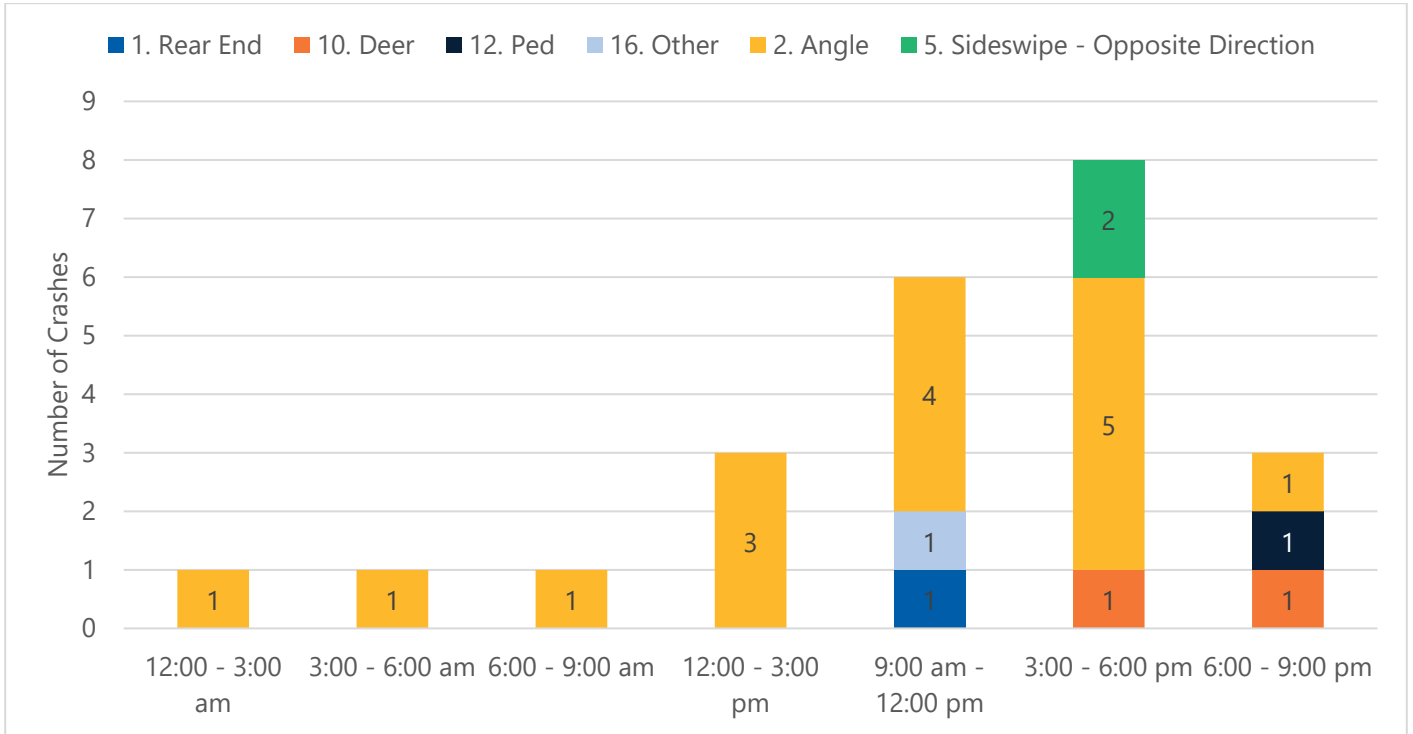


Figure 7. Time of Crashes by Crash Type in the Study Area (2018-2024)

Most of the crashes at the study intersection occurred between the months of June and November as shown in Figure 8.

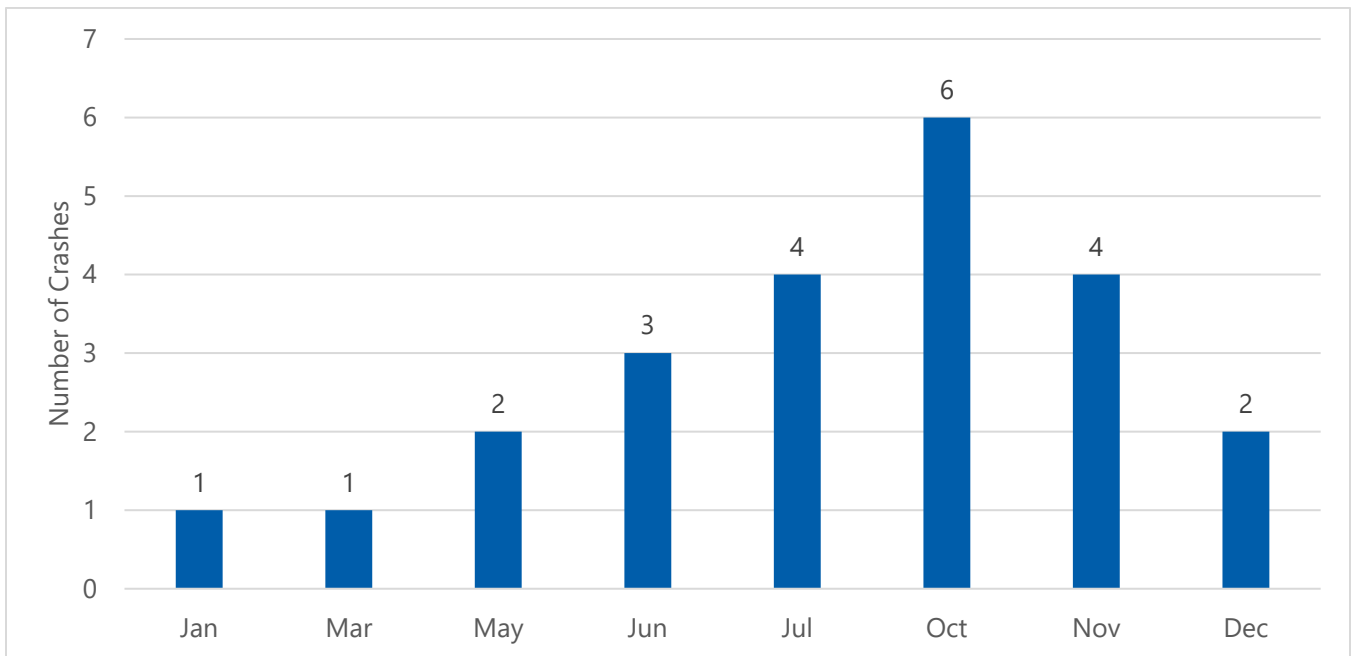


Figure 8. Crashes by Month in the Study Area (2018-2024)

2.4. Traffic Data

2.4.1. Turning Movement Counts

Reviewing turning movement counts, traffic volumes, and types of vehicles using the intersection is essential to the study as potential treatments at the intersection may impact certain turning maneuvers and road users. Table 2 shows the 15-minute volumes for the intersection identified using turning movement traffic counts collected over a 24-hr period from 11:30 am on Thursday, February 20, 2024, to 11:15 am Friday, February 21, 2024. The table shows the traffic counts between the hours of 6:00 am and 6:00 pm. The morning peak hour (7:30 am to 8:30 am) and afternoon peak hour (4:00 pm to 5:00 pm) volumes have also been highlighted in the table. Note that the data presented below contains morning peak hours (6:00 am to 10:00 am) from Friday, while afternoon (2:00 pm to 6:00 pm) are from Thursday. The full turning movement count data is included in Appendix A.

VDOT ROAD SAFETY AUDITS

COURTHOUSE HIGHWAY AND FOURSQUARE ROAD / SCOTTS FACTORY ROAD

Table 2. Turning Movement Counts (Passenger and Heavy Vehicles Combined)

Start Time	SB Courthouse Highway			WB Scotts Factory Road			NB Courthouse Highway			EB Foursquare Road		
	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left
6:00 AM	9	12	2	5	3	0	1	34	1	0	6	20
6:15 AM	12	27	1	4	1	1	2	32	2	1	5	23
6:30 AM	23	20	2	9	3	2	4	22	1	2	12	31
6:45 AM	16	15	3	6	1	4	4	28	0	1	17	20
7:00 AM	17	35	6	8	1	1	3	46	0	1	3	25
7:15 AM	16	31	7	4	3	1	4	58	1	1	3	33
7:30 AM	13	72	4	6	1	8	4	41	0	1	12	30
7:45 AM	8	91	8	4	2	2	0	54	0	5	5	28
8:00 AM	6	49	1	10	3	3	2	68	2	3	4	29
8:15 AM	13	45	4	7	0	3	0	49	4	2	1	27
8:30 AM	14	49	4	7	0	2	3	48	1	2	5	24
8:45 AM	18	24	8	3	4	0	3	30	0	2	3	29
9:00 AM	17	29	7	5	2	2	6	27	0	0	4	20
9:15 AM	10	26	6	1	1	1	2	36	1	0	6	14
9:30 AM	15	23	4	7	2	2	3	33	0	1	3	23
9:45 AM	9	34	3	9	1	1	3	33	1	1	2	16
10:00 AM	5	23	11	4	2	0	1	36	3	1	2	21
AM Peak	40	257	17	27	6	16	6	212	6	11	22	104
Hour Volume												
2:00 PM	22	40	5	6	2	3	3	17	1	0	7	19
2:15 PM	17	35	4	6	3	3	3	16	0	0	1	14
2:30 PM	30	54	8	5	6	3	4	40	0	0	1	29
2:45 PM	28	44	4	12	4	4	7	75	2	1	2	11
3:00 PM	22	54	6	9	12	11	5	52	2	0	3	24
3:15 PM	33	42	5	5	8	3	3	32	0	1	2	11
3:30 PM	29	52	7	6	7	3	9	56	3	0	1	18
3:45 PM	33	52	12	6	9	4	3	41	1	2	5	22
4:00 PM	38	44	9	11	7	6	1	42	3	0	3	11
4:15 PM	39	57	5	10	12	2	0	38	1	5	3	21
4:30 PM	24	43	13	9	5	6	5	29	1	3	4	20
4:45 PM	29	54	14	4	7	6	2	40	4	1	5	15
5:00 PM	29	40	3	8	5	4	2	45	2	2	7	23
5:15 PM	29	49	8	6	6	4	3	41	0	2	2	18
5:30 PM	29	38	10	4	7	3	4	31	1	1	3	23
5:45 PM	24	35	9	5	3	2	6	34	0	1	2	13
6:00 PM	22	32	6	8	4	2	0	20	2	1	1	9
PM Peak	130	198	41	34	31	20	8	149	9	9	15	67
Hour Volume												

3. Prompt Questions

As part of the field review for the RSA, attendees were asked to consider prompt questions while observing traffic flow and intersection characteristics. The following table summarizes the conditions and characteristics observed by the RSA attendees.

Category	Prompt Question	Observation
General	What is working well at the intersection or on the corridor?	<ul style="list-style-type: none"> Traffic volumes on Courthouse Highway are generally low to moderate resulting in sufficient gaps in traffic. Short queue length resulting in minimal wait time for turning traffic.
	What are some positive design features?	<ul style="list-style-type: none"> Presence of left and right turn lanes on Courthouse Highway. Relatively flat grade with minimal vertical curves.
	What is the land use in the study area?	<ul style="list-style-type: none"> Largely rural with farming uses (corn) on the northwest quadrant. Residential on the southwest quadrant. Wooded tree line/vegetation on the northeast/southeast quadrants of the intersection.
	Are there any challenges with access management?	<ul style="list-style-type: none"> No
3.1. Intersection Sight Distance	3.1.1. Are there utility poles, signs or other objects blocking the view of traffic?	<ul style="list-style-type: none"> Yes, tree foliage blocking stop sign.
	3.1.2. Is sight distance sufficient for all turning movements?	<ul style="list-style-type: none"> Sight distance appears to be adequate for left and right turns onto Foursquare/Scotts Factory Road from Courthouse Hwy. Sight distance appears limited from the Foursquare Road approach looking southbound on Courthouse Highway.
	3.1.3. Is sight distance adequate for major road through movements? Can drivers see vehicles on side streets?	<ul style="list-style-type: none"> Sight distance appears to be adequate on Courthouse Highway.
	3.1.4. Do turning vehicles obstruct sight lines for other movements? Are there adequate gaps for turning movements?	<ul style="list-style-type: none"> Over-track of turning movement unto Foursquare Road.
3.2. Barriers, Clear Zones, and Roadside	3.2.1. Are there obstacles within clear zone?	<ul style="list-style-type: none"> Deep ditch on Foursquare Road.
	3.2.2. How wide is the clear zone?	<ul style="list-style-type: none"> Ranges from 10 – 20 ft Clear zone on Foursquare Road limited due to presence of open ditch close to the shoulder
	3.2.3. Are shoulders adequate? What is the shoulder width?	<ul style="list-style-type: none"> 4' paved shoulder on Courthouse Highway

VDOT ROAD SAFETY AUDITS

COURTHOUSE HIGHWAY AND FOURSQUARE ROAD / SCOTTS FACTORY ROAD

	3.2.4. Are the centerline and/or shoulder rumble strips?	<ul style="list-style-type: none"> No
	3.2.5. Is an edge line present? If so, how wide is the pavement marking?	<ul style="list-style-type: none"> 4" edge line present on Courthouse Hwy and Foursquare/Scotts Factory Road.
	3.2.6. What type of pavement edge is present?	<ul style="list-style-type: none"> No pavement edge treatment.
	3.2.7. Is there guardrail present? Are there damages to the guardrail?	<ul style="list-style-type: none"> No
	3.2.8. Are there any run-off-road indications (skid marks, tire tracks, vehicle debris, etc.)?	<ul style="list-style-type: none"> Vehicle debris present on the southeast corner
3.3. Signs, Markings, Lighting	3.3.1. Are signs visible, clear, and appropriate? Are they legible for all drivers?	<ul style="list-style-type: none"> Signs are not reflective and are not well-positioned for drivers approaching the intersection on Foursquare Road.
	3.3.2. Are sign supports in good repair?	<ul style="list-style-type: none"> No, stop ahead is bent on Foursquare Road
	3.3.3. What are the conditions of the pavement markings?	<ul style="list-style-type: none"> Pavement markings are generally in fair to good condition.
	3.3.4. Is lighting present? Is lighting sufficient for the intersection or corridor?	<ul style="list-style-type: none"> The RSA was carried out during the daytime – lighting sufficiency was not determined. Although, there was a light mounted to the utility pole on the northeast corner of the intersection.
	3.3.5. Are pavement markings compliant with the MUTCD and VDOT Road Design Manual?	<ul style="list-style-type: none"> Yes
3.4. Pavement	3.4.1. Are there pavement defects?	<ul style="list-style-type: none"> Edge drop-off on Foursquare Road close to intersection on receiving approach of turn movements from Courthouse Highway.
	3.4.2. Is there loose stone or gravel present in the roadway?	<ul style="list-style-type: none"> Yes, mostly at the driveway on Foursquare Road, as well as eastbound Foursquare Road close to the intersection
	3.4.3. How does the pavement perform during wet conditions?	<ul style="list-style-type: none"> Did not observe in wet conditions. However, crash data did not indicate a history of wet crashes.
3.5. Heavy Vehicles	3.5.1. Is the roadway on a truck route?	<ul style="list-style-type: none"> Though not signed, the routes experience significant heavy vehicle movement, especially with the nearby supermarket chain Food Lion warehouse complex.
	3.5.2. Are there many heavy vehicles present? If so, what vehicle types?	<ul style="list-style-type: none"> Yes, large trucks frequently turned left and right at the intersection from and onto Foursquare Road.
	3.5.3. Are turning radii and stop line placement sufficient for heavy vehicle movements?	<ul style="list-style-type: none"> Some conflicts observed for heavy vehicles turning from Foursquare Road to Courthouse Highway leading to existing lane lines being frequently driven over by these vehicles. Current stop line placement for eastbound Foursquare Road may make heavy vehicle turns onto and off of Foursquare Road challenging.

VDOT ROAD SAFETY AUDITS

COURTHOUSE HIGHWAY AND FOURSQUARE ROAD / SCOTTS FACTORY ROAD

3.6. Human Factors	3.6.1. Are drivers compliant to traffic control signage?	<ul style="list-style-type: none"> • Yes, observations indicate that most drivers are stopping on Foursquare/Scotts Factory Road at the intersection.
	3.6.2. How aggressive are drivers (in terms of passing, gap acceptance, risky maneuvers)?	<ul style="list-style-type: none"> • Some rolling stops were observed, but drivers appeared mostly conservative during site visit.
	3.6.3. Are drivers using turn signal indicators?	<ul style="list-style-type: none"> • Yes, drivers appeared to use turn signal during observations.
	3.6.4. How close are drivers following together?	<ul style="list-style-type: none"> • Average, except for Foursquare Road eastbound which experiences little queue at the intersection (due to stop sign).
3.7. Speed Management	3.7.1. How fast are people driving?	<ul style="list-style-type: none"> • Drivers generally adhere to the speed limit of 55 mph on Courthouse Highway
	3.7.2. Is there significant variation in the speed of vehicles?	<ul style="list-style-type: none"> • No
	3.7.3. Does the existing posted speed limit align with the "comfortable" driving speed of the roadway?	<ul style="list-style-type: none"> • Yes
	3.7.4. Are lane widths sufficient for traffic conditions?	<ul style="list-style-type: none"> • Right turning movements of larger vehicles onto EB Foursquare Road track over the edge line pavement marking (also where the pavement deterioration and rutting is present on the corner)
	3.7.5. Is there a school zone present? If so, what is the posted speed?	<ul style="list-style-type: none"> • No
3.8. Vulnerable Road Users	3.8.1. Are pedestrians or bicyclists utilizing the intersection or corridor? If so, describe the activity present.	<ul style="list-style-type: none"> • None observed during site visit.
	3.8.2. Are sidewalks present?	<ul style="list-style-type: none"> • No
	3.8.3. Are bicyclist facilities present?	<ul style="list-style-type: none"> • No
	3.8.4. Are there marked crosswalks within or near the study area?	<ul style="list-style-type: none"> • No
	3.8.5. Are there trails or connecting facilities nearby?	<ul style="list-style-type: none"> • No
	3.8.6. What pedestrian generators are in the area?	<ul style="list-style-type: none"> • None
	3.8.7. Are there any schools, parks, or recreation centers nearby?	<ul style="list-style-type: none"> • Sandy Mt. Baptist Church off Scotts Factory Road.
	3.8.8. Discuss surrounding neighborhood and characteristics (income, household vehicles, mode of transportation).	<ul style="list-style-type: none"> • Land use indicative of relatively low population and rural housing setting. • Presence of non-local originated trips. • Limited pedestrian and bicyclist activity.

4. Identified Concerns

4.1. Sight Distance Concerns

Reduced sight distance diminishes drivers' capability to spot approaching vehicles and correctly assess chances to enter and exit the minor street approaches to Courthouse Highway. This section specifically describes the obstacles related to sight distance were identified during the field evaluation performed by the RSA Team.

4.1.1. Sightline Obstructions from Scotts Factory Road

As shown in Figure 9, the view of vehicles traveling westbound from Scotts Factory Road is obstructed by tree foliage especially in the summer and fall months when the trees bear the most leaves. The prevalence of foliage during the late spring through early fall months, which can significantly impact sight lines, may be a contributing factor for the higher frequency of crashes recorded from May through November within the analysis period.



Figure 9. Tree foliage obstructing sight lines between through vehicles on Scotts Factory Road and turning vehicles on Courthouse Highway

4.1.2. Sightline Obstructions from Foursquare Road

Similar to the impact of foliage on sight lines, the residence on the southwest corner obstructs sight lines between northbound traveling drivers on Courthouse Highway and vehicles waiting at the stop line on eastbound Foursquare Road as shown Figure 10.



Figure 10. Building obstructing sight lines between turning vehicles on Foursquare Road and Courthouse Highway

Potential Safety Treatment(s): Landscape maintenance/Foliage Trimming, Pavement marking improvements, Geometric improvements

4.1.3. Limited Stop Sign Visibility on Foursquare Road

While Courthouse Highway allows uninterrupted through and turning movements onto the side streets (i.e., cross traffic does not stop), the Foursquare Road/Scotts Factory Road portion of the intersection is stop-controlled. During the RSA, it was mentioned by local stakeholders that had conducted a study previously of vehicle registrations involved in crashes at the intersection that these were mostly out-of-town drivers traveling through Foursquare Road. Most of the out-of-town trips on Foursquare Road originate from U.S. Route 460 in Ivor, a major route connecting Richmond to the Hampton Roads region. When approaching the intersection, drivers are meeting their first stop sign in over 14 miles driving since the last traffic control. Drivers may also not be expecting the stop sign and may miss the stop ahead warning signs as a result.

The stop sign at the approach of Foursquare Road as at the time of the RSA field visit was a 30" by 30" sign, which meets the recommended sign size in the 2009 MUTCD for this roadway type. However, the horizontal curvature of the approach and placement of the near side stop sign pose visibility concerns. The issue is further compounded by the unexpected change in roadway conditions, from a two-lane rural road with no stop control for 14 miles to a stop control approaching a higher volume road. These concerns, when grouped, may contribute to reasons why drivers are not complying with the stop control. During nighttime conditions, sign retro-reflectivity can raise drivers' awareness of the stop ahead when head lights illuminate the stop signs in the roadway.

Furthermore, the single stop ahead warning sign along Foursquare Road is in poor condition and may have experienced a loss in retroreflective properties in recent years.⁴ In the past, as recently as 2021, there were two "Stop Ahead" (MUTCD sign code W3-1) warning signs on the Foursquare Road approach to Courthouse Highway. Since then, one of the signs has been removed from the approach. The stop signs at the intersection and stop ahead signs approaching the intersection have been replaced with oversized stop signs (48" by 48") and dual-indicated stop ahead signs (48" by 48") to address issues identified in VDOT's Fatal Crash Review.

Potential Safety Treatments(s): Oversized stop sign, Stop ahead sign improvements, Stop ahead pavement markings.

4.2. Operational / Driver Behavior Concerns

4.2.1. Conflicting Turning Vehicle Movements

While there are sufficient turning radii at the intersection, it was observed that vehicles turning left onto northbound Courthouse Highway were positioned at the stop line, close to the centerline. Vehicles positioned close to the centerline made the receiving side of Foursquare Road for right turns from southbound Courthouse Highway narrow and challenging for larger vehicles turning right to stay on the pavement. These turning challenges could potentially lead to safety challenges associated with heavy vehicle turning movements and if not properly managed, collisions. During the RSA, this situation was observed multiple times as shown in Figure 11.

⁴ Atkinson, Jennifer E., Brian E. Chandler, Vernon Betkey, Karen Weiss, Karen Dixon, Anna Giragosian, Kelly Donoughe, and Cara O'Donnell. *Manual for Selecting Safety Improvements on High-Risk Rural Roads*. Report FHWA-SA-14-075. Federal Highway Administration, 2014.



Figure 11. Turning Movement showing Truck Turning Restrictions

The potential conflicts that could result from the turning movements of heavy vehicles at the intersection from Courthouse Highway is represented in AutoTurn and shown in Figure 12. The figure below indicates the need for geometric improvements for turns on and off Foursquare Road due to the restricted pavement and lane width for right turns from Courthouse Highway onto Foursquare Road. Additionally, the current stop line placement of Scotts Factory Road conflicts slightly with a 40-foot single-unit truck but falls well within the path of a WB-67 freight truck. Given some of the sight distance limitations on the Scotts Factory Road approach (discussed in Section 4.1.1) to the intersection versus the likelihood of a large freight truck turning left onto Scotts Factory Road, it may be more beneficial to keep the stop line at its current placement.

Moreover, it should be noted that drivers on the eastbound approach tend to position their vehicles close to the double yellow line to increase their sight distance around the house in the southwest corner of the intersection, as shown in Figure 12. This behavior results in vehicles being positioned closer to the turning conflict being discussed.

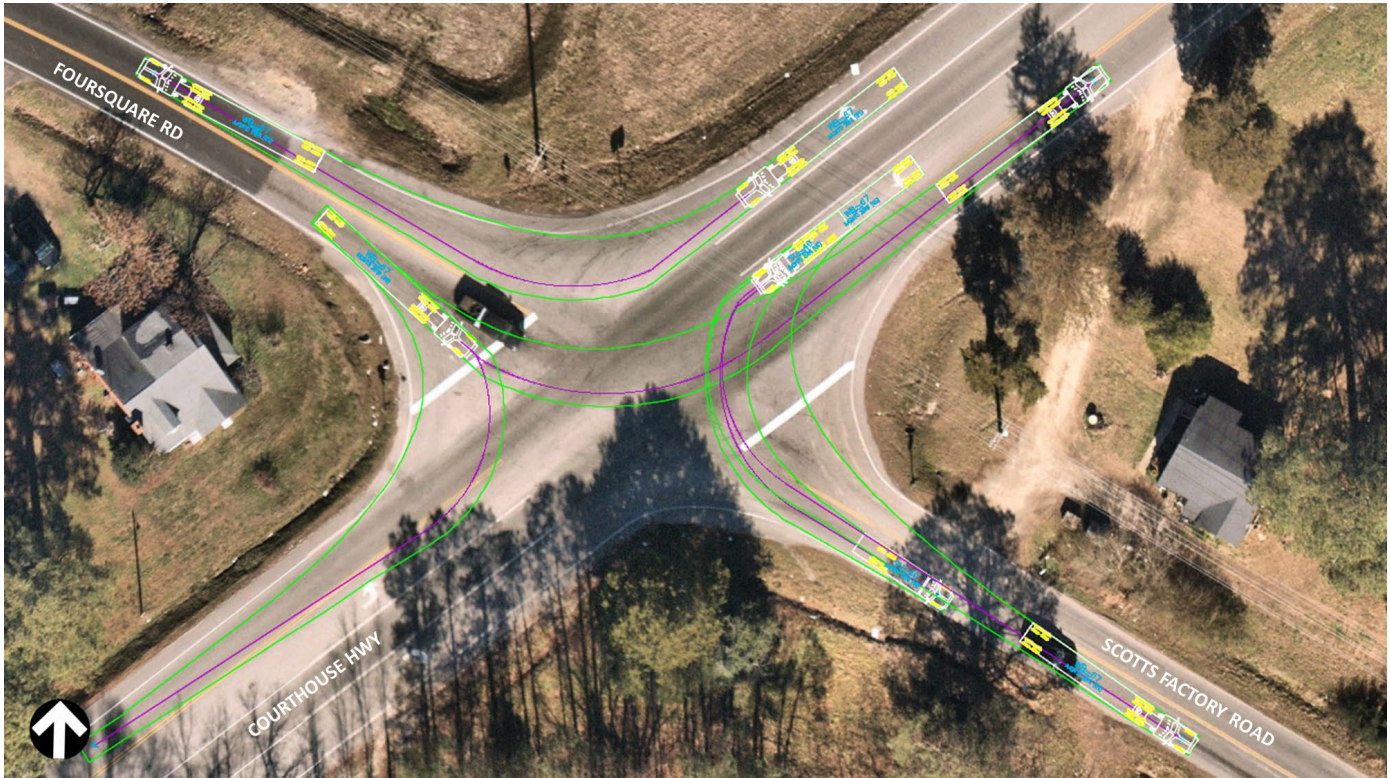


Figure 12. Turning Movement in AutoTurn on to and off of Foursquare Road

It should also be noted that the over-tracking of the southbound left turn across the Scotts Factory Road stop line is less of a concern than the over-tracking and pavement deterioration resulting from the southbound right turn onto Foursquare Road. This is because there are far fewer potential conflicts resulting from heavy vehicles turning left onto Scotts Factory Road while a driver is waiting to turn left onto Courthouse Highway or continue through on Foursquare Road. The predominant movement from Scotts Factory Road involves right turns onto northbound Courthouse Highway. Additionally, the heavy vehicle volumes are significantly less on Scotts Factory Road than they are on Foursquare Road. The Scotts Factory Road approach would need to be widened to fully accommodate both the southbound left turn and the westbound left turn or through movement. This pavement widening would require right-of-way acquisition, stormwater management, and utility relocation. Given the low volumes and infrequent heavy vehicle conflicts on the Scotts Factory Road approach, the safety benefits may not exceed the high costs and high impacts associated with widening the pavement.

Potential Safety Treatment(s): Pavement marking improvements, Geometric improvements.

4.3. Signing, Pavement Marking, and Lighting Concerns

4.3.1. Poor Sign Retroreflectivity

While the predominant lighting condition for crashes observed at the intersection have been daylight, a proactive approach to safety considers the potential for crashes during dark hours (with the approaches not lighted). The sign retroreflective for the stop ahead warning sign and stop sign on Foursquare Road as observed during the field visit has degraded, which can make sign visibility difficult in nighttime conditions. However, the stop signs have been replaced since the RSA was conducted as part of the VDOT Fatal Crash Review.



Figure 13. Pavement markings and stop signs without retroreflective element.

Potential Safety Treatment(s): Replace stop signs and stop ahead warning signs, upgrade stop signs to LED

4.3.2. Small Street Name Signs

Street name signs are essential for driver navigation, especially when drivers are unfamiliar with the area. With the existing street name signs at the intersection, drivers may occasionally struggle to read them, especially at a distance, or under non-daylight conditions due to the width of the intersection. Sudden braking or unexpected turning movements may increase the risk of collisions with other drivers entering the intersection. Additional concern due to the prevailing small street name signs is the associated confusion this may cause for out-of-town drivers who are mostly unfamiliar with the area.

Potential Safety Treatment(s): Street name sign upgrades

4.3.3. Pavement Deterioration

Pavement defects and gravel deposition can be found along the study area as seen in Figure 14. These features can pose property damage risks to drivers entering and exiting Foursquare Road, may cause drivers to abruptly slow or stop while exiting Foursquare Road, or drivers may lose traction while exiting the road. This presents a potentially hazardous situation, where drivers on the receiving side of the intersection can lose control of their vehicles and completely depart the roadway.

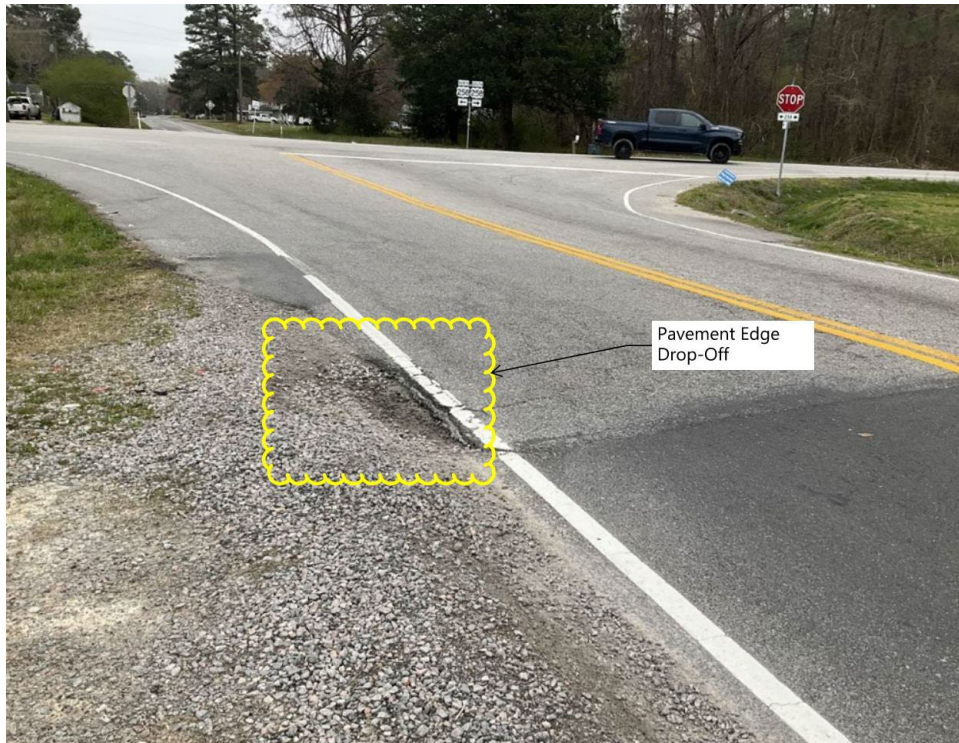


Figure 14. Pavement defects and gravel deposition on Foursquare Road

Potential Safety Treatment(s): Pavement marking improvements, Geometric improvements.

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). CRFs provide some indication of the potential benefit, or lack thereof, associated with 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. A CMF 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.⁵

This section also outlines the relative cost and implementation time frame for each potential countermeasure. Table 3 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 3. Implementation Time Frame and Relative Cost for Potential Countermeasures

Implementation Time		Cost	
Short	Within 1 year	Low	less than \$150,000
Intermediate	1 to 5 years	Medium	\$150,000 to \$500,000
Long	Longer than 5 years	High	greater than \$500,000

As discussed in Section 4, there has been a consistent crash pattern involving drivers approaching Courthouse Highway from westbound Foursquare Road. Based on the review of the crash narratives and observations during the field visit, drivers may not be expecting or be able to react to the stop sign before entering the intersection. The following section details initial short-term potential countermeasures for increasing driver compliance with the stop control on the Foursquare Road approach to Courthouse Highway. The following sections introduce two levels of stop sign compliance countermeasures that can be implemented if the initial short-term countermeasures are ineffective.

5.1. Tier 1 Countermeasures

5.1.1. Stop Sign Visibility Enhancements and Geometric Changes on Foursquare Road Approach

As mentioned in Section 4.1, the visibility of the stop signs, specifically on the Foursquare Road approach, continues to present a significant concern for drivers not complying with the stop control. This problem is particularly prevalent heading eastbound on Foursquare Road.

Crashes resulting from these primary operational and driver behavior safety concerns related to the study intersection could be mitigated through stop sign visibility enhancements which considers the geometric

⁵ American Association of State Highway and Transportation Officials. *Highway Safety Manual*. Washington, DC: American Association of State Highway and Transportation Officials, 2010.

configuration and turning movement of the intersection in relocating the stop sign. Numerous studies have underscored effectiveness of stop sign visibility enhancements in reducing the incidence of intersection-related crashes.⁶ A concept depicting potential improvements to intersection geometry for stop sign visibility improvements is shown in Figure 15.



Figure 15. High-level concept showing stop sign visibility improvements

Stop sign visibility enhancements at the intersection of Courthouse Highway and Foursquare Road/Scotts Factory Road include potentially reducing the turning radius and relocating the stop sign to provide better sight lines between approaching drivers on Foursquare Road. This improvement may require a right-turn truck restriction to reduce the potential for the stop sign being knocked over and the maintenance needed on the reduced corner. Another potential improvement could include repairing the pavement on the corner where right-turning trucks are off tracking near the edge of pavement on the receiving lane of Foursquare Road. This improvement could allow trucks to turn with more distance from the centerline where other large vehicles may be waiting to turn onto northbound Courthouse Highway. This improvement could then be paired with the new gore area and concrete island to help 'T' up the Foursquare Road approach to improve sight lines. During the RSA field visit, drivers who were familiar with the intersection were positioning their

⁶ Le, Thanh. Q., F. Gross, and T. Harmon. " Safety Effects of Low-Cost Systemic Safety Improvements at Signalized and Stop-Controlled Intersections". Presented at the 96th Annual Meeting of the Transportation Research Board, Paper No. 17-05379, Washington, D.C., (2017).

vehicles in this manner to better their sight lines looking southbound on Courthouse Highway. In addition to the sight line improvements, this treatment also reduces the potential for overlap in turning movements between large vehicles turning onto or off of Foursquare Road. It also allows for the placement of an additional stop sign in the roadway.

Priority: High

Implementation Time: Short

Cost: Medium

5.1.2. Oversized Stop Signs on Foursquare Road and Scotts Factory Road Approaches

As noted in Section 4.1.3, a significant number of crashes at stop-controlled intersections are linked to the driver's failure to perceive and react to the stop sign on the Foursquare Road approach.⁷ In addition to stop sign visibility improvements, employing oversized stop signs could serve as an additional countermeasure to increase driver awareness of the stop control. By using larger stop signs (MUTCD sign code R1-1) at the Foursquare Road/Scotts Factory Road approaches, the stop sign conspicuity can be significantly enhanced, thus potentially increasing driver compliance with the stop control. The use of a larger stop sign complies with the MUTCD (FHWA 2009), which discusses the usage of larger regulatory signs under Section 2B.03.

Implementation advantages include the cost-effectiveness of installing oversized stop signs. Often, existing signposts can be utilized, which help reduce installation costs. Furthermore, the increased stop sign size can be particularly beneficial for older drivers that experience degradation in visual abilities. Potential for crash reduction when paired with other systemic signing and pavement marking improvements at a stop controlled intersection is up to 10 percent for fatal and injury crashes, or 8 percent for total crashes.⁸ This countermeasure has since been implemented through the stop sign upgrades to 48" by 48" signs installed on May 16, 2024.

Priority: High

Implementation Time: Short

Cost: Low

5.1.3. Stop Ahead Signing Improvements on Foursquare Road and Scotts Factory Road Approaches

In the past, as recently as 2021, there were two "Stop Ahead" (MUTCD sign code W3-1) warning signs on the Foursquare Road approach to Courthouse Highway. Since then, one of the signs has been removed from the

⁷ Atkinson, Jennifer E., Brian E. Chandler, Vernon Betkey, Karen Weiss, Karen Dixon, Anna Giragosian, Kelly Donoughe, and Cara O'Donnell. *Manual for Selecting Safety Improvements on High-Risk Rural Roads*. Report FHWA-SA-14-075. Federal Highway Administration, 2014.

⁸ Le, Thanh. Q., F. Gross, and T. Harmon. " Safety Effects of Low-Cost Systemic Safety Improvements at Signalized and Stop-Controlled Intersections". Presented at the 96th Annual Meeting of the Transportation Research Board, Paper No. 17-05379, Washington, D.C., (2017).

approach. One recommendation to increase driver awareness of the approaching stop control would be to reinstall the "Stop Ahead" warning sign on the left side of the approach to Courthouse Highway. Additional signing improvements could include the installation of yellow retroreflective strips on both posts to increase driver conspicuity of the warning signs.

Furthermore, the current graphic stop ahead warning sign on Scotts Factory Road is placed at roughly 240 feet in advance of the stop line at Courthouse Highway. The current placement of the stop ahead warning sign aligns closely with a design speed of 50 mph per the 2009 MUTCD Table 2C-4. However, newer guidance in the 2023 MUTCD recommends stop ahead warning sign placement of 425 feet in advance of the stop. One recommendation to increase driver awareness of the approaching stop control would be to relocate the stop ahead warning signs at the distance recommended by newer guidance. Additional signing improvements could include the installation of yellow retroreflective strips on both posts to increase driver conspicuity of the warning signs. Similar to the updates mentioned in Section 5.1.2, the installation of oversized stop signs and dual indicated stop ahead signs by VDOT after the RSA help address some of the stop sign visibility concerns.

Priority: High

Implementation Time: Short

Cost: Low

5.1.4. Stop Ahead Pavement Markings on Foursquare Road and Scotts Factory Road Approaches

Another potential countermeasure to improve driver awareness of the stop control on the approaches to Courthouse Highway is the installation of "STOP AHEAD" pavement word markings.⁹ The implementation of "Stop Ahead" pavement markings is another potential countermeasure for both the Foursquare Road and Scotts Factory Road approaches to Courthouse Highway. The introduction of "Stop Ahead" pavement markings onto stop-controlled approaches provides an advanced warning for drivers, alerting them of the change in road condition, and the need to stop before entering the intersection.

The guidance provided in *NCHRP Report 600: Human Factors for Roadway Systems* indicates that pavement messaging can be particularly effective in raising driver awareness of new road conditions since drivers are constantly scanning the roadway in front of their vehicle and often are focused on the pavement ahead.¹⁰ This allows drivers to receive information without looking away from the roadway. Due to variation in types of drivers and their workload capacity (mental resources needed to handle multiple tasks while operating a

⁹ Torbic, D.J., D.J. Cook, J.M. Hutton, K.M. Bauer, and J.M. Sitzmann. "Advancing Innovating Intersection Safety Treatments for Two-Lane Rural Highways". FHWA-SA-16-003. Federal Highway Administration. Washington, D.C., (December 2015).

¹⁰ Campbell, John L., M. G. Lichty, J. L. Brown, C. M. Richard, J. S. Graving, J. Graham, M. O'laughlin, D. Torbic, and D. Harwood. *NCHRP report 600: Human factors guidelines for road systems*. Transportation Research Board of the National Academies, Washington, DC. 2012.

vehicle), having redundancy in messaging and multiple visual cues can help drivers perceive and react to the change in the road condition.



Figure 16. Example stop ahead pavement markings according to FHWA, Gross et al. (2008)

As shown in Figure 16, this added measure introduces an essential safety layer, emphasizing the need to stop, thereby enhancing the overall road safety at the intersection. This precautionary notification mitigates the risk of sudden stops or the likelihood of not stopping in time, crucial for enhancing driver awareness, especially for those unfamiliar with the area or who travel it infrequently. A 2015 study conducted on rural roads across the U.S. found that the implementation of stop ahead pavement markings contributed to a potential crash reduction of 66 percent for all crashes and a potential decrease in fatal and injury crashes of 69 percent.¹¹ Lane widths on both approaches are typically 11 feet and the word message "AHEAD" with 8-foot lettering is roughly 10.5 feet, meaning that the pavement word marking would fit in the existing lane width. If installed on both approaches, the stop ahead pavement markings should be installed adjacent to the stop ahead warning signs located 570 feet in advance of the stop on Foursquare Road, and 425 feet in advance of the stop on Scotts Factory Road.

Priority: High

Implementation Time: Short

Cost: Low

5.2. Tier 2 Countermeasures

The following recommendations outline countermeasures for enhancing stop sign visibility, intended as the subsequent course of action if initial Tier 1 interventions fail to sufficiently raise driver awareness or achieve the anticipated reduction in intersection-related crashes. Each proposed action in this tier is designed to further heighten stop-sign conspicuity and reinforce driver response to stop controls at the intersection.

5.2.1.LED Signs on Foursquare Road Approach

In addition to other stop sign conspicuity enhancements, light-emitting diode (LED) stop signs can command attention of both local and non-local drivers. The installation of an LED stop sign can have a potential angle crash reduction of 42 percent.¹² If Tier 1 countermeasures for stop sign conspicuity improvements do not adequately increase driver awareness of the stop control on the Foursquare Road approach to Courthouse Highway, an LED stop sign could supplement the existing countermeasures. Stop sign visibility and compliance on the Scotts Factory Road approach are good and have significantly fewer crashes than the Foursquare Road approach, meaning that LED stop signs may be better suited on the Foursquare Road approach. On the Foursquare Road approach, the LED sign could replace either the stop sign on the southwest corner (adjacent to the approach lane) or the two stop signs on both sides of the approach.



Figure 17. Example LED Stop Sign (Source: FHWA)

Given the identified challenge of stop control visibility, the installation of LED stop sign can be implemented to help with stop sign conspicuity. LED stop signs are equipped with small bright lights around the edges of the sign, enhancing the visibility of the stop sign significantly as shown in Figure 17. These signs are more noticeable to drivers, especially at night or in low-visibility conditions, thereby helping in better recognition and compliance with the stop control at the intersection. One potential downside to consider is that light

¹² Davis, G.A., J. Hourdos, H. Xiong. "Estimating the Crash Reduction and Vehicle Dynamics Effects of Flashing LED Stop Signs." Report No. 2014-02. Minnesota Department of Transportation. St. Paul, MN. (January 2014).

emitted from the LEDs could shine into the home adjacent to the intersection, which could be disruptive to the residents during dark hours.

Priority: Medium

Implementation Time: Intermediate

Cost: Low

5.2.2. Transverse Rumble Strips on Foursquare Road Approach

Transverse rumble strips could serve as an additional safety countermeasure to alert drivers of the upcoming stop on the Foursquare Road approach to Courthouse Highway. Essentially, these strips are grooves or elevated patterns on the roadway, positioned perpendicular to the direction of travel. Transverse rumble strips are installed in the roadway to provide tactile feedback to drivers traveling over them, especially for those that may be fatigued or distracted. This feedback ultimately alerts the driver of a change in the roadway conditions, which is a stop sign in the case of the Foursquare Road approach to Courthouse Highway. However, the elevated profile of the transverse rumble strips requires frequent maintenance. Additionally, the sound the rumble strips make when vehicles drive over them may also be loud and bothersome for nearby residents. There is a residence on two corners of the intersection that may be disturbed by the noise generated.



Figure 18. Example Rumble Strips (Source: FHWA)

In terms of composition, the rumble strips are typically placed in closely arrayed groups across the roadway as shown in Figure 18. Transverse rumble strips can be integrated in a variety of methods. For this location, epoxy strips on the existing pavement surface are recommended. Together with the “Stop Ahead” warning signage, these pavement markings provide a tactile and audible warning to drivers, reinforcing their awareness of an impending stop. While studies show that transverse rumble strips have a potential to increase total crashes by 7 percent, the crash reduction potential for fatal and injury crashes is 9 percent,

and for fatal and serious injuries, the reduction potential is 35 percent.¹³ Reasoning for the potential increase in total crashes but reduction in injury and fatal crashes is reflective of the potential increase in less severe rear end crashes, versus the impact on stop sign running angle crashes.

The placement of the first set of transverse rumble strips on the Foursquare Road approach would be at the point of perception of the stop ahead warning sign, 180' in advance of the sign. The other set should be placed roughly 300 feet before the stop sign itself, per best practices identified by the Virginia Transportation Research Council.¹⁴ However, given the residence on the southwest corner of the intersection (shown in Figure 19), placing the rumble strips 300 feet before the stop may not be possible given the noise generated when vehicles drive over them. Alternatively, the first set of rumble strips could be installed at a distance of 400 feet and the second set at 180 feet in advance of the in advance of the stop ahead warning signs (W3-1). Best practices on the placement and spacing of transverse rumble strips for stop-controlled intersections varies significantly among states.¹⁵



Figure 19. Overview of transverse rumble strip placement on Foursquare Road approach.

Priority: Medium

Implementation Time: Intermediate

Cost: Low

¹³ Srinivasan, R., J. Baek, and F. Council, "Safety Evaluation of Transverse Rumble Strips on Approaches to Stop Controlled Intersections in Rural Areas", Presented at the 89th Annual Meeting of the Transportation Research Board, Washington, DC, 2010.

¹⁴ Cottrell Jr, Benjamin H., and In-Kyu Lim. "Systemic Low-Cost Countermeasures for an Unsignalized Intersection Safety Improvement Plan for Virginia." No. VTRC 19-R5. 2018.

¹⁵ Hallmark S., Oneyar, N., Veneziano D., and Naraghi H. "Transverse Rumble Strips at Rural Intersections." Institute for Transportation, Iowa State University. Ames, IA. 2023 https://rosap.nrl.bts.gov/view/dot/67875/dot_67875_DS1.pdf

5.2.3. Install Supplemental Intersection Pavement Markings on Courthouse Highway Approaches

Supplemental intersection pavement markings are added visual cues on the roadway designed to alert drivers about an approaching intersection on the uncontrolled approach of the potential presence of drivers entering or exiting the intersection from or onto the side streets.



Figure 20. Supplemental Intersection Pavement Markings, Torbic et al. (2015)

As shown in Figure 20, these pavement markings are generally arranged in sets and strategically placed along the driver's direction of travel for optimal visibility. The first set of these markings typically carries a warning message instructing drivers to slow down to the speed limit of the roadway, for instance, "SLOW, 45 MPH". This initial set of pavement markings provides an essential alert for drivers along Courthouse Highway, encouraging them to adjust their speed to react to potential turning movements at the upcoming intersection. The second set of markings, located closer to the intersection, provides a symbolic depiction of the intersection's configuration. With the four-legged intersection, the pavement markings would show the intersecting roads as a cross symbol.

A 2015 study found that the treatment was cost-effective and had a substantial impact on intersection crashes, with a potential for a 46 percent reduction in all crashes and 49 percent reduction in fatal and injury

crashes.¹⁶ Similar to the benefits that “Stop Ahead” pavement markings provide, pavement messaging can be particularly effective in raising driver awareness of new road conditions since drivers are constantly scanning the roadway in front of their vehicle and often are focused on the pavement ahead.¹⁷

The recommended pattern length based on the posted speed limit of 55 mph on Courthouse Highway is 485 feet. This represents the placement guidance of the supplementary markings upstream of the stop control intersection on Foursquare Road.

Priority: Low

Implementation Time: Intermediate

Cost: Low

5.3. Tier 3 Countermeasures

The following recommendations outline countermeasures for general intersection safety, intended as the subsequent course of action if initial Tier 1 and Tier 2 interventions fail to sufficiently raise driver awareness of the minor road stop control or achieve the anticipated reduction in intersection-related crashes.

5.3.1. Intersection Control Flashing Beacon

Incorporating a flashing beacon on the stop sign at the Foursquare Road approach to the intersection could mitigate crashes resulting from drivers' unawareness of the stop controls. For drivers who may be unfamiliar with the road layout or complacent due to the unvaried conditions on the Foursquare Road stretch, these flashing beacons serve as an additional cue for driver attention for action, prompting them to slow down and prepare for the stop.

¹⁶ Torbic, D.J., D.J. Cook, J.M. Hutton, K.M. Bauer, and J.M. Sitzmann. "Advancing Innovating Intersection Safety Treatments for Two-Lane Rural Highways". FHWA-SA-16-003. Federal Highway Administration. Washington, D.C., (December 2015).

¹⁷ Campbell, John L., M. G. Lichty, J. L. Brown, C. M. Richard, J. S. Graving, J. Graham, M. O'laughlin, D. Torbic, and D. Harwood. *NCHRP report 600: Human factors guidelines for road systems*. Transportation Research Board of the National Academies, Washington, DC. 2012.



Figure 21. Example Stop Sign Flashing Beacons, Srinivasan et al. (2008)

Along Foursquare Road, a non-actuated (stop sign flashing beacon) warning system could be installed at the intersection as a cost-effective safety improvement. These can be posted above the stop signs and constantly flashing as shown in . This can lead to crash reductions of about 5 percent for all crashes and 10 percent for fatal and injury crashes.¹⁸ Given the similarity in purpose between the flashing beacon and the flashing LED sign, only one of these countermeasures should be selected. While crash reduction potential is higher for the flashing LED sign than the beacon, implementation needs should be considered in the ultimate selection of the countermeasures.

Alternatively, a red overhead flashing beacon could be mounted above the intersection as a supplemental element to reinforce awareness of existing stop signs at the approaches of both Foursquare Road and Scotts Factory Road. Per both the 2009 and 2023 editions of the MUTCD (Chapter 4L and 4S, respectively), an intersection control beacon shall have the assembly of a flashing yellow beacon for the uncontrolled, major road approaches and a flashing red for the stop-controlled approaches. Both editions of the MUTCD also state that intersection control beacons can be used when the intersection has experienced a high crash rate or has unique physical conditions.

Priority: Low

Implementation Time: Intermediate

Cost: Low

¹⁸ Srinivasan, Raghavan; Daniel Carter; Kimberly Eccles; Bhagwant Persaud; Nancy Lefler; Craig Lyon; and Roya Amjadi, "Safety Evaluation of Flashing Beacons at STOP-Controlled Intersections", Federal Highway Administration, FHWA-HRT-08-044, Washington, D.C., December 2007.

5.3.2.Changes to Intersection Control and Geometry

All-Way Stop Control

An all-way stop control requires all vehicles, irrespective of their direction, to come to a complete stop before progressing through the intersection. However, this option might be ruled out considering that the volumes on Courthouse Highway are significantly higher than the side street approaches. From a geometric standpoint, the width of the Courthouse Highway approaches also poses a challenge considering the right and left turn lanes with stop sign placement. This means that it could be possible for drivers to not recognize the stop sign outside of their cone of vision (especially when traveling at 55 mph).

Based on the crash data and the turning movement data, the intersection was reviewed for an all-way stop control. The 2009 MUTCD criteria for an all-way stop control and corresponding intersection performance for each is outlined below:

The following criteria should be considered in the engineering study for a multi-way STOP sign installation:

- A. *Where traffic control signals are justified, the multi-way stop is an interim measure that can be installed quickly to control traffic while arrangements are being made for the installation of the traffic control signal. - Not Applicable*
- B. *Five or more reported crashes in a 12-month period that are susceptible to correction by a multi-way stop installation. Such crashes include right-turn and left-turn collisions as well as right-angle collisions. - Based on the provided crash data, there were seven angle crashes at the intersection in 2023, all involving drivers on Foursquare Road not seeing and/or stopping for the stop sign.*
- C. *Minimum volumes:*
 1. *The vehicular volume entering the intersection from the major street approaches (total of both approaches) averages at least 300 vehicles per hour for any 8 hours of an average day; and - Volumes on Courthouse Highway do exceed 300 vehicles per hour for at least 8 hours.*
 2. *The combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches (total of both approaches) averages at least 200 units per hour for the same 8 hours, with an average delay to minor-street vehicular traffic of at least 30 seconds per vehicle during the highest hour; but - Combined volumes on Foursquare Road and Scotts Factory Road only exceed 200 vehicles per hour from 7:15 to 8:15 am.*
 3. *If the 85th-percentile approach speed of the major-street traffic exceeds 40 mph, the minimum vehicular volume warrants are 70 percent of the values provided in Items 1 and 2.*

Using 70 percent of the 300 vehicles per hour on Courthouse Highway and 200 vehicles per hour on combined Foursquare Road and Scotts Factory Road:

- *Volumes on Courthouse Highway exceed 210 vehicles per hour from 5:15 am through 7:15 pm (14 hours)*

- Combined volumes on Foursquare Road and Scotts Factory Road exceed 140 vehicles per hour from 5:45 am to 9:15 am (3.5 hours) and 2:00 pm to 6:00 pm (4 hours)

D. Where no single criterion is satisfied, but where Criteria B, C.1, and C.2 are all satisfied to 80 percent of the minimum values. Criterion C.3 is excluded from this condition. Volume criteria is not satisfied at 80 percent.

This intersection does not meet the MUTCD traffic volume criteria for an all-way stop control, though it comes close to meeting the 8-hour minor street volume criteria using the 70 percent rule for high-speed roadways. While it does meet the crash criteria for an all-way stop control, an all-way stop configuration would not correct the stop sign visibility problem on the Foursquare Road approach. However, requiring the major road approaches of Courthouse Highway to stop at the intersection could potentially provide some safety benefits if implemented with additional improvements, including consideration of stop sign conspicuity on all approaches and changes to intersection geometry and lane configurations. Installing a stop sign on the major road approach means that drivers would stop and potentially avoid a collision with drivers on Foursquare Road who may miss or disregard the stop sign.

The northbound Courthouse Highway approach has similar characteristics to the current challenges of Foursquare Road – drivers connecting from US 460 in Windsor would not have been required to stop for roughly 13 miles and may not be expecting a stop sign. For this reason, any introduction of an all-way stop would need to have safety countermeasures similar to those being recommended on Foursquare Road, potentially including (but not limited to), oversized stop signs and stop ahead warning signs, stop ahead pavement markings, transverse rumble strips, and LED stop signs. Additionally, the volumes on Courthouse Highway are not balanced with the minor road approaches. During the afternoon hours of 2:00 to 6:00 pm, vehicles on Courthouse Highway exceed volumes from the side street approaches at a 3:1 ratio. This imbalance can lead to rolling stops and noncompliance with the stop sign on Courthouse Highway.

There may also need to be some consideration of lowering the posted speed limit on Courthouse Highway to 45 mph, which is the speed limit north of Waterworks Road as drivers enter or leave the Town of Smithfield. This would mean shifting the 45 mph speed limit an additional 1.25 to 1.5 miles south of the existing change in speed limit. It should also be noted that changing the posted speed limit alone is often not enough to change driver behavior and compliance with the speed limit. NCHRP Synthesis 600 reported that the posted speed limit is not the primary reason why people drive at a certain speed.¹⁹ Most drivers will drive at a speed they consider appropriate, and it is dependent on factors including driver perception of risk, traffic flow (i.e., how fast others are going around them), and road design. Courthouse Highway is currently designed for 55 mph and features 12-foot lanes, edge lines, and 1 to 4-foot shoulders throughout, which

¹⁹ Campbell, John L. *Human factors guidelines for road systems*. Vol. 600. Transportation Research Board, 2012.

may contribute to a driver's speed choice, potentially remaining 55 mph, even after lowering the speed limit to 45 mph.

Lastly, an all-way stop may not be operationally efficient as the population of Smithfield and Isle of Wight County grows. For this reason, a discussion of future conversion to a roundabout is included in Section 5.3.3.

Changes to Geometry and Lane Assignments

An all-way stop control would also require changes to the geometry and lane assignments to simplify intersection operations. Both Courthouse Highway approaches currently have through, right, and left turn-only lanes. These lanes would have to be modified or eliminated to make an all-way stop a feasible solution. Specifically, the left turn lane would need to be consolidated with the through lanes. The additional space gained by eliminating the left turn lane could then be utilized for an offset right turn lane with a stop control. However, the slight intersection offset that would be created by the median and geometric change to the Foursquare Road approach proposed in Section 5.1.1 would need to be reevaluated with these improvements.

It should also be noted that the addition of an offset right turn lane would not yield a significant safety benefit but would help with intersection operations. Traditionally, an offset right turn lane is implemented in order to improve sight lines between the driver stopped on the minor road approach and the through-traveling driver on the major road when a vehicle in the right turn lane obstructs that sight line. This helps the stopped driver on the minor road adequately judge a gap in traffic to enter the intersection. With an all-way stop, this sight line is not critical for gap acceptance, as the major road approach is required to stop.

An all-way stop is included as a Tier 3 improvement at this time since safety concerns are not related to inadequate gap acceptance on the minor street approaches, but rather stop sign conspicuity on the Foursquare Road approach. Nonetheless, if the Tier 1 and 2 countermeasures proposed for improving stop sign visibility do not improve safety at the intersection, then an all-way stop control with changes to lane assignments and intersection geometry could be considered.

Priority: Low

Implementation Time: Intermediate

Cost: High

5.3.3.Roundabout

A potential long-term improvement at the intersection could include redesigning it as a roundabout, especially as the population of the greater Smithfield area grows and traffic volumes increase. A roundabout reduces the overall number of vehicle conflict points at the intersection of Courthouse Highway and Foursquare Road/Scotts Factory Road from 16 to 8. The safety benefits realized from roundabouts are significant and can have a 71 percent reduction in crashes when converting a rural stop-controlled

intersection to a roundabout.²⁰ In fact, a study conducted by FHWA in 2012 found that roundabouts on high-speed rural roads have a more significant safety impact compared to those in urban and suburban environments.²¹ This may be implemented as a standalone project or phased in after the installation of an all-way stop.

Priority: Low

Implementation Time: Long

Cost: High

5.4. Other Intersection Countermeasures

5.4.1. Refurbish Pavement Markings

Improving driver visibility of the existing pavement markings at and close to the intersection through refurbishment could be a critical step in better guiding the drivers. The existing pavement markings at the intersection vary in condition, ranging from fair to good. Refurbishing existing pavement markings at the intersection would help driver visibility and awareness of lane designations and stopping locations. It will also create increased driver alertness about potential hazards, while providing critical information about the roadway layout.

Currently, the pavement markings in need of refurbishment include the centerline on the southbound Courthouse Highway approach and the centerline on the Scotts Factory Road approach. Other areas where heavy truck movements cross over the pavement markings could also use refurbishment, such as the edge line for right turns onto Foursquare Road.

Priority: Medium

Implementation Time: Short

Cost: Low

5.4.2. Street Name Sign Improvements

The current street name signs are on a blue background, which does not align with guidance in the Virginia Supplement to the MUTCD, which states that they should be green unless an alternative color is used to indicate the jurisdictional authority for the road (a non-state road). Additionally, the width of the intersection may justify street name signs with lettering height greater than the 6-inches required for the initial upper case letter and 4.5-inches for all other letters on two-lane roads. On multilane roads with speed limits greater than 40 mph, an initial 8-inch upper case letter with 6-inch lowercase letters is recommended.

²⁰ Rodegerdts, L. A., Blogg, M., Wemple, E., Myers, E., Kyte, M., Dixon, M., List, G., Flannery, A., Troutbeck, R., Brilon, W., Wu, N., Persaud, B., Lyon, C., Harkey, D., and Carter, D., "NCHRP Report 572: Applying Roundabouts in the United States." Washington, D.C., Transportation Research Board, National Research Council. 2007.

²¹ Isebrands, Hillary, and Shauna Hallmark. "Statistical analysis and development of crash prediction model for roundabouts on highspeed rural roadways." Transportation research record 2312, no. 1. 2012.

There is also potential to add a green guide sign for wayfinding on the Foursquare Road approach for the Town of Smithfield. Given the significant traffic from out-of-town, a guide sign (MUTCD sign code D1-1 or D1-1a) could be installed between the stop ahead warning sign and stop sign on the Foursquare Road approach, at least 200 feet in advance of the stop (see MUTCD Figure 2A-4). In addition to providing wayfinding guidance, it can also help reiterate to drivers that they are approaching a change in the roadway (intersection). These visual cues provided with the intersection warning signs, guide signs, and "Stop Ahead" pavement markings, all greatly impact the amount of information a driver must process. All of these treatments together may help a driver may perceive the need to slow down to process such information and stop at the intersection.

Priority: Low

Implementation Time: Short

Cost: Low

5.4.3. Landscaping Maintenance / Foliage Trimming

As noted in Section 4.1, foliage from trees poses sight distance concerns on the minor road approaches, as well as corn grown on the northwest corner of the intersection. General maintenance of foliage within right-of-way is essential to improving sight distance for drivers. While the RSA was conducted in March, foliage was observed as potential sight line obstructions that require regular trimming, especially in peak growth periods from May through September. Foliage trimming within the public right-of-way should be done regularly, along with VDOT coordination with any property owners that have foliage outside of the public right-of-way but obstruct driver sight lines on the side street approaches to Courthouse Highway.

Priority: Medium

Implementation Time: Short

Cost: Low

5.5. Treatments reviewed but not currently recommended.

5.5.1. Traffic Signal

Due to the nature of the intersection traffic volumes and crash history, the study team investigated the potential for a traffic signal installation. Upon review of existing turning movement counts, minor road volumes from Foursquare/Scotts Factory Road throughout the course of the day are not typical of what would be required for a traffic signal. Despite the volume requirements not being met, additional considerations such as crash history and potential safety impacts should also be reviewed.

In the 2009 version of the 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).²² 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-387.²³ The crash history warrant has now been updated in the new 11th Edition of the MUTCD (2023) but has not yet been formally adopted by VDOT. 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. 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 four-leg intersection are listed below:

- 10 angle and pedestrian crashes in a single year (all severities); OR
- 6 fatal/injury angle and pedestrian crashes in a single year; OR
- 16 angle and pedestrian crashes in three years (all severities); OR
- 9 fatal/injury angle and pedestrian crashes in three years.

The intersection of Courthouse Highway and Foursquare Road/Scotts Factory Road does meet the required crash thresholds for signalization per IA-19, with 10 fatal and injury crashes between January 1, 2021, and December 31, 2023. However, the clear safety concerns with driver visibility and compliance with the stop control represents why a signal is not recommended currently. Given the toolbox of stop sign visibility enhancements, the risk of angle crashes could significantly be reduced with the implementation of the safety countermeasures recommended.

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.²⁴ 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).²⁵ 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.²⁶ 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

²² Federal Highway Administration. *Manual on Uniform Traffic Control Devices*. Section 4C.08. Federal Highway Administration, Washington, D.C. 2009.

²³ Virginia Department of Transportation. *IIM TE-387 Signal Justification Reports (SJR) For New and Reconstructed Signals*. Virginia Department of Transportation. 2019

²⁴ National Academies of Sciences, Engineering, and Medicine. *A Guide for Reducing Collisions at Signalized Intersections*. Washington, DC: The National Academies Press. 2004.

²⁵ National Academies of Sciences, Engineering, and Medicine. *Accident Modification Factors for Traffic Engineering and ITS Improvements*.

²⁶ Agent, K.R. and Green, E.R. *Crash history after installation of traffic signals: warranted vs. unwarranted*" University of Kentucky Transportation Research Center. 2008.

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 Courthouse Highway and Foursquare/Scotts Factory Road is not justified given the enumerated safety concerns.

Priority: N/A

Cost: N/A

5.5.2. Intersection Lighting

There is currently no lighting present at the intersection. Six crashes occurred during dark hours, with two deer crashes, one roadway departure crash, and three angle crashes resulting from drivers not stopping for the stop sign on the minor road approaches. All three of the angle crashes during dark hours occurred recently (2023). Although there is not a strong pattern of nighttime crashes, the study team reviewed lighting as a potential safety countermeasure given the effectiveness in reducing crashes at rural intersections (33 percent reduction in angle crashes).²⁷

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.²⁸ 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*.²⁹ 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, which are lighting classes for roadways with higher vehicle speeds and volumes, ambient light, pedestrian, and bicyclist activity, and could be undivided, have on-street parking, or high intersection density.

²⁷ 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.

²⁸ Virginia Department of Transportation. *IIM TE-390 Guidance on Light Emitting Diode (LED) Exterior Lighting*. Virginia Department of Transportation. 2019

²⁹ Gibbons, Ronald B. et al. *Design Criteria for Adaptive Roadway Lighting*. Report No. HRT-14-051, Federal Highway Administration, Washington, D.C. 2014.

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.

Priority: N/A

Cost: N/A

6. Conclusions

The study team has taken into consideration the existing conditions 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 the potential benefits of such countermeasures are unable to be determined.

Table 3 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		Cost	
Short	Within 1 year	Low	less than \$150,000
Intermediate	1 to 5 years	Medium	\$150,000 to \$500,000
Long	Longer than 5 years	High	greater than \$500,000

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	Stop Sign Visibility Enhancements/Intersection Geometry Improvements	Stop Sign Visibility Improvement	0.92	\$320,000	per project
Short	Oversized Stop Signs	Stop Sign Visibility Improvement	0.92	\$10,000	per approach
Short	Stop Ahead Signing Improvements	Stop Sign Visibility Improvement	0.92	\$10,000	per approach
Short	Stop Ahead Pavement Markings	Stop Sign Visibility Improvement	0.34**	\$10,000	per approach
Short	Smithfield Guide Sign	Wayfinding	N/A	\$10,000	per project
Short	Street Name Sign Upgrades	Wayfinding	N/A	\$10,000	per project
Short	Refurbish Pavement Markings	Intersection Safety	0.92	\$10,000	per project
Short	Landscaping Maintenance / Foliage Trimming	Sight Distance	N/A	20,000	per project (with reg maintenance)

**Indicates is from CMF Clearinghouse but not included in the Virginia Preferred CMF list

As discussed in the introduction to Section 5, the countermeasures will be implemented in Tiers starting with initial short-term treatments in Tier 1, and Tier 2 additional countermeasures that can be implemented if the initial efforts are ineffective. Table 6 outlines the Tier 2 countermeasures to be implemented if Tier 1 countermeasures alone have not reduced angle crashes caused by stop sign running on Foursquare Road.

Table 6. Tier 2 Countermeasures for Stop Sign Visibility

Time Needed to Implement	Countermeasure	Addresses Concern(s)	CMF	Cost	Unit
Intermediate	LED Stop Sign	Stop Sign Visibility Improvement	0.59**	\$40,000	per sign
Intermediate	Transverse Rumble Strips	Stop Sign Visibility Improvement	0.65* (KA)	\$50,000	per approach
Intermediate	Intersection Pavement Markings	Intersection Safety/Conflict Awareness	0.54**	\$10,000	per approach

*Indicates is from a Virginia preferred CMF study list but has been selected from documented study based on study area characteristics.

**Indicates is from CMF Clearinghouse but not included in the Virginia Preferred CMF list

As stated in Section 5.3, Tier 3 countermeasures have been included as the subsequent course of action if initial Tier 1 and Tier 2 interventions fail to sufficiently raise driver awareness of the minor road stop control or achieve the anticipated reduction in intersection-related crashes. Table 7 outlines potential intermediate and long-term improvements if intersection safety is not improved adequately by the recommendations in Tier 1 and 2.

Table 7. Tier 3 Countermeasures for Intersection Safety

Time Needed to Implement	Countermeasure	Addresses Concern(s)	CMF	Cost	Unit
Intermediate	Intersection Control Flashing Beacon	Stop Sign Visibility Improvement, Intersection Safety	0.9**	\$90,000	per project
Long	All-Way Stop Control with Offset Right Turn Lanes	Intersection Safety	0.319	\$650,000~	per project
Long	Roundabout	Intersection Safety	0.29*	\$6M+	per project

~Includes cost for intersection geometry improvements

*Indicates is from a Virginia preferred CMF study list but has been selected from documented study based on study area characteristics.

**Indicates is from CMF Clearinghouse but not included in the Virginia Preferred CMF list

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.

Appendix A – Turning Movement Data



Default Comments
 Change These in The Preferences Window
 Select File/Preference in the Main Scree
 Then Click the Comments Tab

File Name : 620&258 24 Hr count
 Site Code : 00258620
 Start Date : 2/20/2024
 Page No : 1

Groups Printed- Unshifted

Start Time	258 From North					Scotts Factory From East					258 From South					Four Square From West					Int. Total
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	
11:30 AM	14	22	8	0	44	6	1	4	0	11	1	40	0	0	41	0	0	20	0	20	116
11:45 AM	21	26	4	0	51	7	3	3	0	13	4	36	3	0	43	3	2	14	0	19	126
Total	35	48	12	0	95	13	4	7	0	24	5	76	3	0	84	3	2	34	0	39	242
12:00 PM	21	37	8	0	66	6	2	2	0	10	1	28	2	0	31	1	4	18	0	23	130
12:15 PM	15	35	4	0	54	6	2	4	0	12	0	34	0	0	34	3	1	9	0	13	113
12:30 PM	15	31	4	0	50	9	2	3	0	14	1	28	0	0	29	1	3	26	0	30	123
12:45 PM	25	35	6	0	66	6	1	0	0	7	2	21	1	0	24	0	1	18	0	19	116
Total	76	138	22	0	236	27	7	9	0	43	4	111	3	0	118	5	9	71	0	85	482
01:00 PM	16	27	10	0	53	7	3	0	0	10	4	30	2	0	36	1	0	17	0	18	117
01:15 PM	27	28	7	0	62	12	5	3	0	20	1	25	0	0	26	2	2	24	0	28	136
01:30 PM	14	38	7	0	59	6	3	2	0	11	2	19	1	0	22	2	3	10	0	15	107
01:45 PM	23	38	5	0	66	7	3	4	0	14	2	27	1	0	30	2	1	8	0	11	121
Total	80	131	29	0	240	32	14	9	0	55	9	101	4	0	114	7	6	59	0	72	481
02:00 PM	22	40	5	0	67	6	2	3	0	11	3	17	1	0	21	0	7	19	0	26	125
02:15 PM	17	35	4	0	56	6	3	3	0	12	3	16	0	0	19	0	1	14	0	15	102
02:30 PM	30	54	8	0	92	5	6	3	0	14	4	40	0	0	44	0	1	29	0	30	180
02:45 PM	28	44	4	0	76	12	4	4	0	20	7	75	2	0	84	1	2	11	0	14	194
Total	97	173	21	0	291	29	15	13	0	57	17	148	3	0	168	1	11	73	0	85	601
03:00 PM	22	54	6	0	82	9	12	11	0	32	5	52	2	0	59	0	3	24	0	27	200
03:15 PM	33	42	5	0	80	5	8	3	0	16	3	32	0	0	35	1	2	11	0	14	145
03:30 PM	29	52	7	0	88	6	7	3	0	16	9	56	3	0	68	0	1	18	0	19	191
03:45 PM	33	52	12	0	97	6	9	4	0	19	3	41	1	0	45	2	5	22	0	29	190
Total	117	200	30	0	347	26	36	21	0	83	20	181	6	0	207	3	11	75	0	89	726
04:00 PM	38	44	9	0	91	11	7	6	0	24	1	42	3	0	46	0	3	11	0	14	175
04:15 PM	39	57	5	0	101	10	12	2	0	24	0	38	1	0	39	5	3	21	0	29	193
04:30 PM	24	43	13	0	80	9	5	6	0	20	5	29	1	0	35	3	4	20	0	27	162
04:45 PM	29	54	14	0	97	4	7	6	0	17	2	40	4	0	46	1	5	15	0	21	181
Total	130	198	41	0	369	34	31	20	0	85	8	149	9	0	166	9	15	67	0	91	711
05:00 PM	29	40	3	0	72	8	5	4	0	17	2	45	2	0	49	2	7	23	0	32	170
05:15 PM	29	49	8	0	86	6	6	4	0	16	3	41	0	0	44	2	2	18	0	22	168
05:30 PM	29	38	10	0	77	4	7	3	0	14	4	31	1	0	36	1	3	23	0	27	154
05:45 PM	24	35	9	0	68	5	3	2	0	10	6	34	0	0	40	1	2	13	0	16	134
Total	111	162	30	0	303	23	21	13	0	57	15	151	3	0	169	6	14	77	0	97	626
06:00 PM	22	32	6	0	60	8	4	2	0	14	0	20	2	0	22	1	1	9	0	11	107
06:15 PM	18	29	4	0	51	5	4	5	0	14	0	8	0	0	8	1	4	13	0	18	91
06:30 PM	18	35	5	0	58	2	1	0	0	3	2	21	2	0	25	2	1	10	0	13	99
06:45 PM	7	11	12	0	30	4	3	1	0	8	0	15	0	0	15	0	3	7	0	10	63
Total	65	107	27	0	199	19	12	8	0	39	2	64	4	0	70	4	9	39	0	52	360
07:00 PM	9	11	3	0	23	3	0	3	0	6	1	6	0	0	7	0	1	3	0	4	40
07:15 PM	2	9	5	0	16	7	2	1	0	10	0	15	0	0	15	1	3	9	0	13	54
07:30 PM	3	9	2	0	14	1	1	2	0	4	0	11	0	0	11	0	4	0	0	4	33
07:45 PM	12	14	3	0	29	0	0	3	0	3	1	11	0	0	12	0	1	5	0	6	50
Total	26	43	13	0	82	11	3	9	0	23	2	43	0	0	45	1	9	17	0	27	177
08:00 PM	10	13	2	0	25	2	3	1	0	6	1	13	4	0	18	0	0	1	0	1	50



File Name : 620&258 24 Hr count
 Site Code : 00258620
 Start Date : 2/20/2024
 Page No : 2

Groups Printed- Unshifted

Start Time	258 From North					Scotts Factory From East					258 From South					Four Square From West					Int. Total
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	
08:15 PM	9	14	3	0	26	2	3	0	0	5	1	8	0	0	9	0	2	8	0	10	50
08:30 PM	7	10	3	0	20	3	1	0	0	4	0	8	0	0	8	0	0	1	0	1	33
08:45 PM	4	6	2	0	12	3	0	0	0	3	0	1	0	0	1	0	0	11	0	11	27
Total	30	43	10	0	83	10	7	1	0	18	2	30	4	0	36	0	2	21	0	23	160
09:00 PM	5	6	5	0	16	1	1	0	0	2	3	8	1	0	12	0	0	5	0	5	35
09:15 PM	5	7	3	0	15	0	4	0	0	4	1	1	0	0	2	0	2	5	0	7	28
09:30 PM	5	5	1	0	11	3	0	0	0	3	1	3	0	0	4	0	0	7	0	7	25
09:45 PM	5	5	2	0	12	2	0	0	0	2	0	3	1	0	4	0	0	3	0	3	21
Total	20	23	11	0	54	6	5	0	0	11	5	15	2	0	22	0	2	20	0	22	109
10:00 PM	5	5	4	0	14	1	0	0	0	1	0	5	0	0	5	0	1	0	0	1	21
10:15 PM	2	4	3	0	9	1	0	0	0	1	0	4	0	0	4	1	1	4	0	6	20
10:30 PM	3	4	2	0	9	1	1	0	0	2	0	9	0	0	9	0	0	4	0	4	24
10:45 PM	1	4	1	0	6	1	0	0	0	1	0	0	0	0	0	0	1	2	0	3	10
Total	11	17	10	0	38	4	1	0	0	5	0	18	0	0	18	1	3	10	0	14	75
11:00 PM	3	4	1	0	8	3	0	1	0	4	0	1	0	0	1	0	0	5	0	5	18
11:15 PM	5	7	1	0	13	0	1	0	0	1	0	1	0	0	1	0	0	1	0	1	16
11:30 PM	3	2	1	0	6	1	0	0	0	1	0	2	0	0	2	0	0	1	0	1	10
11:45 PM	2	5	1	0	8	0	0	0	0	0	0	1	0	0	1	0	0	2	0	2	11
Total	13	18	4	0	35	4	1	1	0	6	0	5	0	0	5	0	0	9	0	9	55
12:00 AM	2	1	2	0	5	0	1	0	0	1	0	1	0	0	1	0	1	0	0	1	8
12:15 AM	3	2	0	0	5	2	2	0	0	4	0	0	0	0	0	0	0	2	0	2	11
12:30 AM	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	1	1	0	0	2	4
12:45 AM	0	1	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	3
Total	6	4	2	0	12	2	3	0	0	5	0	3	0	0	3	1	2	3	0	6	26
01:00 AM	2	1	0	0	3	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	5
01:15 AM	1	4	0	0	5	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	6
01:30 AM	1	3	0	0	4	0	0	0	0	0	0	1	0	0	1	0	1	0	0	1	6
01:45 AM	0	3	2	0	5	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	7
Total	4	11	2	0	17	0	2	0	0	2	0	3	0	0	3	0	1	1	0	2	24
02:00 AM	1	4	0	0	5	1	0	0	0	1	0	0	0	0	0	0	1	1	0	2	8
02:15 AM	2	0	0	0	2	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	4
02:30 AM	3	1	1	0	5	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	6
02:45 AM	0	3	0	0	3	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	4
Total	6	8	1	0	15	2	0	0	0	2	0	2	0	0	2	0	1	2	0	3	22
03:00 AM	0	3	0	0	3	1	0	0	0	1	0	1	0	0	1	0	1	1	0	2	7
03:15 AM	0	2	0	0	2	0	0	0	0	0	0	4	0	0	4	0	0	2	0	2	8
03:30 AM	2	1	1	0	4	0	0	0	0	0	0	6	0	0	6	0	0	4	0	4	14
03:45 AM	2	0	0	0	2	2	1	0	0	3	0	7	0	0	7	0	0	10	0	10	22
Total	4	6	1	0	11	3	1	0	0	4	0	18	0	0	18	0	1	17	0	18	51
04:00 AM	5	0	0	0	5	1	1	0	0	2	0	10	0	0	10	0	4	18	0	22	39
04:15 AM	2	3	0	0	5	0	0	0	0	0	1	24	0	0	25	0	0	19	0	19	49
04:30 AM	5	3	0	0	8	1	0	0	0	1	1	23	0	0	24	0	0	24	0	24	57
04:45 AM	2	6	0	0	8	0	1	0	0	1	0	27	0	0	27	0	1	24	0	25	61
Total	14	12	0	0	26	2	2	0	0	4	2	84	0	0	86	0	5	85	0	90	206
05:00 AM	2	4	0	0	6	4	2	1	0	7	0	26	0	0	26	0	1	28	0	29	68
05:15 AM	3	8	1	0	12	7	0	0	0	7	2	32	0	0	34	0	6	14	0	20	73
05:30 AM	10	6	0	0	16	3	1	0	0	4	2	24	1	0	27	0	2	18	0	20	67
05:45 AM	8	16	2	0	26	10	3	0	0	13	1	32	0	0	33	0	0	20	0	20	92
Total	23	34	3	0	60	24	6	1	0	31	5	114	1	0	120	0	9	80	0	89	300



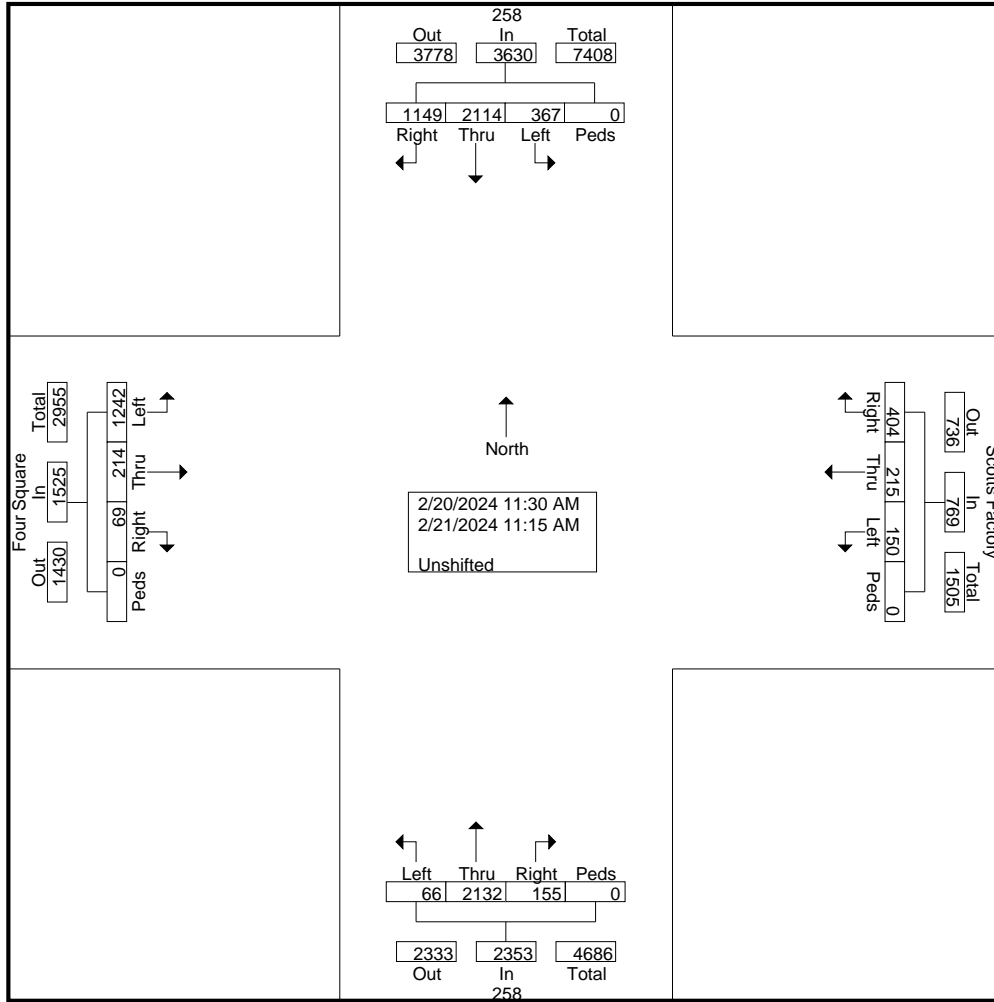
File Name : 620&258 24 Hr count
 Site Code : 00258620
 Start Date : 2/20/2024
 Page No : 3

Groups Printed- Unshifted

Start Time	258 From North					Scotts Factory From East					258 From South					Four Square From West					Int. Total
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	
06:00 AM	9	12	2	0	23	5	3	0	0	8	1	34	1	0	36	0	6	20	0	26	93
06:15 AM	12	27	1	0	40	4	1	1	0	6	2	32	2	0	36	1	5	23	0	29	111
06:30 AM	23	20	2	0	45	9	3	2	0	14	4	22	1	0	27	2	12	31	0	45	131
06:45 AM	16	15	3	0	34	6	1	4	0	11	4	28	0	0	32	1	17	20	0	38	115
Total	60	74	8	0	142	24	8	7	0	39	11	116	4	0	131	4	40	94	0	138	450
07:00 AM	17	35	6	0	58	8	1	1	0	10	3	46	0	0	49	1	3	25	0	29	146
07:15 AM	16	31	7	0	54	4	3	1	0	8	4	58	1	0	63	1	3	33	0	37	162
07:30 AM	13	72	4	0	89	6	1	8	0	15	4	41	0	0	45	1	12	30	0	43	192
07:45 AM	8	91	8	0	107	4	2	2	0	8	0	54	0	0	54	5	5	28	0	38	207
Total	54	229	25	0	308	22	7	12	0	41	11	199	1	0	211	8	23	116	0	147	707
08:00 AM	6	49	1	0	56	10	3	3	0	16	2	68	2	0	72	3	4	29	0	36	180
08:15 AM	13	45	4	0	62	7	0	3	0	10	0	49	4	0	53	2	1	27	0	30	155
08:30 AM	14	49	4	0	67	7	0	2	0	9	3	48	1	0	52	2	5	24	0	31	159
08:45 AM	18	24	8	0	50	3	4	0	0	7	3	30	0	0	33	2	3	29	0	34	124
Total	51	167	17	0	235	27	7	8	0	42	8	195	7	0	210	9	13	109	0	131	618
09:00 AM	17	29	7	0	53	5	2	2	0	9	6	27	0	0	33	0	4	20	0	24	119
09:15 AM	10	26	6	0	42	1	1	1	0	3	2	36	1	0	39	0	6	14	0	20	104
09:30 AM	15	23	4	0	42	7	2	2	0	11	3	33	0	0	36	1	3	23	0	27	116
09:45 AM	9	34	3	0	46	9	1	1	0	11	3	33	1	0	37	1	2	16	0	19	113
Total	51	112	20	0	183	22	6	6	0	34	14	129	2	0	145	2	15	73	0	90	452
10:00 AM	5	23	11	0	39	4	2	0	0	6	1	36	3	0	40	1	2	21	0	24	109
10:15 AM	7	24	3	0	34	8	2	2	0	12	4	25	1	0	30	0	7	10	0	17	93
10:30 AM	12	22	5	0	39	5	2	0	0	7	0	35	2	0	37	2	0	17	0	19	102
10:45 AM	9	29	2	0	40	9	4	0	0	13	3	25	0	0	28	1	0	13	0	14	95
Total	33	98	21	0	152	26	10	2	0	38	8	121	6	0	135	4	9	61	0	74	399
11:00 AM	23	30	6	0	59	5	4	0	0	9	3	32	3	0	38	1	1	17	0	19	125
11:15 AM	9	28	1	0	38	7	2	3	0	12	4	24	1	0	29	0	1	12	0	13	92
Grand Total	1149	2114	367	0	3630	404	215	150	0	769	155	2132	66	0	2353	69	214	1242	0	1525	8277
Apprch %	31.7	58.2	10.1	0		52.5	28	19.5	0		6.6	90.6	2.8	0		4.5	14	81.4	0		
Total %	13.9	25.5	4.4	0	43.9	4.9	2.6	1.8	0	9.3	1.9	25.8	0.8	0	28.4	0.8	2.6	15	0	18.4	

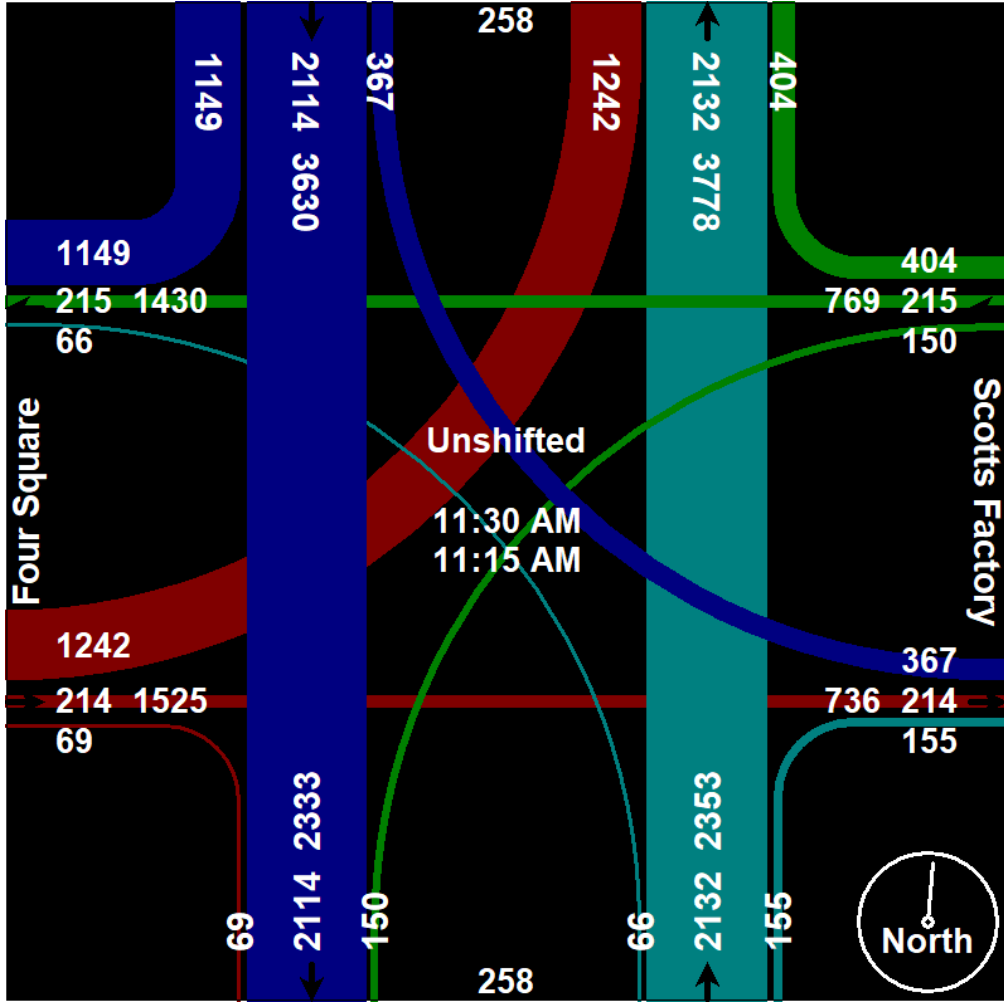


File Name : 620&258 24 Hr count
Site Code : 00258620
Start Date : 2/20/2024
Page No : 4





File Name : 620&258 24 Hr count
Site Code : 00258620
Start Date : 2/20/2024
Page No : 5





File Name : 620&258 24 Hr count
Site Code : 00258620
Start Date : 2/20/2024
Page No : 6

