Route 15 (South Main Street) Corridor Study

Final Report

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From US 460 to Griffin Boulevard

Final Report

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Prepared for

Virginia Department of Transportation

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1 INTRODUCTION

1.1 Background

The Virginia Department of Transportation (VDOT), Town of Farmville, and Prince Edward County, Virginia identified the need to evaluate existing and future conditions for the corridor of Route 15 from north of US 460 to Griffin Boulevard. This STARS corridor study focuses on assessing measures and recommending possible spot improvements to address congestion and safety issues.

Route 15 (South Main Street) in the Town of Farmville within Prince Edward County is a part of the US Highway System. It functions as an important route to connect the Town of Farmville with US 460 as well as Mecklenburg County to the south and Culpeper, Virginia to the north. It serves as an important access route to local retail centers, commerce/office centers and residences within the Town of Farmville.

This corridor experiences some congestion during peak hours. The current (year 2017) daily traffic volume along this corridor varied from 18,000 vehicles per day (vpd) from US 460 to Belmont Circle; 22,000 vph from Belmont Circle to Milnwood Road; 17,000 vpd from Milnwood Road to Gilliam Drive; and 19,000 vpd from Gilliam Drive to Griffin Boulevard. The corridor includes 4 Potential for Safety Improvement (PSI) intersections and one PSI segment.

1.2 Purpose of Study

The primary goal of this study is to determine and assess measures to reduce congestion, recommend possible adjustments to signal phasing and/or spot improvements to alleviate congestion and address safety as well as access management issues. This study is intended to develop short-term and long-term improvement projects, with a goal of identifying improvements that can be programmed into the VDOT Six-Year Improvement Program (SYIP).

The ***operational*** issues intended to be addressed by this study include existing and future projected congestion within the corridor. This congestion is centered at the major intersections within the corridor, which are currently primarily utilized by passenger cars and some truck traffic. Reduction in intersection delays would mitigate congestion, improve mobility and reduce travel time.

This study also intends to address existing and future ***safety*** concerns within the study corridor. During the recent five-year period (August 2012 through August 2017), 245 crashes were reported resulting in 77 visible, 6 ambulatory and 7 non-visible injuries, were reported within this corridor. The types of crashes frequently reported include angle, rear-end and sideswipe – same direction. These crash types typically occur due to multiple driveways and a lack of proper access management. Targeted safety improvements at those intersections may have a corresponding safety benefit, in terms of reducing the number of crashes along the corridor.

Route 15 (South Main Street) serves a mix of commercial, retail and residential uses. This study also intends to address numerous potential ***access*** improvements within the limits of the study corridor by identifying and documenting driveway locations and their spacing. These recommendations will be consistent with the *VDOT Access Management Standards for Entrances and Intersections.*

1.3 Study Work Group

The Study Work Group (SWG) includes local stakeholders, who provide local and institutional knowledge of the corridor, review study goals and methodologies, provide input on key assumptions, and review and approve proposed improvement concepts developed through the study process. The key members included in the SWG represent the following Agencies:

- VDOT Lynchburg District Office
- Prince Edward County, VA
- Town of Farmville, VA
- WSP Team

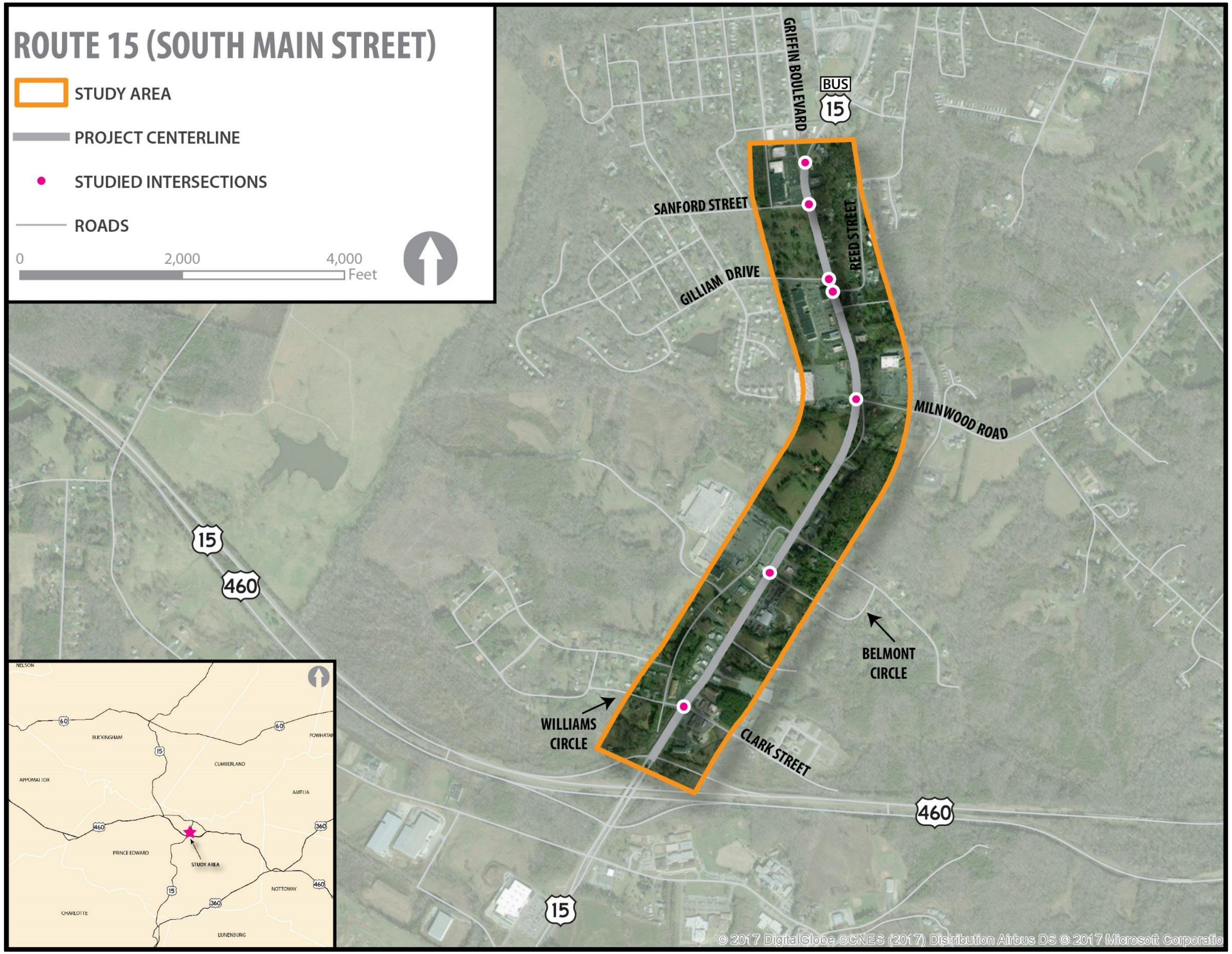
1.4 Project Location

Route 15 (South Main Street) is in the Town of Farmville within Prince Edward County, Virginia. This north-south corridor is approximately 1.7 miles in length that includes seven (7) study intersections. These study intersections are listed below and shown in **Figure 1**.

Study Area Intersections

1. Route 15 and Griffin Boulevard
2. Route 15 and Sanford Street
3. Route 15 and Gilliam Drive
4. Route 15 and Reed Street
5. Route 15 and Milnwood Road
6. Route 15 and Belmont Circle
7. Route 15 and Clark Street

Figure 1. Study Area Map



2 Existing Conditions

2.1 Existing Land Use

Existing zoning between US 460 to Griffin Boulevard consists primarily of R1 A (Low-density Single Family Residential), B4 (Local Business District), B3 (General Business District), and R3 A (High-density Residential District). Layout showing the existing zoning is included in the **Appendix**. This layout was obtained from the *Town of Farmville Interactive GIS Map*.

2.2 Existing Roadway Network

An inventory of the existing roadway conditions was prepared along Route 15 (South Main Street), based on field reviews. Traffic, crash and Geographic Information System (GIS) data was used to document existing conditions. During the field review, the following data was collected and documented:

- Digital photographs, videos, and observation to capture:
  - Roadway geometry to include lane configuration, lane/shoulder widths
  - Signs and pavement markings
  - Posted speed limits
  - Sight distance issues
  - Safety concerns
  - Existing driveway locations, their spacing and potential impact on crashes
  - Observation of traffic operations (traffic mix, congestion, driver behavior)
  - Inventory of existing roadway conditions to determine potential for safety improvements
  - Inventory of intersection operations (signal phasing, queuing)

The study corridor includes seven (7) signalized and unsignalized intersections as discussed in **Sections 2.2.1** through **2.2.8** below:

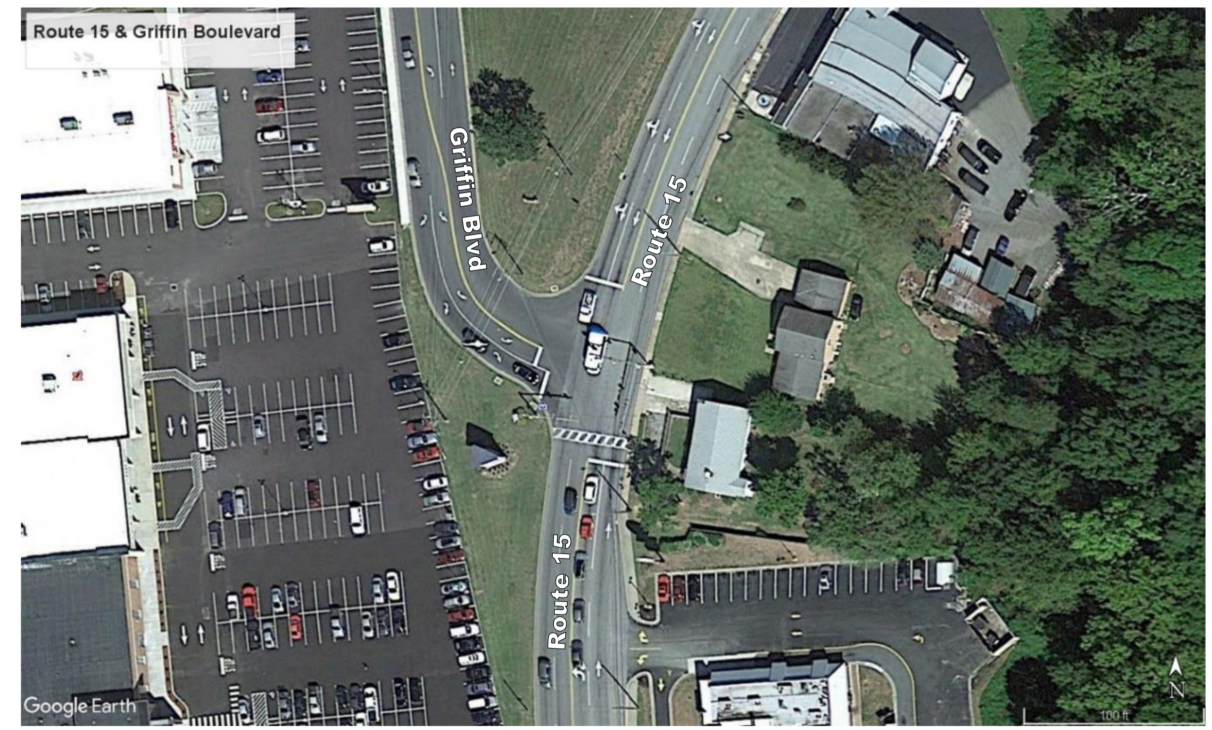
2.2.1 Route 15 (South Main Street) Corridor

Route 15 (South Main Street), between US 460 and Griffin Boulevard, is classified as Other Principal Arterial per *VDOT Functional Classification*. Within the study area, Route 15 is a 4-lane undivided roadway, with a two-way left turn lane south of Belmont Circle. The posted speed limit is 35 miles per hour along the corridor, with the speed limit changing to 45 miles per hour south of Belmont Circle. Pedestrian facilities such as sidewalks and pedestrian crossing signals with ADA ramps are intermittent along each side of the corridor. No dedicated bike facilities are present within the study corridor.

2.2.2 Intersection 1: Route 15 at Griffin Boulevard

Griffin Boulevard is classified as Major Collector per *VDOT Functional Classification.* The intersection of Route 15 at Griffin Blvd is a 3-leg signalized T-intersection. The posted speed limit for Griffin Blvd is 30 miles per hour. The northbound approach of Route 15 has one shared left-thru lane and one through lane. The southbound approach has one through and one shared through-right lane. The eastbound approach of Griffin Blvd has one left-turn lane and one right-turn lane. The signal operations include a permitted left-turn northbound. Pedestrian facilities (crosswalks, pedestrian signals) are present across the northbound approach. **Figure 2** shows an aerial of the intersection.

Figure 2: Route 15 at Griffin Boulevard

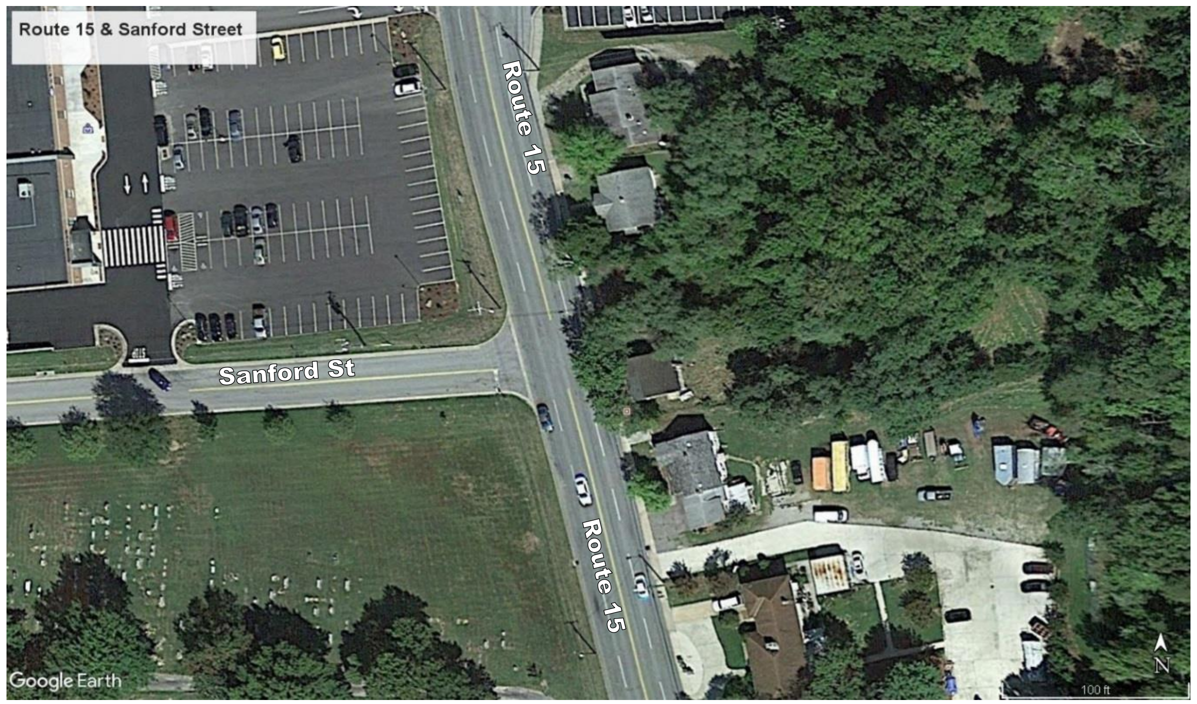


Source: Google Imagery

2.2.3 Intersection 2: Route 15 at Sanford Street

The intersection of Route 15 at Sanford Street is an unsignalized T-intersection. The posted speed limit along Sanford Street is 25 miles per hour. The northbound and southbound approaches of Route 15 are free flow movements with two lanes in each direction. The eastbound approach of Sanford Street has one shared left-right lane. Pedestrian facilities (crosswalks, pedestrian signals) are currently not provided at this intersection. **Figure 3** shows an aerial of the intersection.

Figure 3: Route 15 at Sanford Street

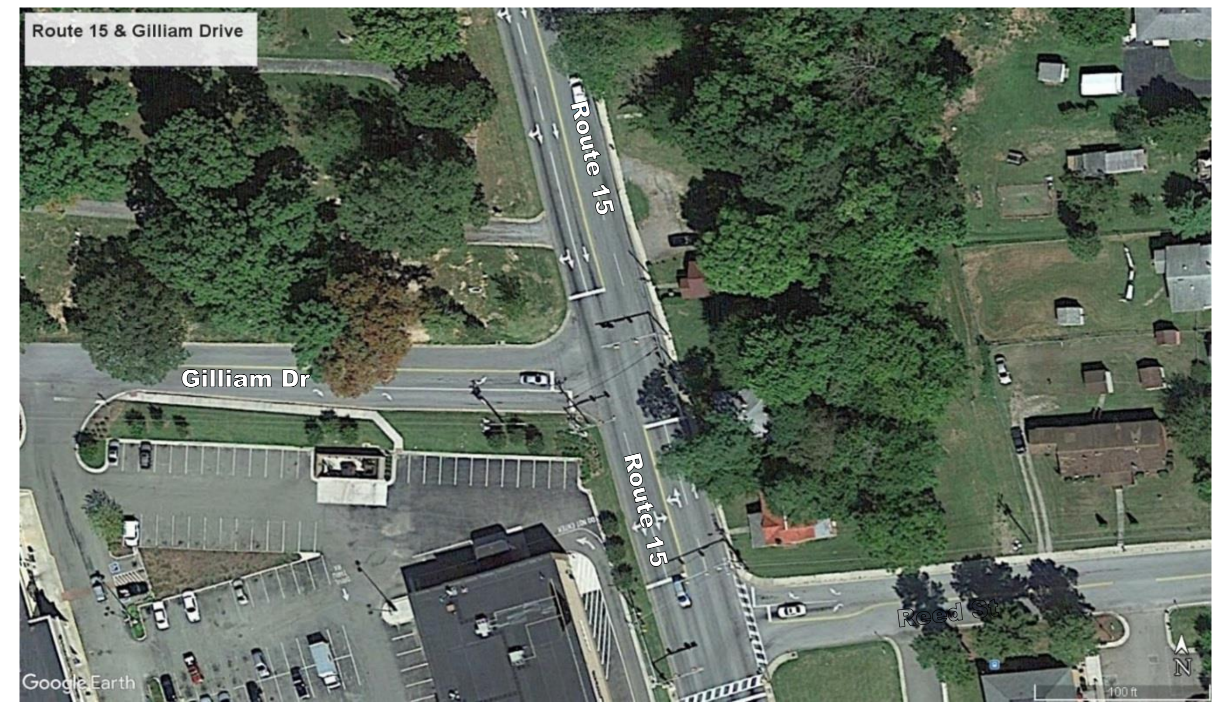


Source: Google Imagery

2.2.4 Intersection 3: Route 15 at Gilliam Drive

The intersection of Route 15 at Gilliam Drive is a signalized T-intersection. The speed limit for Gilliam Drive is 25 miles per hour. The northbound approach of Route 15 has one shared left-thru lane and one through lane. The southbound approach has one through and one shared through-right lane. The eastbound approach of Gilliam Drive has one left-turn lane and one right-turn lane. The signal operations include a permitted left-turn northbound. Pedestrian facilities (crosswalks, pedestrian signals) are currently not provided at this intersection. **Figure 4** shows an aerial of the intersection.

Figure 4: Route 15 at Gilliam Drive

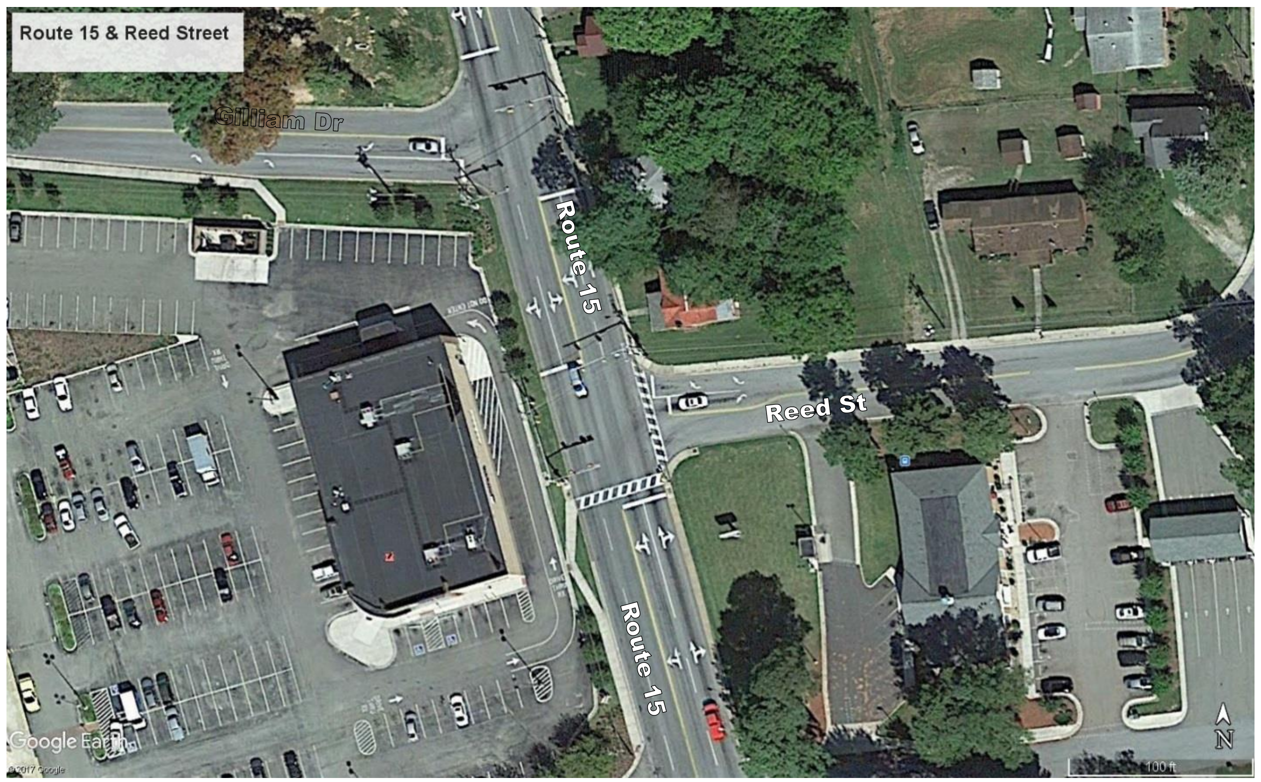


Source: Google Imagery

2.2.5 Intersection 4: Route 15 at Reed Street

The intersection of Route 15 at Reed Street is a signalized T-intersection. The posted speed limit for Reed Street is 25 miles per hour. The northbound approach of Route 15 has one shared through-left and one shared thru-right lane. The southbound approach has one shared right-thru lane and one shared through-left lane. The westbound approach of Reed Street has one left-turn lane and one right-turn lane. The signal operations include permitted/protected left-turns in the southbound direction. This signal and the signal at Gilliam Drive have a shared traffic controller, suggesting the individual movements at the two intersections are controlled by one controller. Pedestrian facilities (crosswalks, pedestrian signals) are present across the northbound and westbound approaches. **Figure 5** shows an aerial of the intersection.

Figure 5: Route 15 at Reed Street



Source: Google Imagery

2.2.6 Intersection 5: Route 15 at Milnwood Road

Milnwood Road is classified as Major Collector per *VDOT Functional Classification.* The intersection of Route 15 at Milnwood Road is currently a 4-leg signalized intersection. The east leg currently serves a Tractor Supply Company and a bank. The posted speed limit for Milnwood Road is 35 miles per hour. The northbound approach of Milnwood Road has one shared left-thru lane, one through lane, and one right-turn lane. The southbound approach has one shared left-thru lane and a shared thru-right lane. The eastbound approach of Milnwood Road has one left-turn lane and a shared thru-right lane. The westbound approach has one left-turn lane and one shared thru-right lane. The signal operations include permitted/protected lefts northbound/southbound and split phasing eastbound/westbound. Pedestrian facilities (crosswalks, pedestrian signals) are provided for the southbound and westbound approaches. **Figure 6** shows an aerial of the intersection.

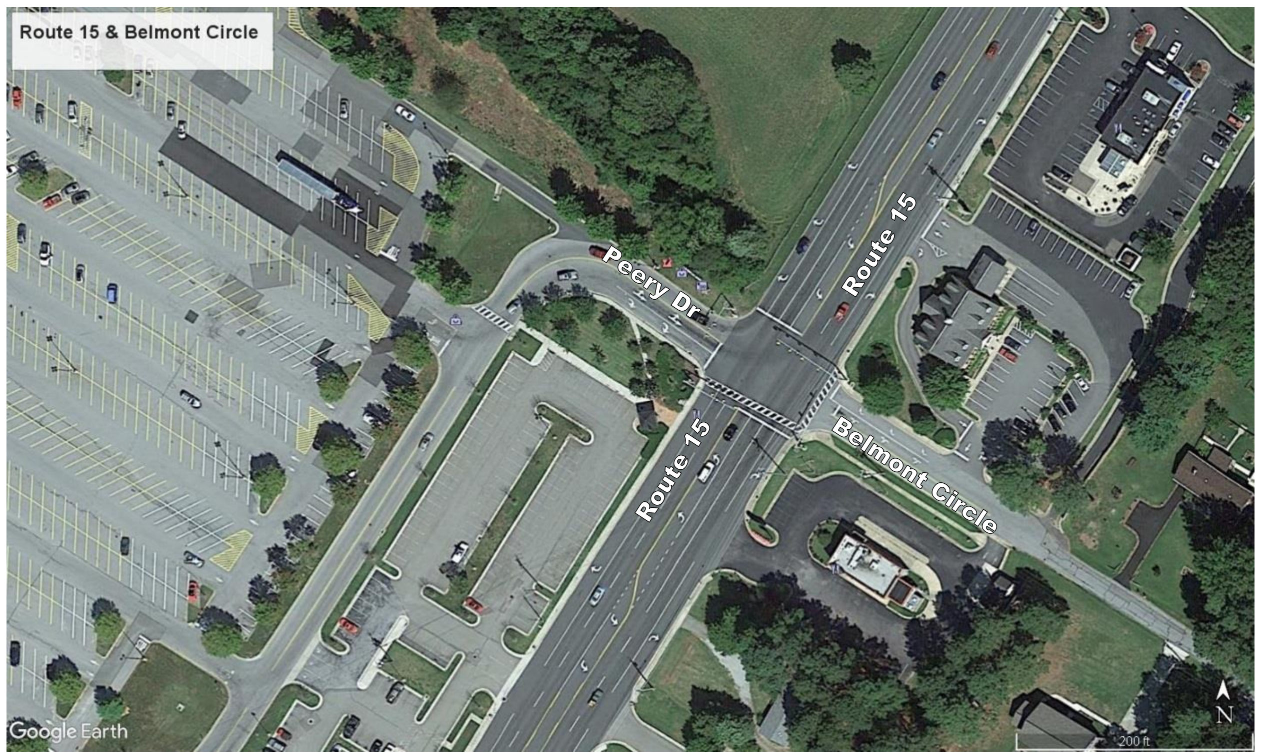
Figure 6: Route 15 at Milnwood Road

Source: Google Imagery

2.2.7 Intersection 6: Route 15 at Belmont Circle

The intersection of Route 15 at Belmont Circle is currently a 4-leg signalized intersection. The northbound approach of Route 15 has one left-turn lane, two through lanes, and one right-turn lane. The southbound approach has one left-turn lane, two through lanes, and one right-turn lane. The eastbound approach of Peery Drive has one shared left-thru lane and one right-turn lane. The westbound approach has one shared left-thru lane and one right-turn lane. The signal operations include permitted/protected lefts northbound/southbound and split phasing eastbound/westbound. The northbound/southbound through movements are coordinated with adjacent signalized intersections. Pedestrian facilities (crosswalks, pedestrian signals) are provided for the northbound and westbound approaches. **Figure 7** shows an aerial of the intersection.

Figure 7: Route 15 at Belmont Circle

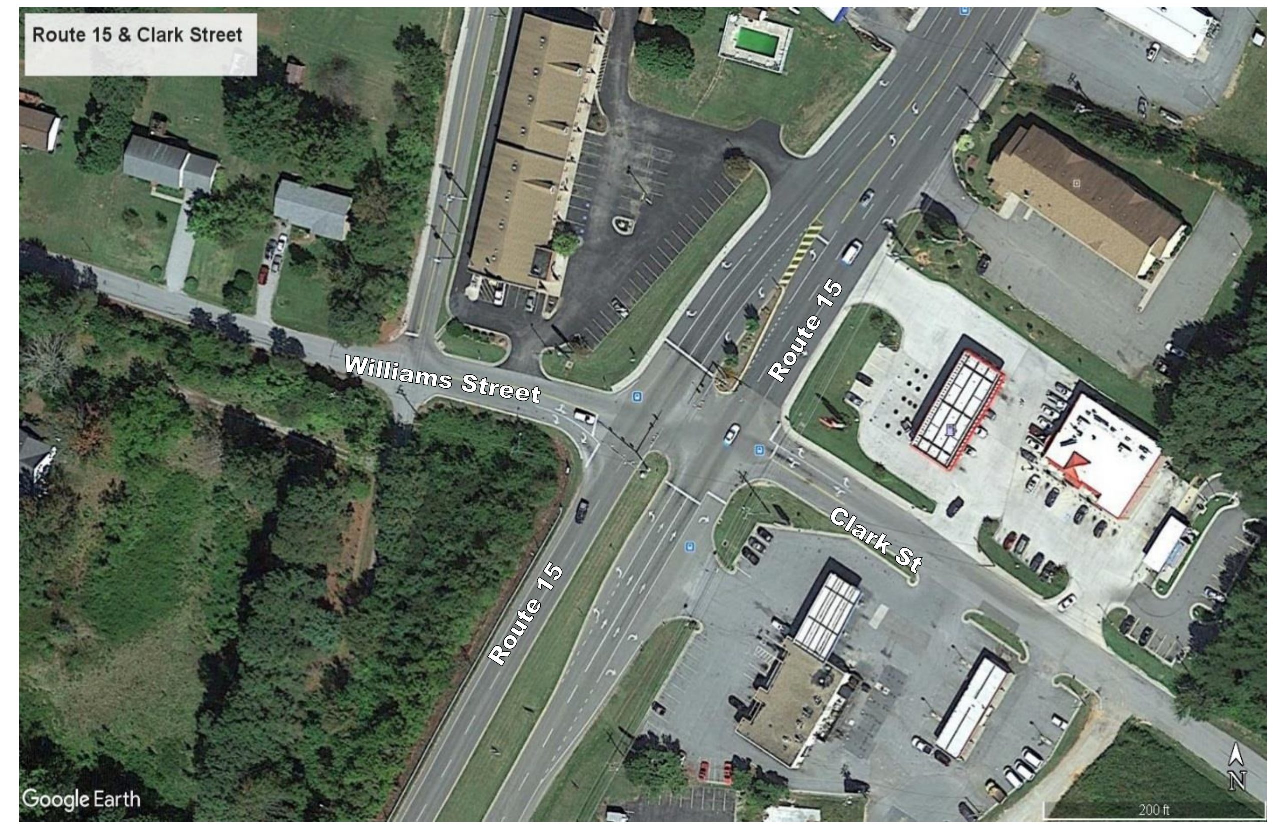


Source: Google Imagery

2.2.8 Intersection 7: Route 15 at Clark Street/Williams Street

The intersection of Route 15 at Clark Street is currently a 4-leg signalized intersection. The posted speed limit for Clark Street is 25 miles per hour. The northbound approach of Route 15 has one left-turn lane, two through lanes, and one right-turn lane. The southbound approach has one left-turn lane, two through lanes, and a shared thru-right lane. The eastbound approach of Williams Street has one shared left-thru lane and one right-turn lane. The westbound approach of Clark Street has one shared left-thru lane and one right-turn lane. The signal operations include protected left turns for northbound and southbound approaches and split phasing for minor street approaches. Pedestrian facilities (crosswalks, pedestrian signals) are currently not provided at this intersection. **Figure 8** shows an aerial of the intersection.

Figure 8: Route 15 at Clark Street



Source: Google Imagery

2.3 Traffic Data

2.3.1 2017 Existing Traffic Volumes

Existing traffic volume data along the study corridor was collected in October, 2017:

- 48-hour classification counts were collected on October 24 and October 25, 2017 at the following locations:
  - S Main Street north of Griffin Blvd
  - S Main Street south of US 460 EB Off-Ramp
  - US 460 EB Off-Ramp to S Main Street
  - US 460 WB Off-Ramp to S Main Street
- AM and PM peak period turning movement counts were collected on October 24 and October 25, 2017 from 8:00 am – 10:00 am and 4:00 – 6:00 pm at the following intersections:
  - S Main Street / Griffin Blvd
  - S Main Street / Sanford Street
  - S Main Street / Gilliam Drive
  - S Main Street / Reed Street
  - S Main Street / Spottswood Drive
  - S Main Street / Milnwood Road
  - S Main Street / Belmont Circle
  - S Main Street / Clark Street / Williams Street
  - S Main Street / US 460 WB Off-Ramp
  - S Main Street / US 460 EB Off-Ramp
  - S Main Street / Commerce Road

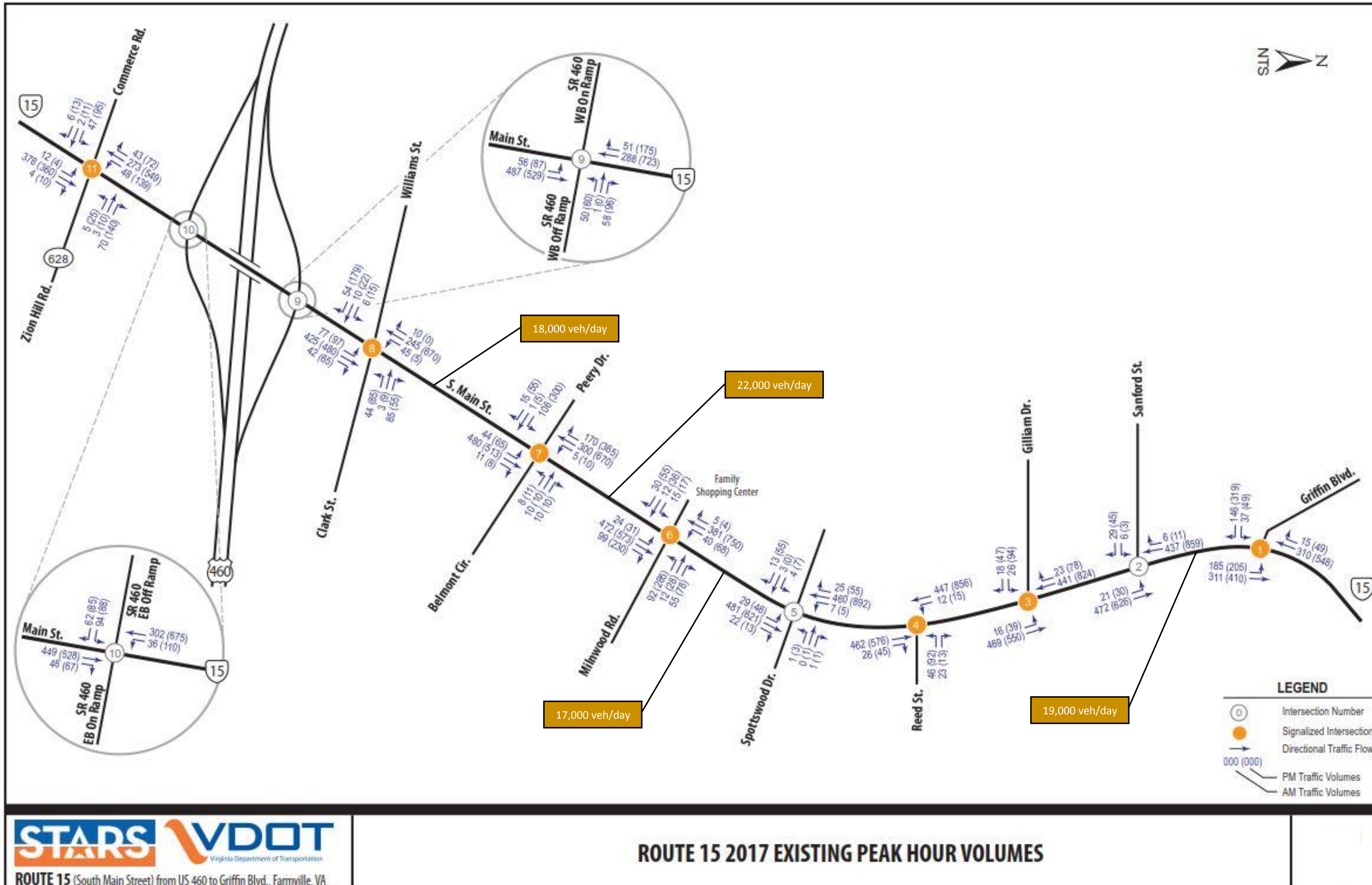
The field counts are enclosed with this report in the **Appendix**. The existing (2017) peak hour volumes and Average Daily Traffic (ADT) volumes are summarized in **Figure 9**.

2.3.2 Additional Data

In addition to traffic volumes, the following supplemental data was collected to support this study:

- Travel time runs, to be used in the calibration of the existing network, in the event SimTraffic needs to be used in the analysis rather than Synchro.
- Crash Data from the last five years to perform the crash analysis.
- Signal timing data from Town of Farmville for input into the Synchro analysis models.

Figure 9. Existing (2017) Peak Hour Volumes and Average Daily Traffic



2.3.3 Existing Access Management

An evaluation of the existing driveways and access points along the study area corridor was completed to assess compliance with *VDOT Access Management Design Standards for Entrances and Intersections,* which is included as *Appendix F* of the *VDOT Roadway Design Manual*. The assessment involved analysis of existing spacing of driveways and intersections and complies with VDOT minimum spacing standards for commercial entrances, intersections and median crossovers. **Table 1** provides a summary of the minimum spacing requirements for a posted speed limit of 35 mph to 45 mph for a Principal Arterial.

Table 1. Minimum Spacing Standards for Commercial Entrances, Intersections, and Median Crossovers

Highway Functional Classification	Minimum Centerline to Centerline Spacing (Feet)			
	Spacing between Signalized Intersections	Spacing between Unsignalized Intersections and Full/Directional Median Crossovers and Other Intersections or Median Crossovers	Spacing between Full Access Entrances and Other Full Access Entrances, Intersections, or Median Crossovers	Spacing between Partial Access Entrances (one or two-way) and Other Entrances, Intersections, or Median Crossovers
Principal Arterial	1,320	1,050	565	305

Source: VDOT Roadway Design Manual, Appendix F (Table 2-2)

A total of 83 access points are located within the study corridor of Route 15 from north of US 460 to Griffin Boulevard. Most of these access points are closely spaced and serve commercial and retail parcels, with a large percentage serving residential parcels. Many of the residential parcels have multiple access points for each parcel. These access points are shown graphically in the **Appendix** and identified as **AP1** through **AP83**. The spacing of these points was analyzed to assess their compliance with the VDOT minimum spacing standards shown in **Table 1**. **Table 2** identifies the access points that do not meet the minimum spacing standard; as well as those that are compliant with the spacing standard.

Table 2. Access Points Analysis for Route 15

Roadway	Number of Access Points	Per VDOT Spacing Guidelines	
		Compliant	Non-Compliant
Route 15	83	<u>0 Total:</u>	<u>83 Total:</u> AP1 through AP7, AP8*, AP9, AP10*, AP11 through AP51, AP52*, AP53 through AP83

Note: Refer to the Appendix for graphical presentation of access points.
Note: An asterisk (*) refers to an entrance that is already in existence but has no development currently utilizing the entrance.

Along Route 15, the spacing standards are not satisfied for any of the 83 access point locations involving full/partial access driveways, entrances, median crossovers and intersections. The area serves suburban land uses, with developments and a significant amount of private residences along both sides of the roadway. Application of access management practices would benefit corridor operations by reducing conflict points along the corridor.

3 Traffic Operational Analysis

3.1 Analysis Peak Periods

Weekday peak hours were identified from the count data for the arterial segments and for each study intersection. The overall AM and PM peak hours for the network were determined based on the highest volume of traffic in a one hour period, travel patterns along the study corridor and percentage of traffic during the highest hour. Based upon a review of the traffic count data, the following peak hours were identified for this study:

- AM Peak: 9:00 AM – 10:00 AM
- PM Peak: 4:30 PM – 5:30 PM

3.2 Analysis Tools

Traffic operations analysis for the corridor was conducted using *Synchro 9.2* analysis software. The operational analysis was based on guidance provided in *VDOT Traffic Operations and Safety Analysis Manual (TOSAM), Version 1.0, November 2015 update.* Synchro is utilized for unsaturated operations, and is based on methodologies presented in *2010 Highway Capacity Manual*.

3.3 Measures of Effectiveness

The Measures of Effectiveness (MOEs) in traffic operations analysis quantify operational results and provides a basis for evaluating the performance of a transportation network. The MOEs reported for this study are consistent with TOSAM guidance for undersaturated intersection analysis using Synchro software. A summary of the MOEs evaluated for the study corridor is presented below:

- Intersection Control Delay (seconds/vehicle) and resulting Level of Service (LOS)
- 95th Percentile Queue Length (feet)

Level of service (LOS) describes traffic conditions in terms of the amount of traffic congestion at an intersection or on a roadway. LOS ranges from A to F, where LOS A indicates a condition of little or no congestion and LOS F indicates a condition with severe congestion, unstable traffic flow, and stop-and-go conditions. For many localities, LOS A through LOS D is considered acceptable, while LOS E and LOS F are considered unacceptable conditions. As indicated in the *2010 Highway Capacity Manual (HCM)*, LOS at an intersection is based on the average amount of delay (seconds/vehicle) experienced by vehicles approaching the intersection. LOS thresholds for signalized and unsignalized intersections are shown in **Table 3**.

Table 3: HCM Intersection LOS Criteria Based on Average Delay

LOS	Signalized Intersection Delay Thresholds (sec/veh)	Unsignalized Intersection Delay Thresholds (sec/veh)
A	< 10	< 10
B	> 10 – 20	> 10 – 15
C	>20 – 35	>15 – 25
D	>35 – 55	>25 – 35
E	>55 – 80	>35 – 50
F	>80	>50

Source: Highway Capacity Manual 2010

3.4 Base Model Development

The Synchro model was developed utilizing the following information:

- The geometry and speed limits of the roadways and intersections as existed in the field during the data collection period, using aerial photography, streetview photography, and field observations
- Balanced peak hour traffic volumes, including truck percentages and overall intersection Peak Hour Factors as identified in the traffic count data
- Minimum and maximum splits as provided by Town of Farmville.
- In the absence of detailed signal timings, the pedestrian timings (walk, flashing don't walk) were calculated following the procedure outlined in the *Manual of Uniform Traffic Control Devices (MUTCD), 2009 Edition, Section 4E.06: Pedestrian Intervals and Signal Phases.*
- The clearance intervals (yellow, all-red) were determined following the process outlined in *VDOT Yellow Change and Red Clearance Interval Calculator (VDOT YRIC), version 1.0.*

3.5 Intersection Operations: 2017 Existing Conditions

Traffic operations analyses were conducted using Synchro to evaluate overall performance of the study intersections within the Route 15 corridor for the Existing 2017 Conditions scenario.

Delay is reported from Synchro using HCM 2010 methodology for the signalized intersections, while HCM 2000 methodology results were reported for all unsignalized intersections and several signalized intersections that did not comply with standard NEMA phasing. **Table 4** provides a detailed summary of the average AM and PM peak hour delay and corresponding level of service for each movement for the study intersections along the corridor. **Figure 10** provides a graphical representation of the LOS for each movement as well as overall intersection LOS.

The results show that all intersections are operating at acceptable overall levels of service of C or better for both AM and PM peak periods. Movements operating at LOS D were found during the PM peak at the intersections of Milnwood Road/Route 15 and Williams Street/Clark Street/Route 15.

Queue length, or the distance to which stopped vehicles accumulate in a lane at an intersection, is another performance measure of intersection operations. Lengthy queues may be indicative of intersection capacity or operational issues, such as absence of or insufficient dedicated turn lanes, inefficient signal timings or phasing. **Table 5** provides a summary of the 95th percentile queue lengths during the AM and PM peak hours as compared to the available storage bay lengths. Based upon the results, the existing storage bay lengths are sufficient length to manage the queues. Synchro output is included in the **Appendix**.

Table 4. Existing (2017) AM and PM Hour Delay and Level of Service (LOS)

Intersection Number and Description	Type of Control	Lane Group	Eastbound				Westbound				Northbound				Southbound				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM		AM	PM
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
1			Griffin Blvd								Route 15				Route 15					
Route 15 and Griffin Blvd		Left	12.5	B	12.8	B	--	--	--	--	5.6	A	8.0	A	--	--	--	--	Delay	Delay
	Signal	Through	--	--	--	--	--	--	--	--					3.9	A	5.2	A	6.3	8.2
		Right	12.5	B	13.6	B	--	--	--	--	--	--	--	--					LOS	LOS
		Approach	12.9	B	13.5	B	--	--	--	--	5.6	A	8.0	A	3.9	A	5.2	A	A	A
2			Sanford St								Route 15				Route 15					
Route 15 and Sanford St		Left	11.2	B	12.8	B	--	--	--	--	1.2	A	1.7	A	--	--	--	--	Delay	Delay
	Two-Way Stop	Through	--	--	--	--	--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	0.6	0.6
		Right	11.2	B	12.8	B	--	--	--	--	--	--	--	--					LOS	LOS
		Approach	11.2	B	12.8	B	--	--	--	--	0.4	A	0.6	A	0.0	A	0.0	A	A	A
3			Gilliam Dr								Route 15				Route 15					
Route 15 and Gilliam Dr		Left	16.8	B	17.2	B	--	--	--	--	0.9	A	1.5	A	--	--	--	--	Delay	Delay
	Signal	Through	--	--	--	--	--	--	--	--					2.8	A	4.9	A	2.5	4.7
		Right	16.0	B	15.6	B	--	--	--	--	--	--	--	--					LOS	LOS
		Approach	16.5	B	16.7	B	--	--	--	--	0.9	A	1.5	A	2.8	A	4.9	A	A	A
4							Reed St				Route 15				Route 15					
Route 15 and Reed St		Left	--	--	--	--	17.3	B	16.9	B	--	--	--	--	0.9	A	1.3	A	Delay	Delay
	Signal	Through	--	--	--	--	--	--	--	--	3.3	A	4.8	A					3.1	3.7
		Right	--	--	--	--	15.8	B	15.4	B					--	--	--	--	LOS	LOS
		Approach	--	--	--	--	16.8	B	16.7	B	3.3	A	4.8	A	0.9	A	1.3	A	A	A
5			Spottswood Dr				Spottswood Dr				Route 15				Route 15					
Route 15 and Spottswood Dr		Left	20.7	C	21.7	C	14.7	B	19.5	B	1.2	A	2.0	A	0.3	A	0.1	A	Delay	Delay
	Signal	Through									0.0	A	0.0	A	0.0	A	0.0	A	0.7	0.9
		Right	9.6	A	9.9	A													LOS	LOS
		Approach	13.3	B	11.3	B	14.7	B	19.5	B	0.6	A	1.1	A	0.2	A	0.1	A	A	A
6			Milnwood Rd				Milnwood Rd				Route 15				Route 15					
Route 15 and Milnwood Rd		Left	22.2	C	38.9	D	20.6	C	34.5	C	10.5	B	16.5	B	10.3	B	20.1	C	Delay	Delay
	Signal	Through	22.2	C	42.1	D	18.8	B	25.5	C									12.0	21.6
		Right									8.8	A	13.8	B					LOS	LOS
		Approach	22.2	C	41.5	D	19.8	B	32.0	C	10.2	B	15.7	B	10.3	B	20.1	C	B	C
7			Peery Dr				Belmont Cir				Route 15				Route 15					
Route 15 and Belmont Cir/ Peery Dr		Left	23.4	C	31.6	C	32.9	C	23.3	C	11.0	B	15.7	B	13.4	B	17.5	B	Delay	Delay
	Signal	Through									14.5	B	19.1	B	15.0	B	23.2	C	14.4	20.1
		Right	21.1	C	22.8	C	28.6	C	39.1	D	12.2	B	16.0	B	4.9	A	4.7	A	LOS	LOS
		Approach	23.1	C	30.2	C	31.4	C	41.9	D	14.2	B	18.7	B	11.4	B	16.7	B	B	C
			Williams St				Clark St				Route 15				Route 15					
Route 15 and Williams St/ Clark St		Left	30.5	C	33.6	C	29.3	C	41.6	D	29.4	C	41.7	D	15.0	B	17.1	B	Delay	Delay
	Signal	Through									16.1	B	16.4	B	17.5	B	23.3	C	17.4	24.6
		Right	29.5	C	33.1	C	27.4	C	33.2	C	13.9	B	14.1	B	16.1	B	0.0	A	LOS	LOS
		Approach	29.8	C	33.2	C	28.1	C	38.5	D	17.8	B	20.0	B	17.1	B	23.2	C	B	C

Figure 10. Existing (2017) AM(PM) Peak LOS

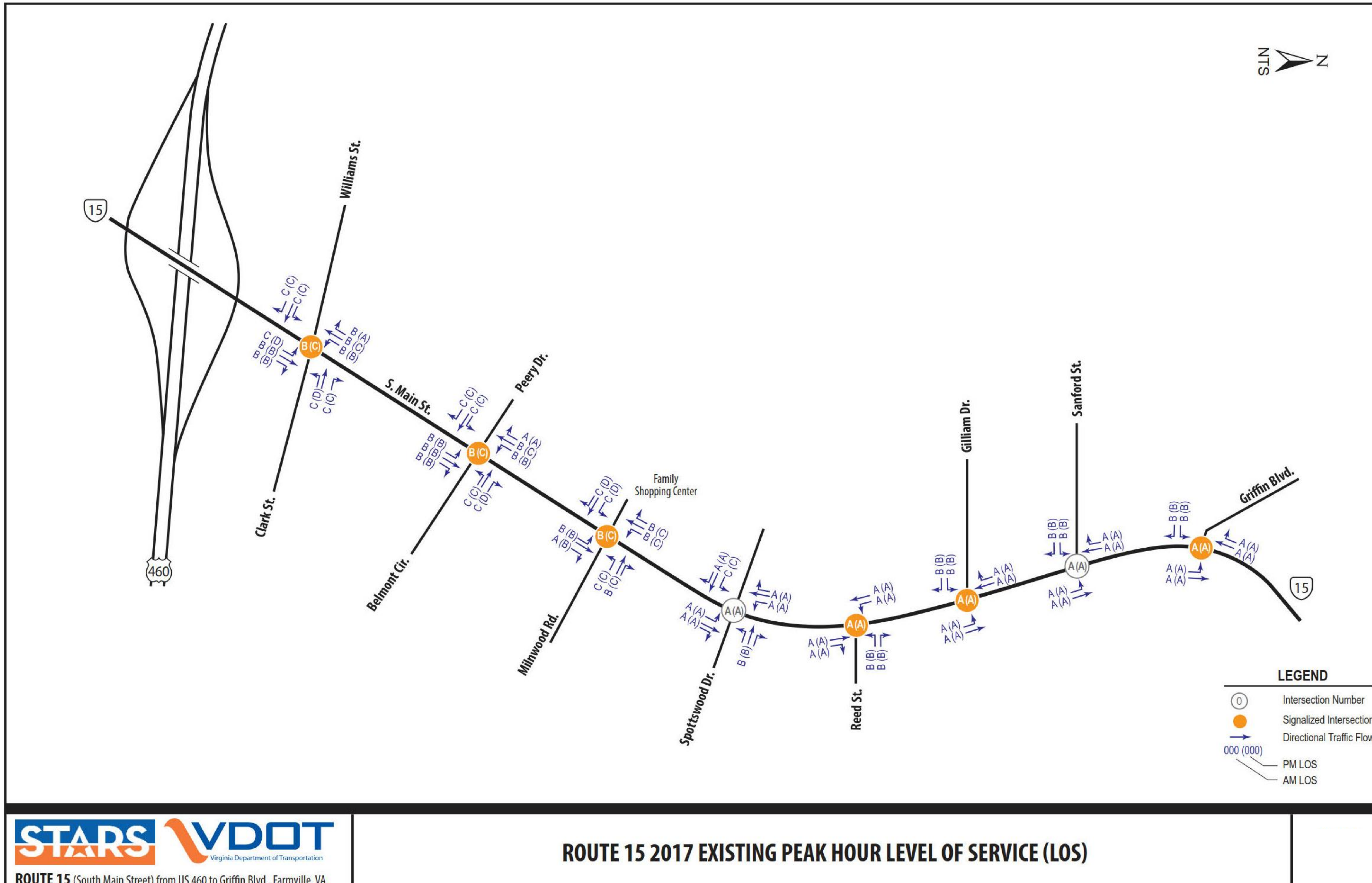


Table 5. 2017 Existing Conditions: Summary of Intersection Queues (95th Percentile Queue, feet)

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
1 Route 15 and Griffin Blvd			Griffin Blvd						Route 15			Route 15		
	Signal	Left	155	22	38	--	--	--	--	60	109	--	--	--
		Through	--	--	--	--	--	--	--			--	30	76
		Right	--	30	66	--	--	--	--	--	--	--		
2 Route 15 and Sanford St			Sanford St						Route 15			Route 15		
	Signal	Left	--	5	8	--	--	--	--	2	3	--	--	--
		Through	--	--	--	--	--	--	--			--	0	0
		Right	--	5	8	--	--	--	--	--	--	--		
3 Route 15 and Gilliam Dr			Gilliam Dr						Route 15			Route 15		
	Signal	Left	--	19	53	--	--	--	--	12	13	--	--	--
		Through	--	--	--	--	--	--	--			--	45	107
		Right	175	11	19	--	--	--	--	--	--	--		
4 Route 15 and Reed St						Reed St			Route 15			Route 15		
	Signal	Left	--	--	--	50	28	51	--	--	--	--	12	20
		Through	--	--	--	--	--	--	--	53	71	--		
		Right	--	--	--	--	12	10	--			--	--	--
5 Route 15 and Spottswood Dr			Spottswood Dr			Spottswood Dr			Route 15			Route 15		
	Signal	Left	--	2	3	--	0	2	--	2	5	--	1	0
		Through	--			--			--			--		
		Right	--	1	6	--			--	2	5	--	1	0
6 Route 15 and Milnwood Rd			Milnwood Rd			Milnwood Rd			Route 15			Route 15		
	Signal	Left	--	20	37	--	68	300	--	115	208	--	--	--
		Through	--	29	92	--	32	62	--			--	100	321
		Right	--			--			190	19	42	--		
7 Route 15 and Belmont Cir/ Peery Dr			Peery Dr			Belmont Cir			Route 15			Route 15		
	Two-Way Stop	Left	--	87	269	--	28	42	150	28	54	115	7	15
		Through	--			--			--	145	207	--	92	278
		Right	100	0	0	125	0	0	1000	0	0	380	24	26
8 Route 15 and Williams St/ Clark St			Williams St			Clark St			Route 15			Route 15		
	Signal	Left	--	26	57	--	51	113	130	74	116	120	30	7
		Through	--			--			--	137	162	--	91	266
		Right	75	0	7	--	0	0	220	0	0	1000	0	0

NOTE: Lane configurations with a shared through lane shown as "through" lane group; with shared left-right lane shown as "left" lane group.
'--' Storage Bay Length not provided or the movements do not exist.
Red text indicates queue lengths that exceed the available storage lengths.

3.6 Future Traffic Volumes

The existing traffic volumes were forecasted to the Future Year 2030, which was determined by the SWG as the design year for the improvements suggested by this study. Projecting the traffic volumes at the study intersections to the design year with an appropriate growth rate was the first step in developing future conditions analysis. The methodology that was followed for development of growth rate is discussed below.

3.6.1 Traffic Forecasting Methodology

During the kick-off meeting held on October 26, 2017, the members of SWG directed the consulting firm WSP to consider the Statewide Planning System (SPS) data for the Lynchburg District. Additionally the consultants were asked to consider VDOT AADT volumes to determine an appropriate average annual growth rate for Route 15 corridor. The SPS data was obtained from VDOT Lynchburg District, which was further narrowed down to the Route 15 corridor between Clark Street and Griffin Boulevard. **Table 6** summarizes the SPS data for segments of Route 60 with their respective AADT volumes for existing year (2014), interim year (2035) and future year (2045). The AAGR between 2014 to 2035 were calculated and then interpolated to obtain the year 2030 volumes for this study. The resulting AAGR between 2014 to 2030 was then computed for each segment and then averaged to obtain a single AAGR.

Table 6. SPS Recommended Growth Rates

County	Route	From	To	SPS 2014 Volumes	SPS Projected 2035 Volumes	SPS Calculated AAGR (2014-2035)	Interpolated 2030 Volumes	Calculated AAGR (2014-2030)
Farmville	15	Gilliam Drive	Griffin Boulevard	12,063	14,737	1.0%	14,100	1.0%
Farmville	15	Milnwood Road	Gilliam Drive	17,656	27,700	2.2%	25,309	2.3%
Farmville	15	Peery Drive	Milnwood Road	20,275	29,310	1.8%	27,159	1.8%
Farmville	15	William Street	Peery Drive	20,275	27,700	1.5%	25,932	1.5%
Farmville	15	SCL Farmville	William Street	16,781	25,000	1.9%	23,043	2.0%
							Average	**1.7%**

The SPS data suggests an aggregate growth rate of 1.7% for the corridor, with the highest growth for the segment of Route 15 between Milnwood Road and Gilliam Drive.

Historic AADT volumes published by VDOT were reviewed from year 2004 to 2016 for the study corridor. The AADT data is available for the following segments within the corridor:

- Route 15 – From US 460 to Belmont Circle
- Route 15 – From Belmont Circle to Milnwood Road
- Route 15 – From Milnwood Road to Gilliam Drive
- Route 15 – From Gilliam Drive to Griffin Boulevard

Table 7 summarizes these AADT volumes per segment.

Table 7. VDOT Historic Traffic Volumes (veh/day)

Year	Roadway Segment/AADT Volume			
	US 15, US 460 to Belmont Circle	Belmont Circle to Milnwood Road	Milnwood Road to Gilliam Drive	Gilliam Drive to Griffin Blvd
2004	13,000	15,000	15,000	14,000
2005	16,000	19,000	17,000	16,000
2006	16,000	19,000	17,000	16,000
2007	16,000	19,000	17,000	16,000
2008	18,000	20,000	17,000	16,000
2009	18,000	21,000	18,000	17,000
2010	19,000	21,000	18,000	17,000
2011	17,000	19,000	18,000	16,000
2012	17,000	19,000	18,000	16,000
2013	17,000	19,000	18,000	16,000
2014	17,000	20,000	16,000	18,000
2015	17,000	21,000	16,000	18,000
2016	18,000	22,000	17,000	19,000

From the AADT data summarized in **Table 7**, historic linear growth rates were calculated for the segments of Route 15 for three periods: 3-year, 9-year and 12-year. They are summarized in **Table 8**.

Table 8. Historic Traffic Growth Rates

Roadway Segment	Linear Growth Rates		
	3-Year (2013-2016)	9-Year (2007-2016)	12-Year (2004-2016)
US 15, US 460 to Belmont Circle	1.9%	1.3%	2.7%
Belmont Circle to Milnwood Road	5.0%	1.6%	3.2%
Milnwood Road to Gilliam Drive	-1.9%	0.0%	1.0%
Gilliam Drive to Griffin Blvd	5.9%	0.7%	2.6%
Average	2.7%	0.9%	2.4%

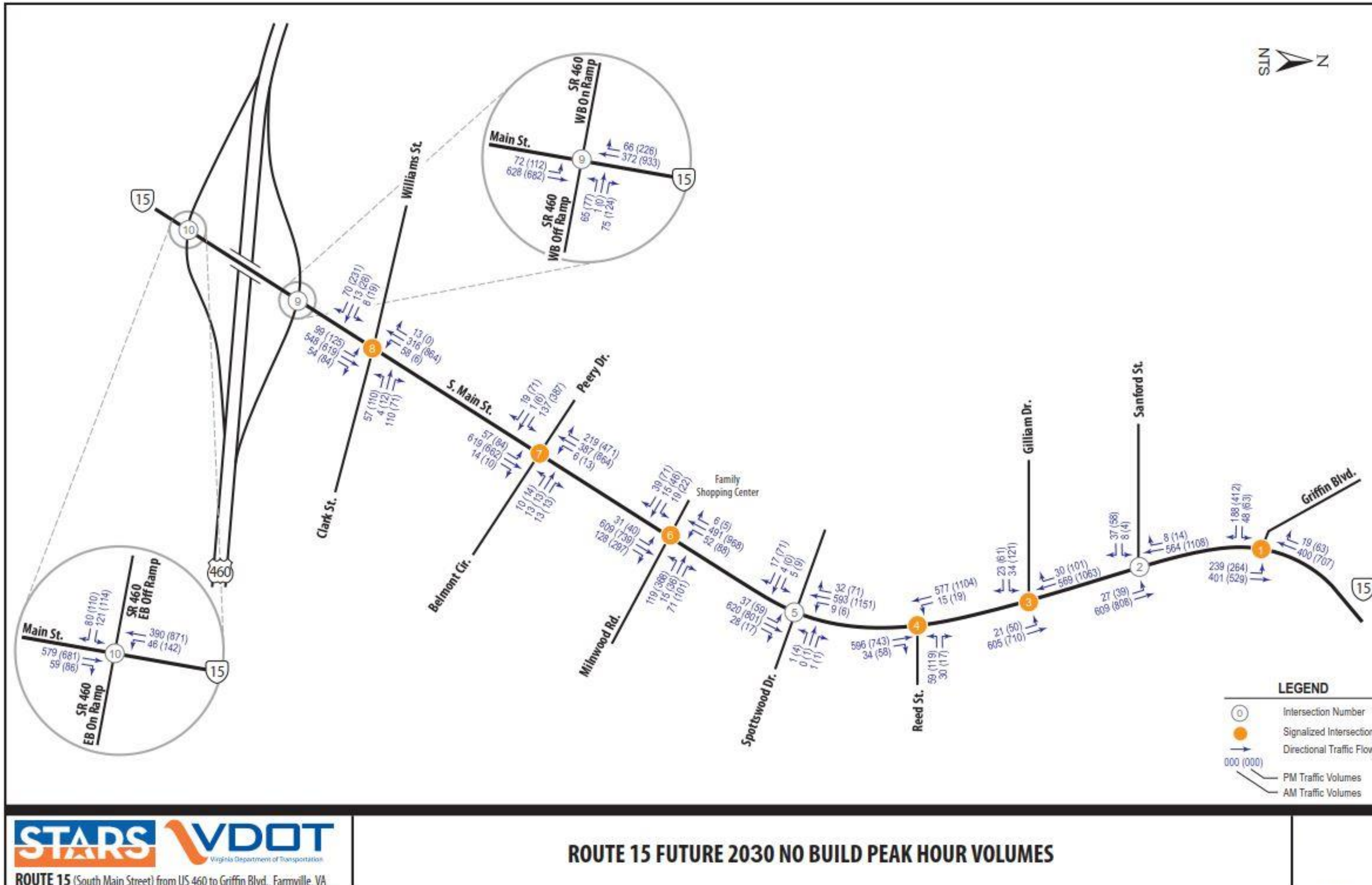
The growth over the three time periods were reviewed to establish a recent and expected short-term future growth along the corridor.

- 3-year period (2013-2016) – 2.7% linear growth
- 9-year period (2007-2016) - 0.9% linear growth
- 12-year period (2004-2016) – 2.4% linear growth
- Full dataset 2004-2016 - 2.0% linear growth

Based on the analysis of SPS data, the calculated AAGR primarily shows a growth in the range of 1.0% - 2.3%, with an aggregate AAGR of 1.7% for the entire corridor. The review of VDOT Historic Traffic Volumes suggests that the traffic volumes during most recent 3-year period grew at an AAGR of 2.7% within the corridor. Based upon this evaluation, the project team suggests an annual growth rate of 2.0% for this study.

The suggested growth rate of 2.0% per year was applied to the Existing 2017 traffic volumes to generate projected 2030 AM and PM peak hour traffic volumes. These volumes are presented in **Figure 11**.

Figure 11. Future (2030) AM (PM) Peak Hour Traffic Volumes



3.7 Planned Improvements

The intersection of Route 15 (S Main Street) and Milnwood Road is identified in the town of Farmville's 2020 Transportation Plan as a planned improvement. The planned improvement includes reconstructing the intersection to add left turn bays for both northbound and southbound traffic on Route 15 and a right turn channelized lane for southbound traffic, prohibit right-on-red from Milnwood Road and the shopping center on the west side of Route 15, and to close the bank driveway closest to the intersection in the southwest quadrant. These planned improvements at Milnwood Road are modeled in the Future 2030 No Build Synchro models.

3.8 Intersection Operations: Future 2030 No-Build Conditions

Operational analysis was performed at each of the study intersections for the Future 2030 No-Build Conditions scenario. **Table 9** summarizes the average AM and PM peak hour delay and LOS for each movement for the study intersections along the Route 15 corridor. **Figure 12** summarizes the overall intersection delay graphically. Synchro output sheets are provided in **Appendix**.

The results in **Table 9** show that, under Future 2030 No Build conditions, all intersections are operating at acceptable overall levels of service of C or better for both AM and PM peak periods. Movements operating at LOS D were found during the PM peak at the intersections of Milnwood Road/Route 15, Belmont Circle/Peery Drive/Route 15 and Williams Street/Clark Street/Route 15.

Queuing analysis was completed for the study intersections during the AM and PM peak hours for 2030 No Build conditions. *Synchro* 95th Percentile Queue Lengths in feet were reported for each lane. **Table 10** summarizes the 95th percentile queue lengths during the AM and PM peak hours. Based upon the results, the existing storage bay lengths are sufficient length to manage the queues. Synchro output is included in the **Appendix**.

Table 9. Future 2030 No Build AM and PM Hour Delay and Level of Service (veh/sec)

Intersection Number and Description	Type of Control	Lane Group	Eastbound				Westbound				Northbound				Southbound				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
1 Route 15 and Griffin Blvd			Griffin Blvd								Route 15				Route 15					
	Signal	Left	13.5	B	17.5	B	--	--	--	--	6.9	A	14.1	B	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--					4.4	A	7.3	A	7.3	13.6
		Right	13.5	B	23.9	C	--	--	--	--	--	--	--	--					LOS	LOS
		Approach	13.5	B	23.0	C	--	--	--	--	6.9	A	14.1	B	4.4	A	7.3	A	A	B
2 Route 15 and Sanford St			Sanford St								Route 15				Route 15					
	Two-Way Stop	Left	12.8	B	13.9	B	--	--	--	--	1.3	A	2.3	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	0.7	0.8
		Right	12.8	B	13.9	B	--	--	--	--	--	--	--	--					LOS	LOS
		Approach	12.8	B	13.9	B	--	--	--	--	0.5	A	0.8	A	0.0	A	0.0	A	A	A
3 Route 15 and Gilliam Dr			Gilliam Dr								Route 15				Route 15					
	Signal	Left	16.8	B	18.1	B	--	--	--	--	1.1	A	1.9	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--					3.4	A	6.0	A	2.9	5.5
		Right	16.2	B	15.9	B	--	--	--	--	--	--	--	--					LOS	LOS
		Approach	16.6	B	17.4	B	--	--	--	--	1.1	A	1.9	A	3.4	A	6.0	A	A	A
4 Route 15 and Reed St							Reed St				Route 15				Route 15					
	Signal	Left	--	--	--	--	17.3	B	17.7	B	--	--	--	--	1.0	A	1.5	A	Delay	Delay
		Through	--	--	--	--	--	--	--	--	4.0	A	5.3	A					3.5	4.0
		Right	--	--	--	--	16.0	B	15.6	B					--	--	--	--	LOS	LOS
		Approach	--	--	--	--	16.8	B	17.4	B	4.0	A	5.3	A	1.0	A	1.5	A	A	A
5 Route 15 and Spottswood Dr			Spottswood Dr				Spottswood Dr				Route 15				Route 15					
	Signal	Left	18.6	B	21.2	C	12.7	B	19.5	B	1.4	A	3.0	A	0.4	A	0.2	A	Delay	Delay
		Through									0.0	A	0.0	A	0.0	A	0.0	A	0.7	1.1
		Right	9.6	A	10.0	A													LOS	LOS
		Approach	12.8	B	11.3	B	12.7	B	19.5	B	0.7	A	1.6	A	0.2	A	0.1	A	A	A
6 Route 15 and Milnwood Rd			Milnwood Rd				Milnwood Rd				Route 15				Route 15					
	Signal	Left	30.2	C	44.7	D	28.7	C	52.5	D	15.5	B	33.4	C	17.8	B	33.4	C	Delay	Delay
		Through	32.3	C	77.5	E	27.8	C	32.1	C	18.6	B	29.1	C	18.1	B	34.2	C	19.9	35.9
		Right									15.3	B	23.6	C	15.1	B	21.2	C	LOS	LOS
		Approach	31.7	C	72.4	E	28.3	C	47.0	D	17.9	B	27.7	C	18.0	B	34.1	C	B	C
7 Route 15 and Belmont Cir/ Peery Dr			Peery Dr				Belmont Cir				Route 15				Route 15					
	Signal	Left	24.2	C	37.3	D	39.4	D	51.4	D	11.6	B	22.2	C	13.4	B	18.9	B	Delay	Delay
		Through									15.8	B	23.4	C	15.8	B	29.2	C	15.3	24.0
		Right	21.4	C	23.2	C	30.4	C	43.8	D	12.5	B	18.3	B	4.7	A	4.6	A	LOS	LOS
		Approach	23.9	C	24.3	C	36.2	D	49.0	D	15.4	B	23.2	C	11.8	B	20.5	C	B	C
Route 15 and Williams St/ Clark St			Williams St				Clark St				Route 15				Route 15					
	Signal	Left	31.2	C	42.1	D	31.8	C	48.3	D	34.0	C	47.3	D	15.4	B	18.4	B	Delay	Delay
		Through									18.3	B	16.8	B	19.0	B	28.1	C	21.7	28.5
		Right	30.4	C	40.8	D	29.1	C	37.8	D	15.1	B	13.8	B	16.9	B	0.0	A	LOS	LOS
		Approach	30.6	C	41.0	D	30.1	C	44.4	D	20.3	C	21.1	C	18.4	B	28.0	C	B	C

Figure 12. Future 2030 No-Build AM(PM) Peak Intersection Operations Results

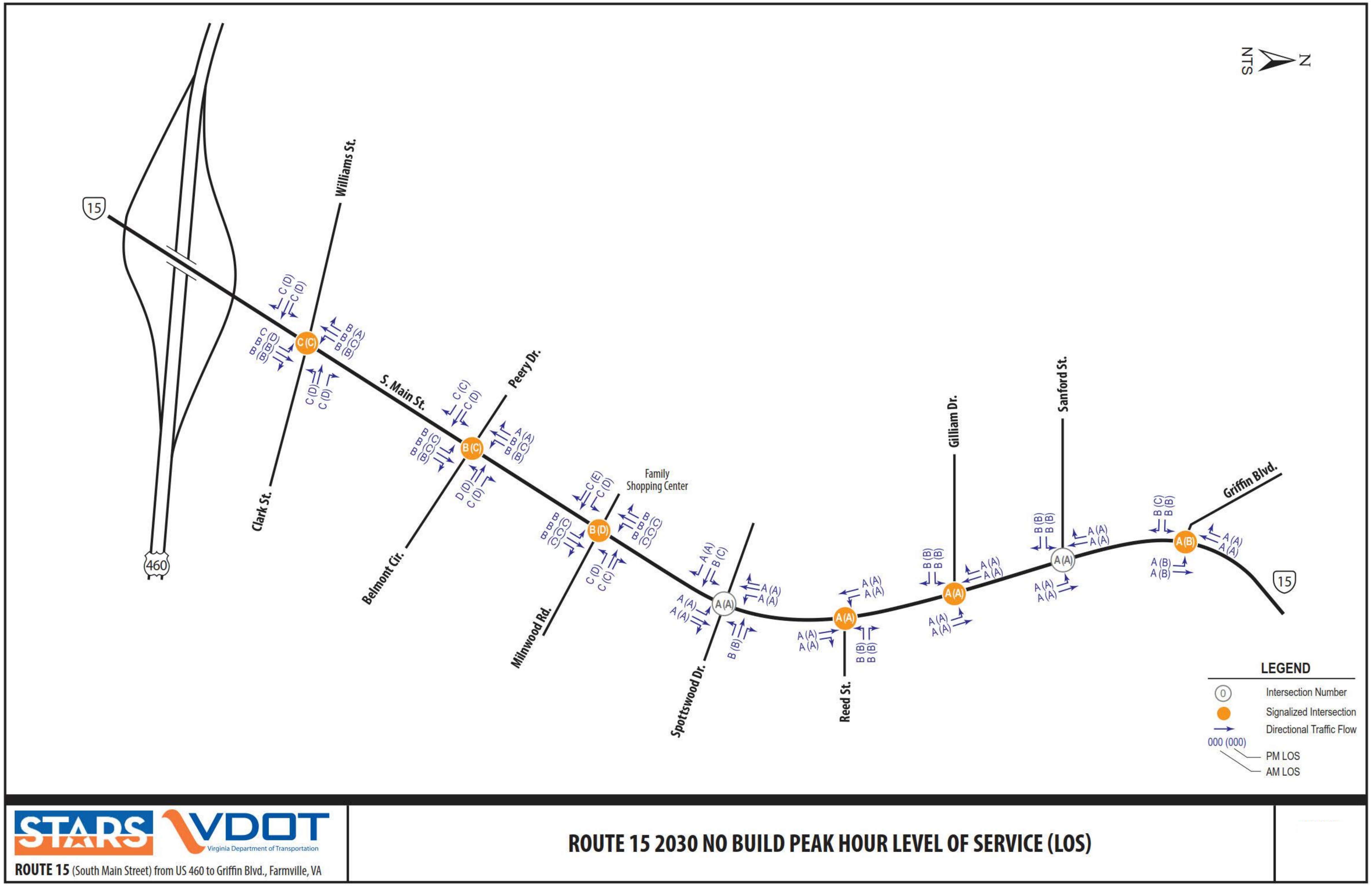


Table 10. Future 2030 No-Build AM/PM Peak Conditions: Summary of Intersection Queues (95th Percentile Queue, feet)

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
1 Route 15 and Griffin Blvd			Griffin Blvd						Route 15			Route 15		
	Signal	Left	155	33	54	--	--	--	--	89	252	--	--	--
		Through	--	--	--	--	--	--	--			--	42	155
		Right	--	40	191	--	--	--	--	--	--	--		
2 Route 15 and Sanford St			Sanford St						Route 15			Route 15		
	Signal	Left	--	8	13	--	--	--	--	2	6	--	--	--
		Through	--	--	--	--	--	--	--			--	0	0
		Right	--	8	13	--	--	--	--	--	--	--		
3 Route 15 and Gilliam Dr			Gilliam Dr						Route 15			Route 15		
	Signal	Left	--	24	64	--	--	--	--	15	17	--	--	--
		Through	--	--	--	--	--	--	--			--	59	167
		Right	175	13	21	--	--	--	--	--	--	--		
4 Route 15 and Reed St						Reed St			Route 15			Route 15		
	Signal	Left	--	--	--	50	37	62	--	--	--	--	14	25
		Through	--	--	--	--	--	--	--	70	102	--		
		Right	--	--	--	--	16	11	--			--	--	--
5 Route 15 and Spottswood Dr			Spottswood Dr			Spottswood Dr			Route 15			Route 15		
	Signal	Left	--	2	3	--	0	2	--	2	5	--	1	0
		Through	--			--			--			--		
		Right	--	1	6	--			--	2	5	--	1	0
6 Route 15 and Milnwood Rd			Milnwood Rd			Milnwood Rd			Route 15			Route 15		
	Signal	Left	--	32	47	--	114	#517	--	32	43	--	50	80
		Through	--	67	#231	--	88	165	--	204	307	--	176	426
		Right	--			--			190	38	54	--	0	0
7 Route 15 and Belmont Cir/ Peery Dr			Peery Dr			Belmont Cir			Route 15			Route 15		
	Two-Way Stop	Left	--	117	360	--	36	49	150	37	66	115	8	17
		Through	--			--			--	203	274	--	124	380
		Right	100	0	0	125	0	0	1000	0	0	380	24	28
8 Route 15 and Williams St/ Clark St			Williams St			Clark St			Route 15			Route 15		
	Signal	Left	--	33	69	--	68	#149	130	99	148	120	38	9
		Through	--			--			--	183	223	--	120	272
		Right	75	0	48	--	0	0	220	0	0	1000	0	0

NOTE: Lane configurations with a shared through lane shown as "through" lane group; with shared left-right lane shown as "left" lane group.
'--' Storage Bay Length not provided or the movements do not exist.
Red text indicates queue lengths that exceed the available storage lengths.

4 Safety Analysis

In addition to the operational analysis, a safety analysis was performed for Route 15 (South Main Street) from Griffin Boulevard to US 460 in Prince Edward County, VA. The safety analysis, which included a review of crash data and existing field conditions, was conducted to evaluate the potential areas of improvement for safety that occur along the roadway segment, determine the likely factors contributing to crashes, and propose potential mitigation activities.

4.1 Procedure

Crash data for the most recent five (5) years (August 30, 2012 through August 30, 2017) were obtained from VDOT's *Crashtools* Database. The crash data was evaluated to identify crash locations and patterns, severity of crashes, and likely causes for crashes. As part of the crash analysis, collision diagrams illustrating all crashes by year were developed and are included in **Appendix**. The crash data and collision diagrams were examined to identify crash locations on which to focus during field reviews. Field reviews were conducted, with focus on the crash patterns, to evaluate conditions in the field that could be influencing the crash locations shown in the collision diagrams. Field reviews were conducted during both the AM and PM peak periods to examine factors such as traffic conditions, human-vehicle interaction, geometric layout, and the presence and condition of signing, pavement markings, and delineation. A night-time field review was also conducted to examine roadway illumination and delineation.

The crash data analysis and field review data were used to identify potential contributing factors to crashes and to make recommendations regarding safety improvements that could mitigate future crashes.

4.2 Crash Data Analysis

4.2.1 Crashes by Year

A total of 245 crashes occurred from Griffin Boulevard to US 460 between August 30, 2012 and August 30, 2017, as shown in **Figure 13**. Note that the 2012 and 2017 bars are striped since the data does not include a full calendar year. The AADT values were used to associate the traffic volume with crashes per year, as shown in **Figure 13** (orange line). The AADT values steadily increased from 2013 to 2016, and the total number of crashes moderately fluctuated between 2013 and 2015 and then peaked in 2016.

Additionally, **Figure 14** shows that 6 ambulatory injuries (3%), 7 non-visible injuries (3%) and 77 visible injuries (31%) occurred in the study area within the five-year period. The majority of crashes that occurred were property damage, which accounted for 63% of all crashes. **Figure 15** provides a crash density map of the overall corridor.

Figure 13. Number of crashes per year for the project study area.

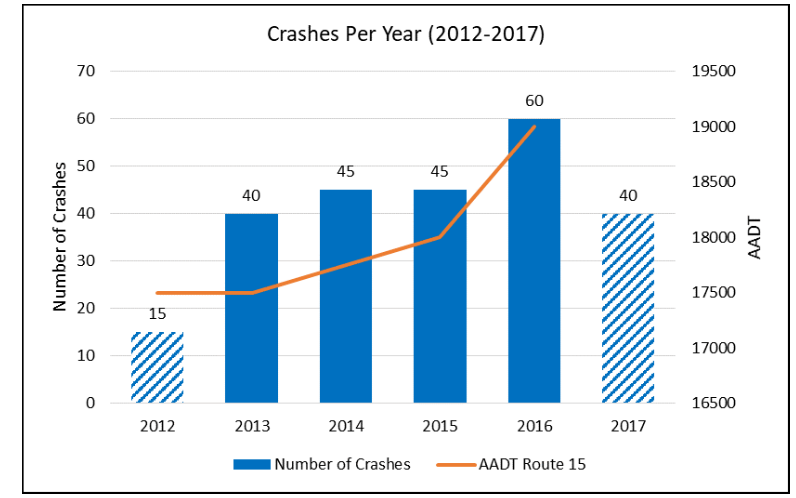


Figure 14. Severity of crashes for the project study area.

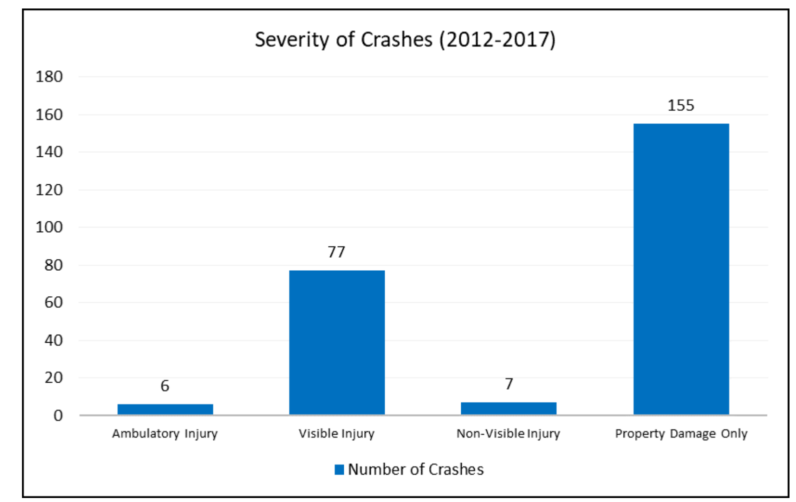
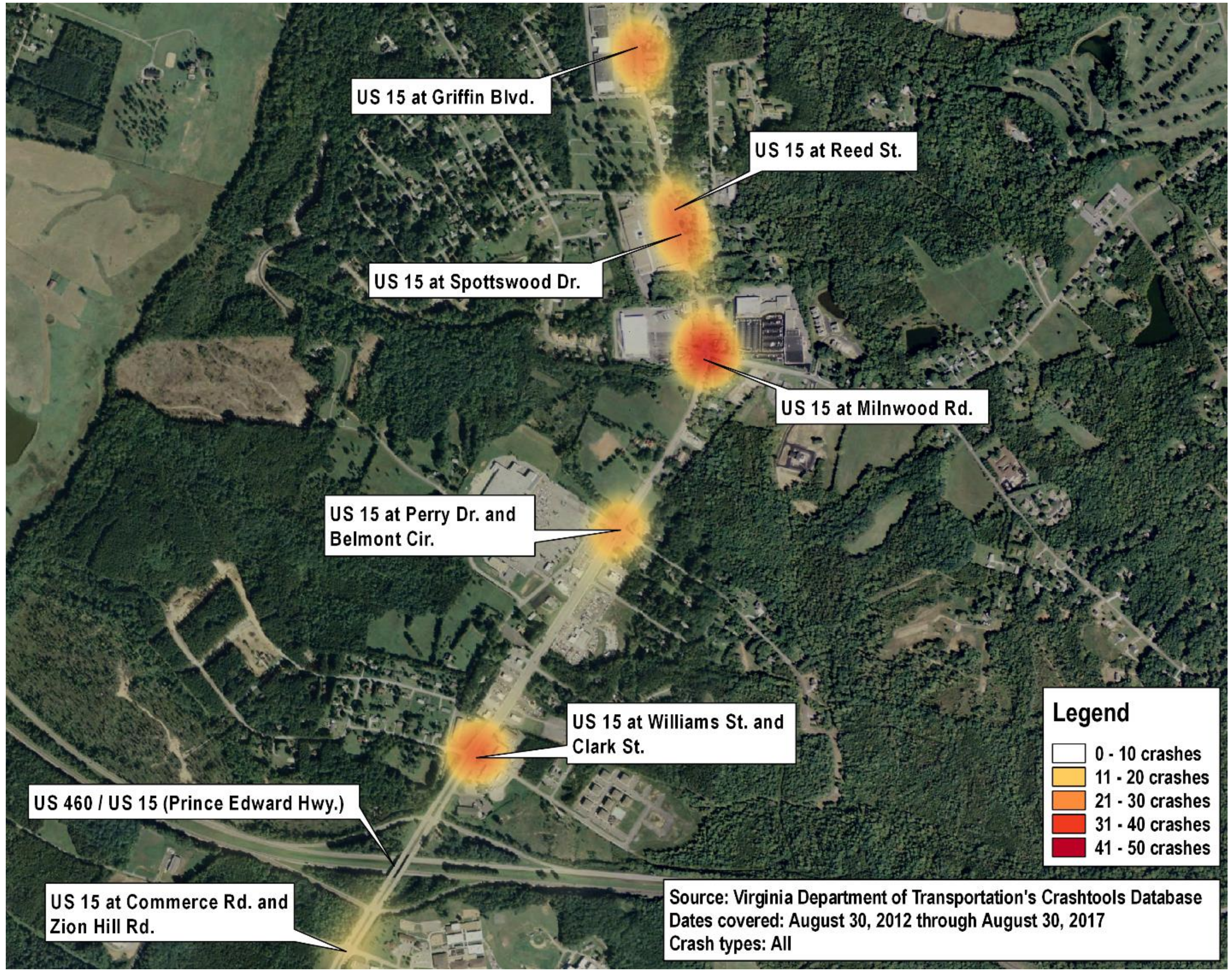


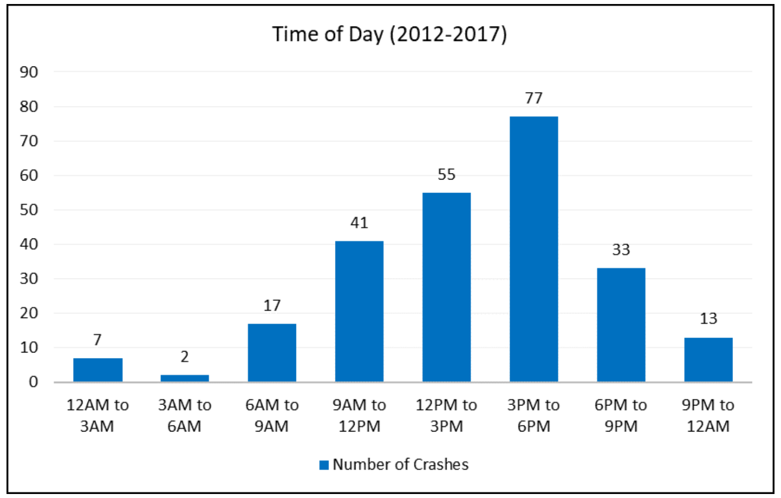
Figure 15. Crash heat map for Route 15/South Main Street (2012-2017).



4.2.2 Crashes by Time of Day

Figure 16 displays the number of crashes that occurred by time of day, presented in 3-hour increments. The highest frequency of crashes occurred from 3PM–6PM (31%), from 12PM–3PM (22%), from 9AM–12PM (17%), and from 6PM–9PM (13%).

Figure 16. Number of crashes by time of day for the project study area.



4.2.3 Crashes by Type

As shown in **Figure 17**, the majority of crashes that occurred were angle crashes (44%), followed by rear-end crashes (33%), and side-swipe same direction crashes (11%). The remaining crash types each accounted for less than 4% of the overall crashes. It should be noted that 10 crashes were incorrectly categorized within the *Crashtools* database; these crash classifications were corrected and updated, based on the crash descriptions provided within the database, to ensure the accuracy of the crash type analysis.

Figure 17. Number of crashes by type of crash for the project study area.

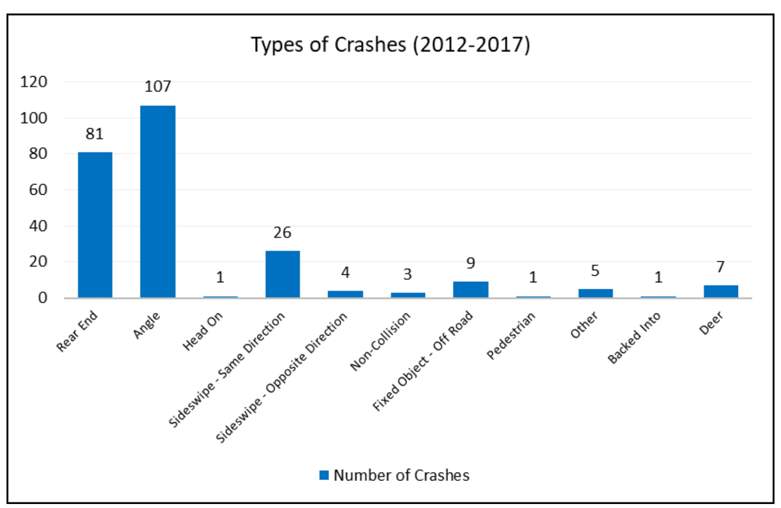


Table 11 includes the most prominent crashes along the route. Note that for the purposes of analyzing the most frequent crashes, not all crashes are included in the crash pattern analysis.

Table 11. Crash patterns along the project study area.

Location (Intersection, Segment)	Intersection Approach/Leg/Ramp	Most Prominent Crash Type(s)	Vulnerable Road User Crashes	Year(s)	Total Crashes (Highest Crash Type %)
Route 15 at William Street	North leg	Angle	N/A	2013	3 total (67% angle)
	EB approach	Angle	N/A	2014-2017	11 total (100% angle)
Route 15 at Peery Drive	SB approach	Angle	1 Pedestrian (2014)	2013-2014	6 total (50% angle)
	NB approach	Rear-end	N/A	2016	3 total (67% rear-end)
Route 15 at Milnwood	NB approach	Angle	N/A	2012; 2014; 2016-2017	16 total (50% angle)
	SB approach	Rear-end, angle	N/A	2013-2014; 2017	11 total (36% rear-end)
Route 15 at Spottswood Drive	NB approach	Angle, rear-end	N/A	2013; 2016	5 total (40% angle; 40% rear-end)
	EB approach	Angle	N/A	2015	3 total (100% angle)
Route 15 at Reed Street	NB approach	Rear-end	N/A	2016	2 total (100% rear-end)
Route 15 at Griffin Boulevard	NB approach	Angle	N/A	2013-2014; 2017	13 total (46% angle)

4.2.4 Crashes by Roadway and Weather Conditions

Figure 18 indicates the number of crashes by roadway surface condition. The majority (81%) of crashes occurred during dry roadway conditions. Wet conditions accounted for 18% of crashes. Additionally, **Figure 19** shows that most of the collisions occurred under clear/cloudy weather conditions (84%), followed by rainy weather conditions (14%).

Figure 18. Number of crashes by roadway surface condition for the project study area.

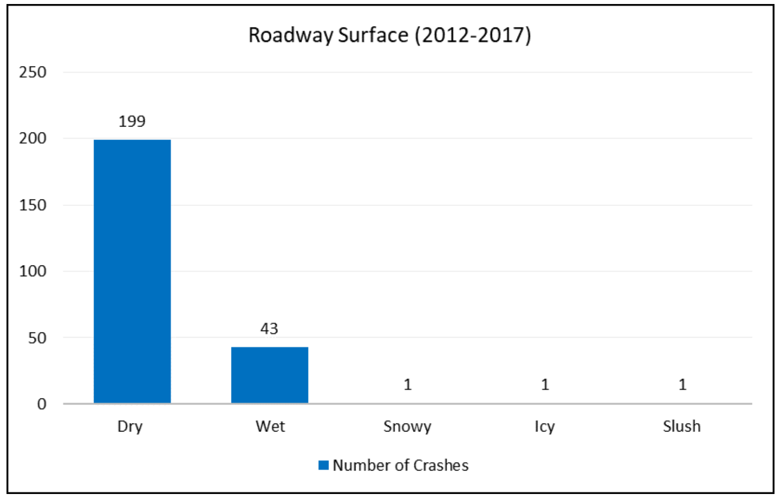
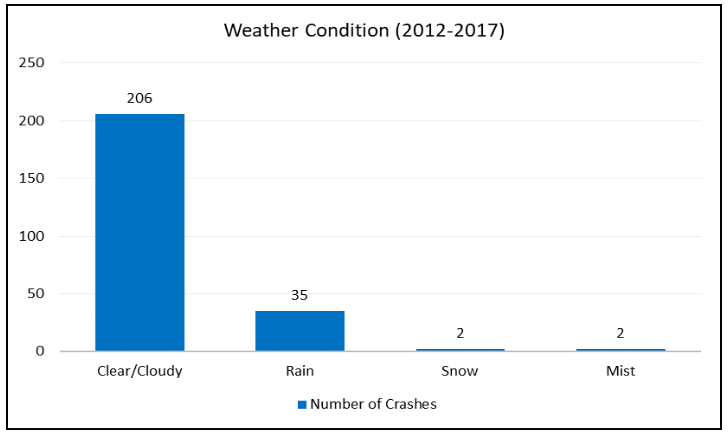


Figure 19. Number of crashes by weather condition for the project study area.



4.2.5 Crash Density by ¼-mile

Crash density histograms were developed in ¼-mile increments to provide a visual representation of crashes along the corridor based on crash type, crash severity, time-of-day, and roadway conditions. Crash hot spots were identified along the corridor as locations with the highest crash density. As shown in **Figure 20**, four (4) crash hotspots were identified for Route 15: 1) Clark/William Street Intersection, 2) Milnwood Road Intersection, 3) Spottswood Drive Intersection, and 4) Griffin Drive Intersection. A discussion of the crash hotspots is provided below.

4.2.5.1 Route 15 Northbound/Southbound

HOTSPOT 1: CLARK/WILLIAMS STREET INTERSECTION (MILEPOST 59.75-60.0)

A total of 39 crashes occurred at this hotspot. The majority of crashes were angle (59%) and rear-end (23%) crashes, with most crashes resulting in property damage and visible injuries. In addition, the crashes predominately occurred from 3:00PM-6:00PM (23%) and 6:00PM-9:00PM (23%) and primarily under dry pavement conditions.

HOTSPOT 2: MILNWOOD ROAD INTERSECTION (MILEPOST 60.50-60.75)

A total of 48 crashes occurred at this hotspot. The majority of crashes were rear-end (48%) and angle (46%) crashes, with most crashes resulting in property damage and visible injuries. In addition, the crashes predominately occurred from 3:00PM-6:00PM (40%) and 12:00PM-3:00PM (25%) and primarily under dry pavement conditions.

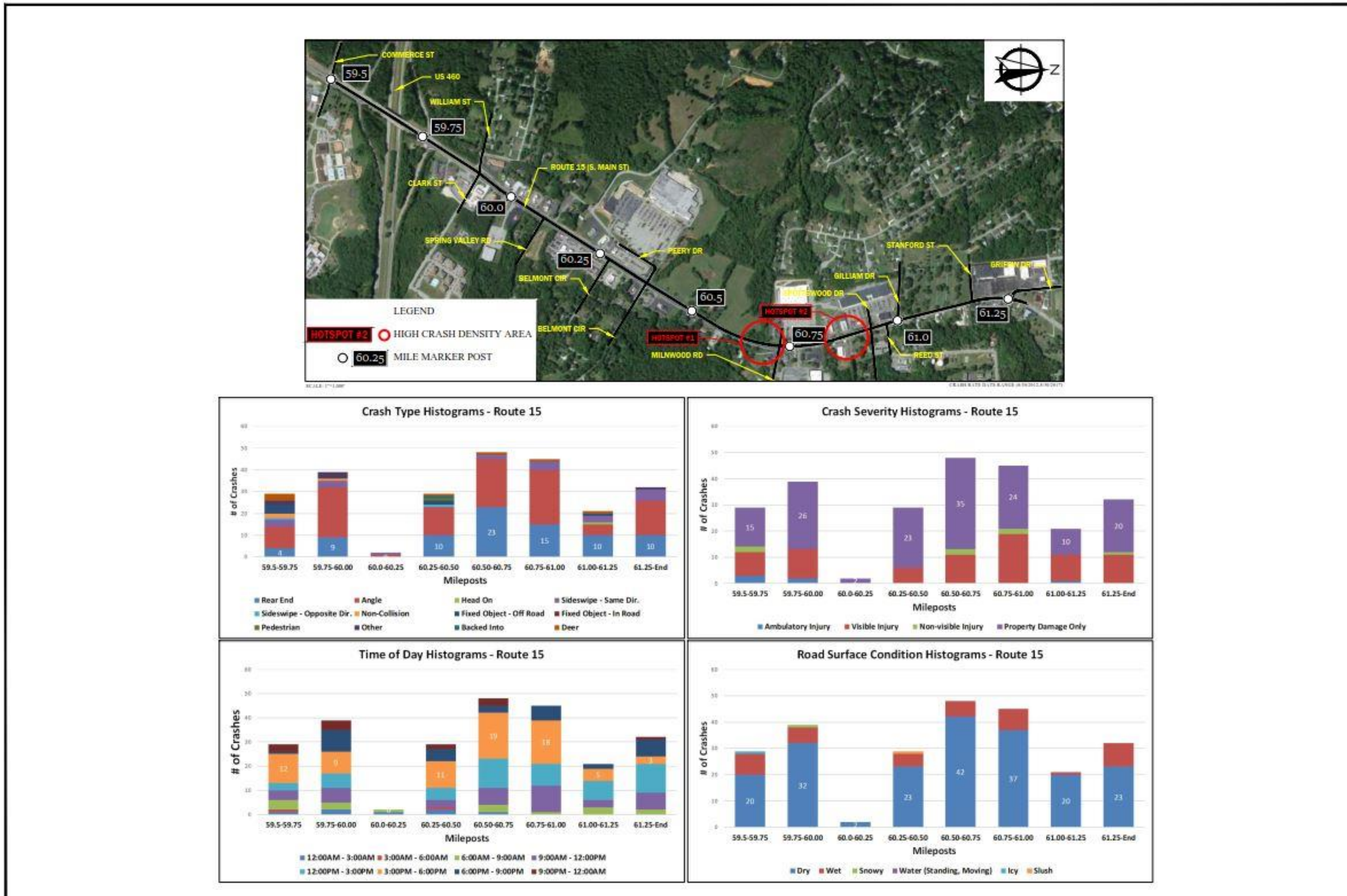
HOTSPOT 3: SPOTTSWOOD DRIVE INTERSECTION (MILEPOST 60.75-61.00)

A total of 45 crashes occurred at this hotspot. The majority of crashes were angle (56%) and rear-end (33%) crashes, with most crashes resulting in property damage and visible injuries. In addition, the crashes predominately occurred between the time periods of 3:00PM-6:00PM (40%) and 9:00AM-12:00PM (24%) and primarily under dry pavement conditions.

HOTSPOT 4: GRIFFIN DRIVE INTERSECTION (MILEPOST 61.25-END)

A total of 32 crashes occurred at this hotspot. The majority of crashes were angle (50%) and rear-end (31%) crashes, with most crashes resulting in property damage and visible injuries. In addition, the crashes predominately occurred from 12:00PM-3:00PM (38%), 9:00AM-12:00PM (22%), and 6:00PM-9:00PM (22%) and primarily under dry pavement conditions.

Figure 20. Crash density histograms per ¼-mile (Route 15)



4.2.6 Crash Rate (by intersection, segment, and ramps)

The crash rates were calculated utilizing the rate calculations described in the *Highway Safety Manual*. For our project areas, crash rates were calculated by using the road segment equation and intersection equation, as shown in **Table 12** and **Table 13.** Road segments that exceed the statewide average for the same type of facility are shaded in red in **Table 13.** Two of the eight segments exceed the statewide average rate for total crashes as well as injury crashes.

Table 12. Crash rates (intersections)

Intersection	Total Crash Rate (Per MEV)	Fatal Crash Rate (Per MEV)	Injury Crash Rate (Per MEV)	PDO Crash Rate (Per MEV)
Zion Hill Rd./Commerce Rd.	0.34	0.00	0.17	0.17
US 460 EB Ramp	0.19	0.00	0.08	0.12
US 460 WB Ramp	0.07	0.00	0.04	0.04
Clark St./Williams St.	1.09	0.00	0.36	0.73
Belmont Cir./Peery Dr.	0.56	0.00	0.16	0.40
Milnwood Rd.	1.04	0.00	0.29	0.75
Reed St.	0.28	0.00	0.18	0.11
Gilliam Dr.	0.32	0.00	0.14	0.18
Griffin Blvd.	0.95	0.00	0.42	0.53

Table 13. Crash rates (segments).

Segment	Total CR (Per 100 MVM)		Statewide Average (2015)	Fatal CR (Per 100 MVM)		Statewide Average (2015)	Injury CR (Per 100 MVM)		Statewide Average (2015)	PDO CR (Per 100 MVM)		Statewide Average (2015)
Zion Hill Rd./Commerce Rd. to US 460 EB Ramp	0.00	≤	151.62	0.00	≤	0.86	0.00	≤	51.77	0.00	≤	98.99
US 460 EB Ramp to US 460 WB Ramp	45.74	≤	151.62	0.00	≤	0.86	22.87	≤	51.77	22.87	≤	98.99
US 460 WB Ramp to Clark St./Williams St.	28.92	≤	151.62	0.00	≤	0.86	0.00	≤	51.77	28.92	≤	98.99
Clark St./Williams St. to Belmont Cir./Peery Dr.	148.79	≤	151.62	0.00	≤	0.86	29.76	≤	51.77	119.03	≥	98.99
Belmont Cir./Peery Dr. to Milnwood Rd.	92.73	≤	151.62	0.00	≤	0.86	27.82	≤	51.77	64.91	≤	98.99
Milnwood Rd. to Reed St.	522.11	≥	151.62	0.00	≤	0.86	214.20	≥	51.77	307.91	≥	98.99
Reed St. to Gilliam Dr.	0.00	≤	151.62	0.00	≤	0.86	0.00	≤	51.77	0.00	≤	98.99
Gilliam Dr. to Griffin Blvd.	199.19	≥	151.62	0.00	≤	0.86	99.60	≥	51.77	99.60	≥	98.99
	Exceeds the state average crash rate											

4.2.7 Crash Data Summary

The following observations were made for crashes that occurred during the five (5) year period from Griffin Boulevard to US 460:

- No fatal crashes occurred.
- 37 percent (37%) of crashes resulted in non-fatal injuries (90 crashes) (i.e., ambulatory, visible, and non-visible injuries).
- 81 percent (81%) of crashes occurred under dry pavement conditions (199 crashes).
- 18 percent (18%) of crashes occurred under wet pavement conditions (43 crashes).
- 44 percent (44%) of crashes that occurred over the five (5) year period were angle crashes (107 crashes).
- 33 percent (33%) of crashes that occurred over the five (5) year period were rear-end crashes (81 crashes).
- 9 percent (9%) of crashes occurred during dark lighting conditions, which includes the following time periods: 9PM–12AM, 12AM–3AM, and 3AM–6AM (22 crashes).
- 7 percent (7%) of crashes (17 crashes) occurred during the AM peak period (6AM–9AM). 31 percent (31%) of crashes (77 crashes) occurred during the PM peak period (3PM–6PM).

4.3 Field Review

Field observations were conducted at the project study area from Tuesday, November 14, 2017 through Thursday, November 16, 2017 during the AM and PM peak periods to assess traffic operations, roadway geometrics, safety, queuing, vehicle interaction conflicts, and existing signage. In order to evaluate these conditions within the field, various engineering manuals (e.g. Manual on Uniform Traffic Control Devices (MUTCD), Virginia Supplement to MUTCD, VDOT Traffic Engineering Design Manual (TEDM), 2010 ADA Standards for Accessible Design (ADA)) were used. It should be noted that while collision diagrams were utilized to determine crash patterns and areas of focus, other recommendations and/or observations were noted that may not be directly related to crash patterns but may reduce the risk of crashes. It was important to record all field recommendations and/or observations since they could potentially create unsafe conditions for road users.

Table 14 lists common observations/recommendations from the field and the respective standards. Note that existing standards will be cited within the Field Review and Recommendations sections for any unique observations/recommendations that are not listed within **Table 14**.

Table 14. Common field observations/recommendations and the associated standards.

Observation/Recommendation	Associated Standard
Tactile domes do not comply with standards and should be updated	VDOT RBS; ADA Section 705.1
Pedestrian crossing pavement markings are faded and should be refurbished	MUTCD Section 3B.18
Stop bar/yield lines are faded and should be refurbished	MUTCD Section 3B.16
Stop sign is not present and should be installed	MUTCD Section 2B.10
Pedestrian facilities are not provided and should be installed	MUTCD Section 3B.18 and MUTCD Chapter 4E

A field review reference figure has been provided in the **Appendix** to provide specified locations of each of the numbered field review observations listed in the following sections.

4.3.1 Route 15 (South Main Street) at Commerce Road/Zion Hill Road

Figure 21

- Sign posts are provided on the northwest and northeast corners of the intersection for all approaching vehicles (**Figure 21**); however, no street sign panels are provided on the mast arms. *(See Recommendation A1)*
- The signal heads for all approaches have backplates but do not have yellow retroreflective borders installed. Based on the collision diagrams, rear-end and sideswipe crashes occurred in the past five years and could be due to poor visibility of the signal heads. *(See Recommendation A2)*

4.3.2 Route 15 (South Main Street) at Southbound Route 15 to Westbound US 460

Figure 22

- A deep stormwater ditch exists on the southwest corner of the on-ramp to westbound US 460 from southbound Route 15 (**Figure 22**). Based on the collision diagrams, a non-collision crash occurred due to a vehicle making a wide right-turn and crashing into this ditch. *(See Recommendation A3)*

4.3.3 Route 15 (South Main Street) at Williams Street/Clark Street

- The signals for all approaches have backplates but do not have yellow retroreflective borders installed. *(See Recommendation A4)*
- Pedestrian facilities are not provided at the intersection, except for the non-compliant ADA ramps provided on the northeast and northwest corners. *(See Recommendation A5)*

Figure 23

- The left sight distance for the northbound right-turn lane may be limited due to the traffic control, utility boxes, and the mast arm pole located in the median on the south leg. Additionally, the horizontal and vertical curvature of the eastbound approach may limit sight distance (**Figure 23**). Please note, the existing stop bar for the northbound right-turn lane is located approximately 13 feet closer to the intersection, in comparison to the northbound left and through lane stop bars; however, the sight distance may still be limited. *(See Recommendation A6)*
- Currently, southbound left-turning vehicles must yield to oncoming traffic when the protected green arrow is *not* provided. During the yield condition, northbound left-turn vehicles in the storage bay are obstructing the southbound left-turning vehicles' sight line of northbound through vehicles. Based on the collision diagrams, angles crashes were observed in 2013 and may be attributed to this obstruction. *(See Recommendation A7)*

4.3.4 Route 15 (South Main Street) from Williams Street/Clark Street to Spring Valley Road

Figure 24

- A continuous sidewalk is provided on the west side of the road from Williams Street/Clark Street to Spring Valley Road; however, sidewalk discontinuity is present on the east side of this roadway segment (**Figure 24**). *(See Recommendation A8)*

4.3.5 Route 15 (South Main Street) at Spring Valley Road

- There are no pavement markings (e.g., stop bar, pavement arrows) on the westbound approach. Additionally, neither ADA-compliant pedestrian ramps nor tactile domes are provided. *(See Recommendation A9)*

4.3.6 Route 15 (South Main Street) from Spring Valley Road to Belmont Circle (unsignalized intersection)

- Currently, continuous sidewalk is provided on the west side of the road; however, sidewalk discontinuity is present on the east side of the road. *(See Recommendation A10)*

4.3.7 Route 15 (South Main Street) at Belmont Circle (unsignalized intersection)

- There are no pavement markings (e.g., stop bar, pavement arrows) on the westbound approach. Additionally, neither ADA-compliant pedestrian ramps nor tactile domes are provided. *(See Recommendation A11)*

4.3.8 Route 15 (South Main Street) at Belmont Circle/Peery Drive

- The signals for all approaches have backplates but do not have yellow retroreflective borders installed. Based on the collision diagrams, rear-end crashes occurred in 2016 and could be due to poor visibility of the signal heads. *(See Recommendation A12)*
- Pedestrian facilities are provided across the south and east legs of the intersection; however, the existing ramps and tactile domes are non-ADA compliant and the pedestrian signals are outdated (i.e., pedestrian countdown timer is not provided) (**Figure 25**). *(See Recommendation A13)*
- Currently, no "Turning Vehicles Yield to Pedestrians" sign panels (R10-15) are provided for the northbound, eastbound, and westbound approaches. *(See Recommendation A14)*

Figure 25

4.3.9 Route 15 (South Main Street) from Belmont Circle/Peery Drive to Graham Road

- The northbound rightmost lane at the Taco Bell driveway, located just north of the Belmont Circle/Peery Drive intersection, provides little indication that the lane is ending (**Figure 26**). *(See Recommendation A15)*

Figure 26

4.3.10 Route 15 (South Main Street) at Graham Road

- There are no pavement markings (i.e. stop bar, pavement arrows) on the westbound approach. Additionally, the pedestrian ramps are non-ADA compliant and do not provide tactile domes. *(See Recommendation A16)*

4.3.11 Route 15 (South Main Street) from Graham Road to Milnwood Road

- Currently, continuous sidewalk is provided on the east side of the road; however, no sidewalk is provided on the west side of the road.

4.3.12 Route 15 (South Main Street) at Milnwood Road

- The signals for all approaches have backplates but do not have yellow retroreflective borders installed. Based on the collision diagrams, rear-end crashes occurred in 2013-2014 and in 2017 and could be due to poor visibility of the signal heads. *(See Recommendation A17)*
- The eastbound approach pavement markings are faded. *(See Recommendation A18)*
- Pedestrian facilities (e.g., crosswalks and pedestrian signals) exist across the north and east legs of the intersection; however, the existing ramps and tactile domes are non-ADA compliant and the pedestrian signals are outdated (i.e., pedestrian countdown timer is not provided) (**Figure 27**). In addition, there is no sidewalk on the west side of the roadway; therefore, the intersection cannot accommodate pedestrians utilizing the crossing on the north leg. *(See Recommendation A19)*
- No "Turning Vehicles Yield to Pedestrians" sign panels (R10-15) are provided for the northbound, southbound, and westbound approaches. *(See Recommendation A20)*
- The northbound approach right-turn lane is a terminal lane and does not provide a "Right Lane Must Turn Right" sign panel (R3-7R). *(See Recommendation A21)*

Figure 27

4.3.13 Route 15 (South Main Street) from Milnwood Road to Spottswood Drive

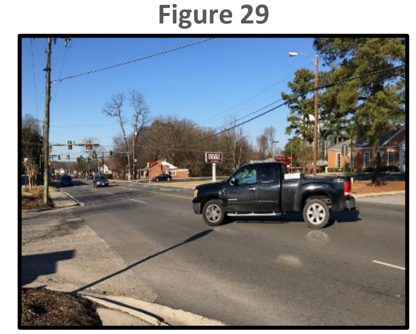
- Currently, continuous sidewalk is provided on the east side of the road; however, sidewalk discontinuity is present on the west side of the road.
- During the peak hours, numerous vehicles were observed entering and exiting (i.e., northbound left turn, eastbound left turn) via the "Shoppes at College Park" access point, south of the Spottswood Drive intersection. Eastbound turning vehicles were observed entering the northbound and southbound lanes with inadequate gaps, causing several near miss incidents with the northbound and southbound vehicles. Additionally, northbound left-turning vehicles do not have a dedicated left-turn lane to turn into the shopping plaza, which caused vehicle backups in the northbound left- lane. Based on the collision diagrams, angle crashes and rear-end crashes were prominent in 2016, and the difficulty of entering/exiting this shopping center could be contributing to these high crash statistics. *(See Recommendation A22)*

4.3.14 Route 15 (South Main Street) at Spottswood Drive

- The pavement markings are faded on the eastbound approach of the intersection, and there are no pavement markings (i.e., stop bar, pavement arrows) on the westbound approach. *(See Recommendation A23)*
- There are no street signs provided for any of the approaches at the intersection (**Figure 28**). *(See Recommendation A24)*
- No pedestrian crosswalks are provided on the east and west sides of the intersection. Additionally, the northeast and southeast corners do not provide pedestrian ramps. *(See Recommendation A25)*
- This unsignalized intersection provides an entrance/exit point for the "Shoppes at College Park" shopping center on the west side of the road. During the peak hours, vehicles were observed entering and exiting (northbound left turn and eastbound left turn) the shops with inadequate gaps which resulted in near-miss crashes (**Figure 29**). The proximity of the signalized intersections just north of the intersection (Reed Street and Gilliam Drive) provided the necessary southbound gaps for northbound left turning vehicles and eastbound vehicles; however, northbound traffic was continuous with few gaps for eastbound vehicles to turn northbound. Additionally, northbound left turning vehicles are not provided a separate left-turn lane into the shopping plaza, which often caused vehicle backups in the northbound left lane. Based on the collision diagrams, angle crashes and rear-end crashes were prominent from 2013 through 2015, and the difficulty of entering/exiting this shopping center could be contributing to these high crash statistics. *(See Recommendation A26)*

Figure 28

Figure 29



4.3.15 Route 15 (South Main Street) at Reed Street

- The signals for all approaches have backplates but do not have yellow retroreflective borders installed. Based on the collision diagrams, rear-end crashes occurred in 2016 and could be due to poor visibility of the signal heads. *(See Recommendation A27)*

Figure 30

- Pedestrian crosswalks are provided across the south and east legs; however, no ramps or tactile domes are provided on the northeast, southeast, and southwest corners of the intersection. Additionally, the provided pedestrian signals are non-ADA compliant and outdated (i.e., pedestrian countdown timer is not provided). *(See Recommendation A28)*
- Currently, no "Turning Vehicles Yield to Pedestrians" sign panels (R10-15) are provided for the northbound, southbound, and westbound approaches (**Figure 30**). *(See Recommendation A29)*

4.3.16 Route 15 (South Main Street) from Reed Street to Gilliam Drive

Figure 31

- The Gilliam Drive intersection is located approximately 150 feet north of the Reed Street intersection, which does not comply with the distance separation between two signalized intersections (**Figure 31**), outlined in Table 2-2 of VDOT Road Manual Appendix F. Based on the crash diagrams, rear-end crashes were prominent from 2013 through 2017, along the northbound and southbound lanes. The proximity issues of these two intersections could be attributing to these crash statistics. *(See Recommendation A30)*

4.3.17 Route 15 (South Main Street) at Gilliam Drive

- The signals for all approaches have backplates but do not have yellow retroreflective borders installed. *(See Recommendation A31)*

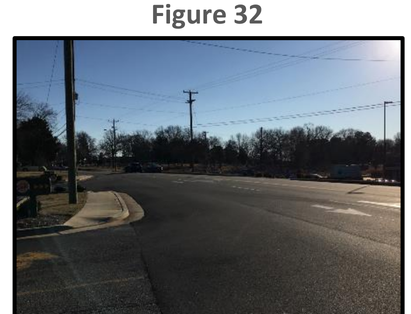
4.3.18 Route 15 (South Main Street) at Sanford Street

- The eastbound approach does not provide pavement marking arrows. *(See Recommendation A32)*

4.3.19 Route 15 (South Main Street) at Griffin Boulevard

- The signals for all approaches have backplates but do not have yellow retroreflective borders installed. *(See Recommendation A33)*
- A pedestrian crosswalk is provided across the south leg of the intersection; however, no ADA-compliant ramps/tactile domes are provided at the intersection and no sidewalk is provided on the west side of the roadway. Additionally, pedestrian signals are non-ADA compliant and outdated (i.e., pedestrian countdown timer is not provided). *(See Recommendation A34)*

Figure 32



- Just south of the intersection, along the northbound lanes, two Burger King entrance/exit driveways exist. These two driveways provide access for both northbound and southbound vehicles. The driveway furthest south is the entrance driveway (based on pavement marking arrows) and the driveway closest to the intersection of Route 15 at Griffin Boulevard is the exit driveway. Westbound vehicles left-sight distance may be limited due to commercial signage and utility poles as well as the overall horizontal alignment of the road (**Figure 32**). During the field review, westbound turning vehicles were observed having difficulty making left and right turning movements onto Route 15. Based on the crash diagrams, angle crashes due to vehicles entering and exiting the Burger King driveways were observed from 2012 through 2017. Additionally, rear-end crashes and side-swipe crashes between these driveways and the northbound approach of the Route 15 at Griffin Boulevard intersection were prevalent from 2012 through 2014 and from 2016 through 2017. The concentration of crashes could be due to the current conditions of the roadway and oncoming northbound and southbound vehicle sight limitations. *(See Recommendation A35)*

Figure 33

- The northbound approach currently has a skewed horizontal alignment and thus limits sight distance to the approaching intersection of Route 15 at Griffin Boulevard. Currently, no advanced warning signal signs are provided along the northbound lanes for vehicles approaching the intersection. Based on the collision diagrams, rear-end crashes were prominent from 2012 through 2014 and from 2016 through 2017. The lack of advanced warning for the northbound approaching vehicles could be contributing to the high crash rates at the northbound approach of the intersection. *(See Recommendation A36)*
- During the PM peak hour, vehicles queues were observed extending back along the eastbound approach right-turn lane. These vehicle queues blocked vehicles from accessing the eastbound left turn pocket lane (**Figure 33**). Additionally, during the PM peak hour, vehicles were observed unable to proceed through the eastbound phase in one cycle.

4.3.20 Overall Site Review

- Private driveways occur frequently along the Route 15 corridor, and in most cases, these driveways provide little-to-no pedestrian facilities, pavement markings, or signage. While the City of Farmville is not responsible for the maintenance of private driveways the lack of these improvements could be contributing to dangerous vehicular movements and crashes along the corridor.
- Currently, sidewalk is provided sporadically along the Route 15 corridor. This sidewalk discontinuity forces pedestrians to cross Route 15 midblock. *(See Recommendation A37)*
- Signalized intersections along the corridor experienced queuing issues at some approaches, and in some scenarios prevented or blocked other movements from proceeding. These blockages could be contributing to some of the crashes as vehicles approach or proceed through the intersection. *(See Recommendation A38)*

4.4 Recommendations

4.4.1 Route 15 (South Main Street) at Commerce Road/Zion Hill Road

A1. Consider installing overhead signs on the mast arms for all intersection approaches, per standards outlined in **Table 14**.

A2. Consider installing backplates with retroreflective borders on all traffic signal heads for all intersection approaches.

4.4.2 Route 15 (South Main Street) at Southbound Route 15 to Westbound US 460

A3. Consider installing a guardrail, per standards outlined in VDOT Guardrail Installation Training Manual (GRIT), to prevent future ditch-related crashes.

4.4.3 Route 15 (South Main Street) at Williams Street/Clark Street

A4. Consider installing backplates with retroreflective borders on all traffic signal heads for all intersection approaches.

A5. Consider installing pedestrian facilities (i.e., crosswalk, ramps, tactile domes, pedestrian signals) across the north leg of the intersection, per standards outlined in **Table 14.** Should pedestrian facilities be implemented, install "Turning Vehicles Yield to Pedestrians" sign panels (R10-15) on the mast arms for the southbound westbound, and eastbound approaches.

A6. Consider relocating the existing stop bar for northbound right-turning vehicles closer to the southeast corner of the intersection (approximately 5 feet) to improve the left site distance and mitigate future angle crashes.

A7. Consider converting the existing protected/permissive five-head signal with a protected green arrow signal for southbound left-turning vehicles. Eliminating the permissive movement could reduce future angle crashes at the intersection. Please note, this phasing change will impact operations at the intersection; therefore, evaluation of northbound left-turning volumes should be considered before implementation.

4.4.4 Route 15 (South Main Street) from Williams Street/Clark Street to Spring Valley Road

A8. Consider installing a continuous sidewalk along the east side of the roadway to provide refuge for pedestrians and safer access to establishments along Route 15.

4.4.5 Route 15 (South Main Street) at Spring Valley Road

A9. Install pavement markings (e.g., stop bar and pavement arrows) and tactile domes for the westbound approach, per standards outlined in **Table 14**.

4.4.6 Route 15 (South Main Street) from Spring Valley Road to Belmont Circle (unsignalized intersection)

A10. Consider installing a continuous sidewalk along the east side of the roadway to provide refuge for pedestrians and safer access to establishments along Route 15.

4.4.7 Route 15 (South Main Street) at Belmont Circle (unsignalized intersection)

A11. Install pavement markings (e.g., stop bar and pavement arrows) and tactile domes for the westbound approach, per standards outlined in **Table 14**.

4.4.8 Route 15 (South Main Street) at Belmont Circle/Peery Drive

A12. Consider installing backplates with retroreflective borders on all traffic signal heads for all intersection approaches.

A13. Install pedestrian ramps and tactile domes that comply with standards outlined in **Table 14** on the northeast, southeast, and southwest corners of the intersection, and replace the existing pedestrian signals, per standards outlined in MUTCD 4E.04.

A14. Consider installing "Turning Vehicles Yield to Pedestrians" sign panels (R10-15) on the northbound, eastbound, and westbound approach mast arms.

4.4.9 Route 15 (South Main Street) from Belmont Circle/Peery Drive to Graham Road

A15. Consider installing supplementary merging arrow pavement markings for vehicles traveling northbound in compliance with the standards outlined in **Table 14**. Additionally, merging signage should be installed according to MUTCD Standard Section 3B.14 with sign panels indicating that the lane is ending (W4-2).

4.4.10 Route 15 (South Main Street) at Graham Road

A16. Install pavement markings (e.g., stop bar and pavement arrows) and tactile domes for the westbound approach, per standards outlined in **Table 14**.

4.4.11 Route 15 (South Main Street) at Milnwood Road

A17. Consider installing backplates with retroreflective borders on all traffic signal heads for all intersection approaches.

A18. Refurbish the eastbound approach pavement markings to provide clear directions to drivers, per standards outlined in **Table 14**.

A19. Install ramps and tactile domes that comply with standards outlined in **Table 14 on** the northeast, northwest, and southeast corners of the intersection, and replace the existing pedestrian signals, per standards outlined in MUTCD 4E.04. Additionally, the pedestrian crosswalk interval for the east leg should be increased to a minimum of 29 seconds, per standards and calculations outlined in MUTCD 4E. Should a ramp be installed on the northwest corner, consider evaluating the need for sidewalk installation on the west side of the roadway.

A20. Consider installing "Turning Vehicles Yield to Pedestrians" sign panels (R10-15) on the mast arms for the northbound, southbound, and westbound approaches.

A21. Consider installing a "Right Lane Must Turn Right" sign panel (R3-7R) for the northbound right turn lane approximately 50 feet south of the intersection along the east side of the road.

4.4.12 Route 15 (South Main Street) from Milnwood Road to Spottswood Drive

A22. Consider installing MUTCD median/lane delineator posts along the northbound/southbound centerline. Installing these delineators restricts this driveway to a right-in/right-out condition, and will divert vehicles to utilize the unsignalized Route 15 at Spottswood Drive intersection or the signalized Route 15 at Gilliam Drive intersection to make cross street turning movements. This will mitigate future rear-end, side-swipe, and angle crashes for this section of roadway. Please note, as this restriction does require vehicles to be diverted to a new turning location, volumes at this intersection in addition to the two intersections that are being utilized by diverted vehicles would need to be evaluated to determine operationally how these restrictions would impact the intersections.

4.4.13 Route 15 (South Main Street) at Spottswood Drive

A23. Refurbish the pavement markings on the eastbound approach of the intersection. Additionally, install pavement markings (e.g., stop bar, pavement arrows) on the westbound approach, per standards outlined in **Table 14**.

A24. Consider installing street sign posts for "South Main Street" and "Spottswood Drive" for the eastbound/westbound approaches and northbound/southbound approaches, respectively, on the northeast and southeast corners of the intersection, per standards outlined in **Table 14**.

A25. Consider installing ADA-compliant ramps with tactile domes and crosswalk pavement markings, per standards outlined in **Table 14**.

A26. Consider evaluating this driveway access opening, and restricting certain movements (e.g., eastbound through and left-turns, northbound left-turns) as it currently operates as an unsignalized intersection, with many angle crashes resulting from vehicular turns occurring with inadequate gaps in the northbound and southbound traffic and its proximity to the signalized intersection of Route 15 at Reed Street. With the restrictions to some of the turning movements at the intersection, future rear-end, side-swipe, and angle crashes for this section of roadway should be mitigated. Please note, as a restriction is being recommended at the driveway access point just south of this intersection, volumes at this intersection would need to be evaluated to determine operationally how these restrictions would impact the both this intersection as well as intersections that diverted vehicles will be using.

4.4.14 Route 15 (South Main Street) at Reed Street

A27. Consider installing backplates with retroreflective borders on all traffic signal heads for all intersection approaches.

A28. Install ramps and tactile domes that comply with standards outlined in **Table 14** on the northeast, southeast, and southwest corners of the intersection. Additionally, replace the existing pedestrian signals, per standards outlined in MUTCD 4E.04.

A29. Consider installing "Turning Vehicles Yield to Pedestrians" sign panels (R10-15) on the mast arms for the northbound, southbound, and westbound approaches.

4.4.15 Route 15 (South Main Street) from Reed Street to Gilliam Drive

A30. Per standards outlined in Table 2-2 in the VDOT Road Manual Appendix F, the minimum distance required between signalized intersections on a principal arterial road with a 35 mph speed limit is 1,320 feet. Consider adjusting the spacing of the two subject intersections as they fall below the VDOT minimum spacing threshold requirements.

4.4.16 Route 15 (South Main Street) at Gilliam Drive

A31. Consider installing backplates with retroreflective borders on all traffic signal heads for all intersection approaches.

4.4.17 Route 15 (South Main Street) at Sanford Street

A32. Refurbish the pavement markings on the eastbound approach of the intersection, per standards outlined in **Table 14**.

4.4.18 Route 15 (South Main Street) at Griffin Boulevard

A33. Consider installing backplates with retroreflective borders on all traffic signal heads for all intersection approaches.

A34. Install ramps and tactile domes that comply with standards outlined in **Table 14** at the southeast and southwest corners of the intersection. Additionally, replace the existing pedestrian signals, per standards outlined in MUTCD 4E.04. Should a ramp be installed on the southwest corner, consider installing a sidewalk on the west side of the roadway.

A35. Consider further evaluating the Burger King private access driveways and its proximity to the intersection of Route 15 at Griffin Boulevard.

A36. Consider installing advanced warning signal sign panels (W3-3) along the sides of roads along the northbound lanes. Providing advanced warning signage for northbound approaching vehicles could create better awareness of the upcoming signalized intersection and mitigate future rear-end crashes at the approach as well as angle crashes with westbound vehicles at the Burger King exit driveway.

4.4.19 Overall Site Review

A37. Consider evaluating the need for updating and standardizing pedestrian facilities along the corridor and at subject intersections**,** per standards outlined in **Table 14**.

A38. Consider evaluating and/or optimizing current signal timings along the corridor to help alleviate congestion and queuing issues.

Note: While these recommendations were provided based on the field review, it is up to the City of Farmville and the Virginia Department of Transportation to provide both input and the final decision on what is to be modified, replaced, and/or updated.

5 Improvement Alternatives

This section summarizes the improvement alternatives considered for the Route 15 (South Main Street) corridor. The proposed improvements along Route 15 are primarily driven by a need to address existing and future safety and operational concerns. The alternatives were developed based upon the results of the Existing Conditions and No-Build Conditions analyses, field observation, review of prior studies/recommendations, as well as coordination with VDOT Lynchburg District Office and TMPD, Prince Edward County, and the Town of Farmville. An in-person Alternatives Development Workshop was held on May 10, 2018 at the Town of Farmville, Town Manager's Conference Room.

5.1 Future Year 2030 Build Alternatives

5.1.1 Preliminary Improvement Alternatives

The approximately 1.7-mile study corridor of Route 15 comprised of 6 signalized intersections:

- Route 15 and Griffin Blvd
- Route 15 and Gilliam Drive
- Route 15 and Reed Street
- Route 15 and Milnwood Road
- Route 15 and Belmont Circle
- Route 15 and Williams Street/Clark Street

The discussion during the Alternatives Development Workshop primarily focused on these intersection locations, since the congestion and safety issues within the study corridor are centered on these intersections. However, Milnwood Road was not discussed at the Alternatives Development Workshop due to the improvements already planned for this intersection.

5.1.1.1 Innovative Intersections

The improvements also considered innovative intersection concepts. Incorporating innovative intersections and interchanges into the transportation network is one strategy that VDOT is using to improve safety and mobility for congested corridors like Independence Blvd. Preliminary screening for innovative intersections was performed using VDOT Junction Screening Tool (VJuST)[1]. This tool assists engineers and planners to screen number of innovative intersection and interchange ideas by evaluating the Critical Lane Volume (CLV) and identifies innovative intersection and interchange concepts that have potential to address congestion and safety issues. Congestion results are based on user inputs such as turning movement volumes, number of lanes and lane configurations. Safety results are based on conflict points—any points where roadway users' paths can cross with other roadway users. The screened concepts can then be analyzed further for their suitability considering site specific data such as potential right-of-way and utility impacts, potential impacts to adjacent business access points, impacts to the pedestrian movements. **Figure 34** shows a screen capture of an example of VJuST screening at the intersection of Route 15/Griffin Blvd.

Figure 34. Screen Capture of VJuST Analysis: Route 15/Griffin Blvd

VDOT Junction Screening Tool

Results Worksheet

VJuST
VDOT Junction Screening Tool

General Information	
Project Title:	STARS Route 15 (S Main St) Corridor Study
EW Facility:	Griffin Blvd
NS Facility:	Route 15
Date:	May 7, 2018

Volumes (veh/hr)	U-Turn / Left	Through	Right
Eastbound	63	0	412
Westbound	0	0	0
Northbound	264	529	0
Southbound	0	707	63

General Instructions: All intersection and interchange configurations have a default assumption of one exclusive lane per movement. No results shall be interpreted until the user has verified the lane configurations on each

Intersection Results

Type	Dir	Maximum V/C (Congestion)	Accommodation Compared to Conventional (Pedestrian)	Weighted Total Conflict Points (Safety)	Notes
Conventional	-	0.67		48	No improvements
Bowtie	-	0.70	+	24	Not feasible for the site
Continuous Green-T	-	0.53	-	12*	Best option
Median U-Turn	-	0.70	+	20	No median for U-turns
Partial Median U-Turn	-	0.60	+	28	No median for U-turns
Restricted Crossing U-Turn	-	0.40		20	No median for U-turns
Roundabout	-	0.71		8	Requires 2 circulating lanes

*The continuous green-T is the only three-legged innovative intersection in this tool. To compare the continuous green-T to other innovative intersections, conflicts corresponding with the fourth leg must be removed. This has been done for the conventional intersection. Conflict point diagrams for three-legged and four-legged conventional intersections have been provided on the

[1] VDOT Innovative Intersections and Interchanges: Junction Screening Tool, Version 1.02

Several preliminary improvement alternatives were presented based on the operational, safety and VJuST analysis results. The improvement alternatives were vetted and screened by the Study Work Group (SWG) and a list of "Preferred Alternatives" were selected to move forward for the Future 2030 Build Analysis and is summarized in **Table 15**.

Planning level conceptual layouts for each of these preferred alternatives were developed and are briefly summarized below. The layouts presented in **Figures 35 through 39** cover only those locations where improvements are proposed.

5.1.2 Year 2030 Build Option

5.1.2.1 Alternative 1: Route 15/Griffin Blvd Intersection

This improvement alternative proposes to change this intersection layout to a Continuous Green-T intersection. In changing the intersection layout, the existing northbound left+thru lane will be converted into a left only lane, a southbound exclusive right-turn lane with a 200' storage will be added and the existing southbound shared thru+right lane will be converted to a thru only lane. The existing sidewalk and pedestrian ramps along the east side of Route 15 will be improved/retrofitted to current ADA standards. **Figure 35** shows the conceptual layout of Alternative 1 at this location.

5.1.2.2 Alternative 2: Route 15/Gilliam Drive/Reed Street Intersection

This improvement alternative proposes to relocate fixed objects off the sidewalk and upgrade sidewalk and pedestrian ramps to current ADA standards. **Figure 36** shows the conceptual layout of Alternative 2 at this location.

5.1.2.3 Alternative 3: Route 15/Belmont Circle/Peery Drive Intersection

The improvement alternative proposes to change the lane configuration for the eastbound and westbound approaches to left and thru+right. It also proposes to change all left turns at the intersection to protected only phasing. **Figure 37** shows the conceptual layout of Alternative 3 at this location.

5.1.2.4 Alternative 4: Route 15/Williams St/Clark St Intersection

This improvement alternative proposes to extend the existing grass median on the north side to an additional 300 feet and change the northbound and southbound left turn types to protected only phasing. **Figure 38** shows the conceptual layout of Alternative 4 at this location.

5.1.2.5 Alternative 5: Corridor Wide Improvements

This improvement alternative proposes to construct missing sidewalk connections along the east side of Route 15 north of Clark Street, retrofit existing signal heads with high-visibility backplates, optimize signal timings and splits and refurbish faded pavement markings along the corridor. A grass median is proposed to be constructed along Route 15 from north of Clark Street to north of Peery Drive to replace the existing two-way left-turn lane, allow full median openings at all major intersections, and allow directional median openings at major driveways. **Figure 39** shows the conceptual layout of Alternative 5 at this location.

Table 15. List of Preferred Improvement Alternatives

Location/Improvement Alternative	Proposed Improvements
ALTERNATIVE 1: Route 15/Griffin Boulevard Intersection	Continuous Green-T intersection layout: 1. Convert the existing NB left+thru lane into left only lane 2. Add a SB exclusive right-turn lane with 200' storage 3. Convert the existing SB shared thru+right lane into thru only 4. Improve/retrofit existing sidewalk and pedestrian ramps along east side of Route 15 to current ADA standards
ALTERNATIVE 2: Route 15/Gilliam Drive/Reed Street Intersection	1. Relocate fixed objects off the sidewalk, upgrade sidewalk and pedestrian ramps to current ADA standards
ALTERNATIVE 3: Route 15/Belmont Circle/Peery Drive Intersection	1. Change the lane configuration for EB approach to left and thru+right 2. Change the lane configuration for WB approach to left and thru+right 3. Change all the left turns at the intersection to protected only phasing
ALTERNATIVE 4: Route 15/Williams St/Clark St Intersection	1. Extend the existing grass median on the north side to additional 300 ft 2. Change the NB and SB left turn types to protected only phasing
ALTERNATIVE 5: Corridor-wide	1. Construct missing sidewalk connections along east side of Route 15 north of Clark Street 2. Retrofit existing signal heads with high-visibility backplates 3. Optimize signal timings and splits 4. Refurbish faded pavement markings 5. Construct grass median along Route 15 from north of Clark Street to north of Peery Drive to replace existing two-way left-turn lane; allow full median openings at all major intersections and strategic locations; allow directional median openings at major driveways.

Sources:

1. STARS Route 15 Corridor Study: Alternatives Development Workshop, May 10, 2018.
2. FHWA Intersection Safety Strategies Brochure (https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa08008/#ub)
3. FHWA Proven Safety Countermeasures (https://safety.fhwa.dot.gov/provencountermeasures/)
4. VDOT Road Design Manual, Appendix F (Access Management Design Standards for Entrances and Intersections)
5. VDOT Junction Screening Tool (VJuST)

Figure 35. Alternative 1 Conceptual Layout (Route 15/Griffin Blvd Intersection)

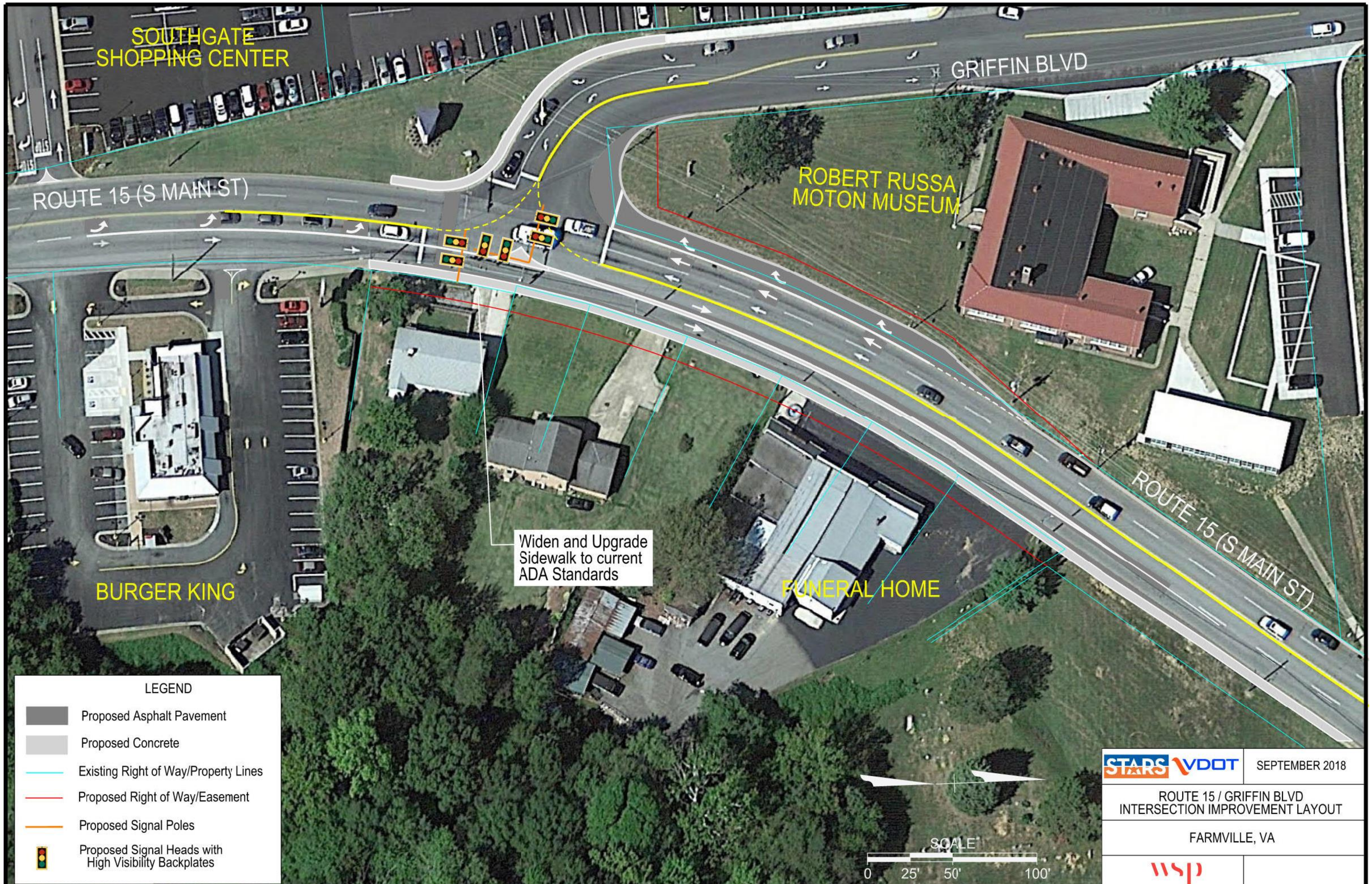


Figure 36. Alternative 2 Conceptual Layout (Route 15/Gilliam Dr/Reed St Intersection)

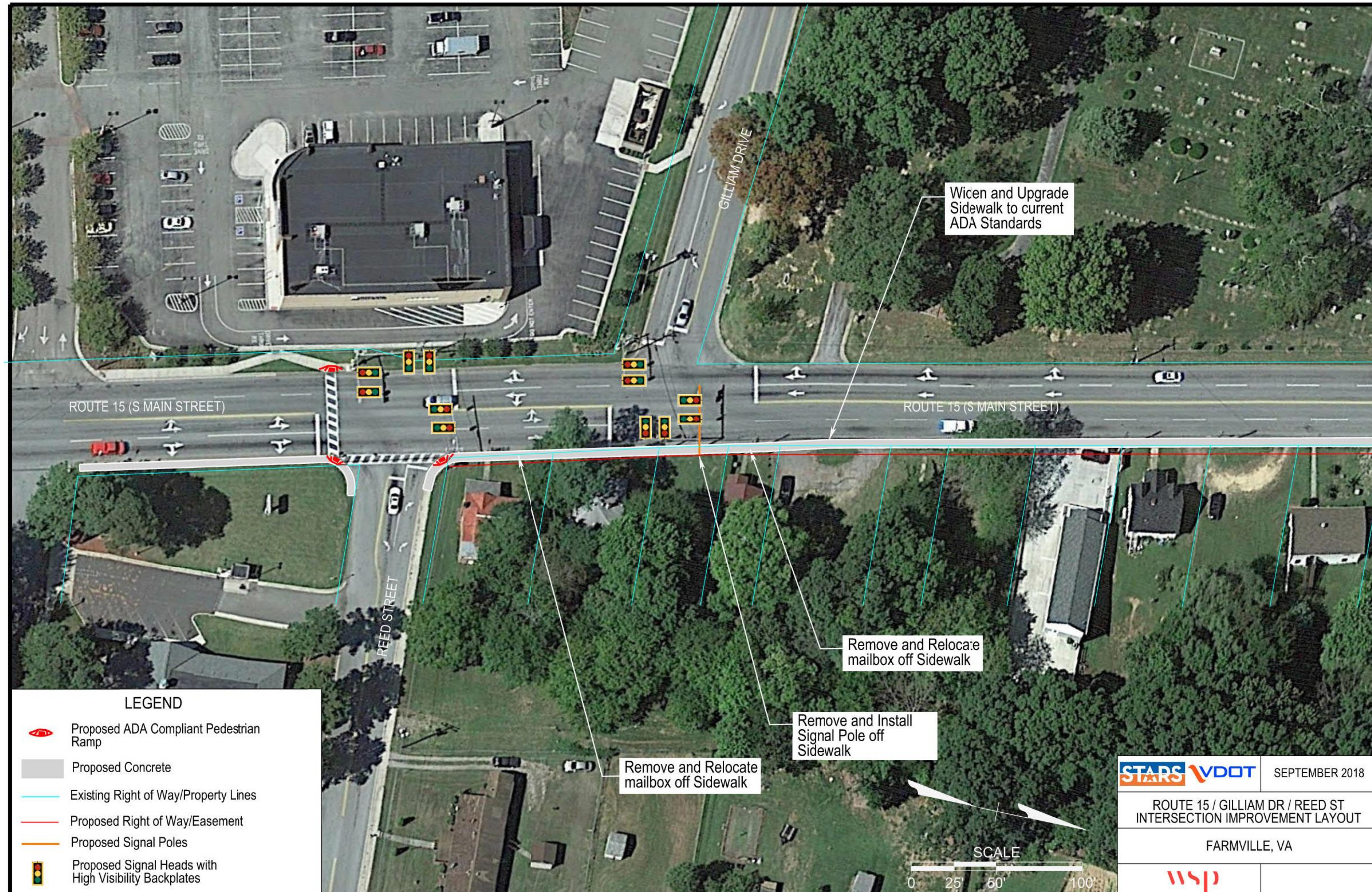


Figure 37. Alternative 3 Conceptual Layout (Route 15/Belmont Circle/Peery Dr Intersection)

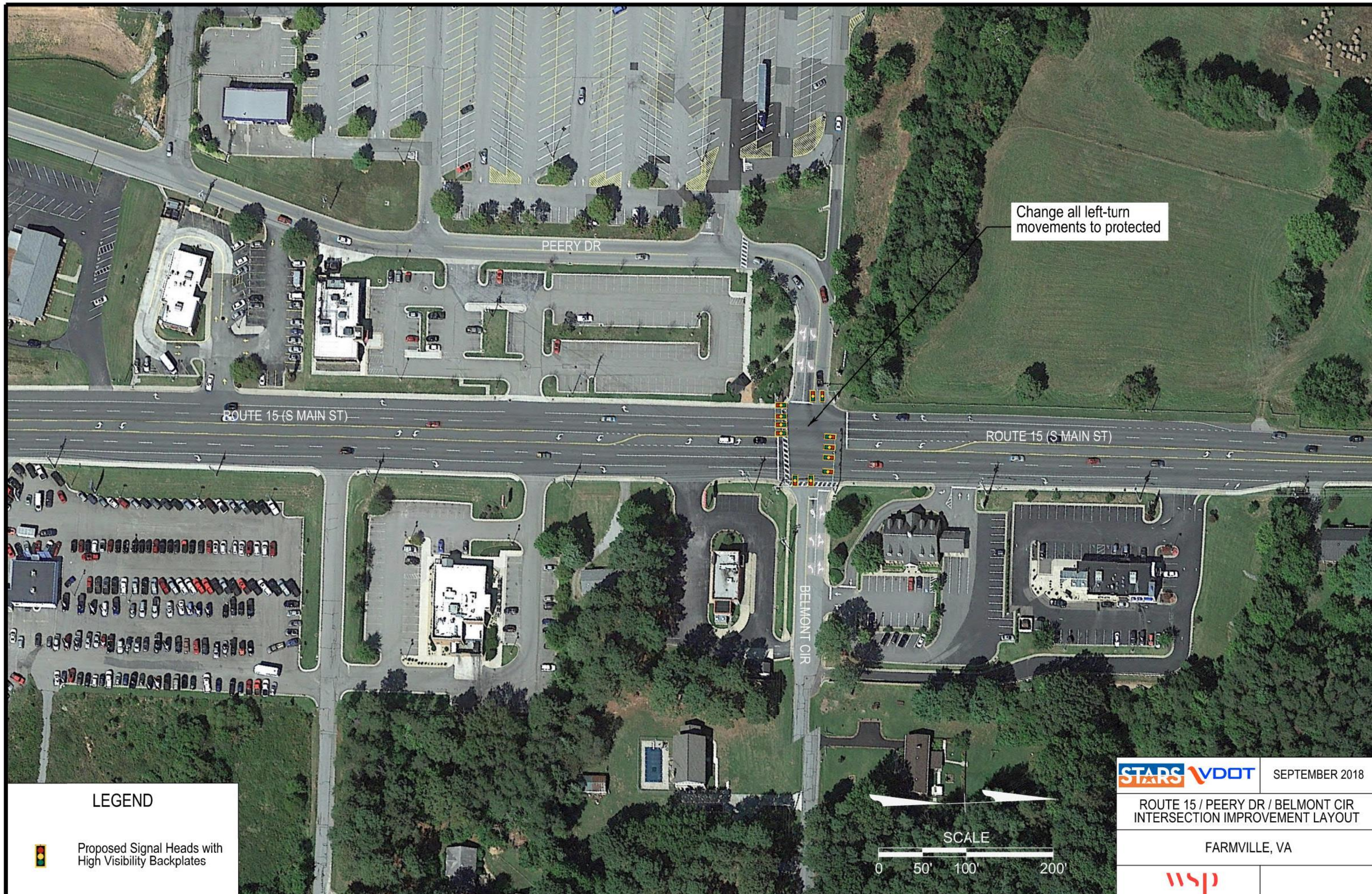


Figure 38. Alternative 4 Conceptual Layout (Route 15/Williams St/Clark St Intersection)

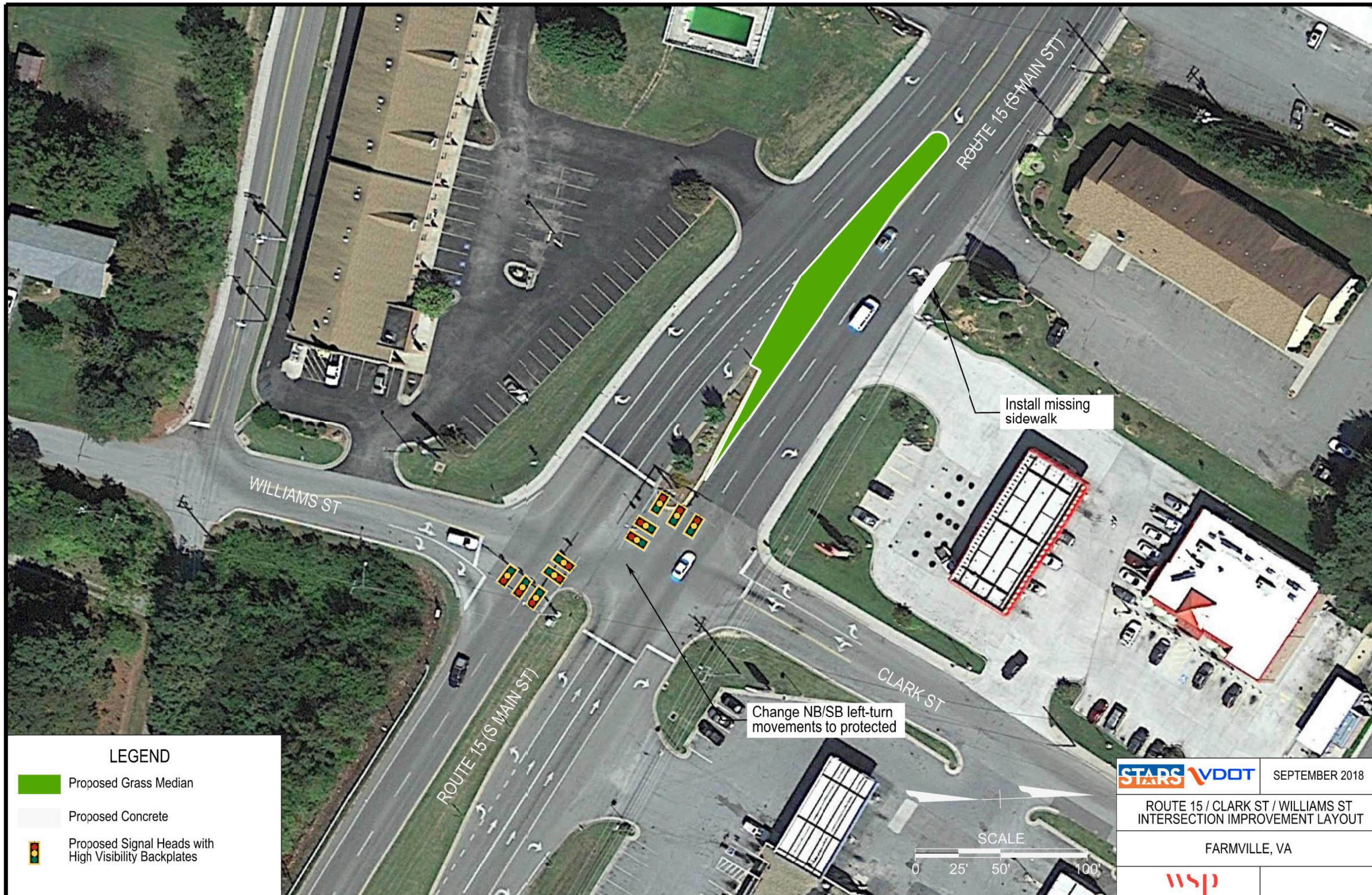


Figure 39. Alternative 5 Conceptual Layout (Corridor-Wide Improvement)

Figure 39 (Continued). Alternative 5 Conceptual Layout (Corridor-Wide Improvement)

6 FUTURE 2030 BUILD CONDITIONS

The "Preferred Alternatives" from the alternatives development exercise were distributed among the members of SWG for feedback. Their feedback was further discussed, vetted and included in the final alternative conceptual layouts. These alternatives were modeled in Synchro for the Future 2030 Build condition traffic operations.

6.1 Intersection Operations: Future 2030 Build Condition

Operational analysis was performed at each of the study intersections for the 2030 Future Build Condition. The Synchro models were developed to test the combination of alternatives for the entire corridor. **Table 16** summarizes the average AM and PM peak hour delay for each movement for the study intersections along the corridor. **Figure 40** shows the intersection delay and LOS graphically.

Queuing analysis was completed for the study intersections during the AM and PM peak hours for 2030 Build conditions. *95th Percentile* Queue Lengths in feet were reported for each lane. **Table 17** summarizes the maximum queue lengths during the AM and PM peak hours.

Results of the Build conditions Synchro analysis suggests the following changes in overall intersection delays:

Route 15 and Gilliam Drive/Reed Street (Relocate Objects, Pedestrian Improvements, 2030 Build)

- Microsimulation delay of 2.8 sec/veh (LOS A) during the AM peak hour and 5.3 sec/veh (LOS A) during the PM peak hour (2030 No-Build delays: AM Peak – 2.9 sec/veh (LOS A), PM Peak – 5.5 (LOS A) sec/veh);

Results of the Build conditions Synchro analysis indicate that the overall delay will get worse for the following intersection under 2030 Build Conditions:

Route 15 and Griffin Blvd (Continuous Green-T layout, 2030 Build)

- Delay of 11.0 sec/veh (LOS B) during the AM peak hour and 13.9 sec/veh (LOS B) during the PM peak hour (2030 No-Build delays: AM Peak – 7.3 sec/veh (LOS A), 13.6 sec/veh (LOS B));

Route 15 and Belmont Circle/Peery Drive (All Left Turns Protected, 2030 Build)

- Delay of 16.5 sec/veh (LOS B) during the AM peak hour and 28.5 sec/veh (LOS C) during PM peak hour (2030 No-Build delays: AM Peak – 15.3 sec/veh (LOS B), PM Peak – 24.0 sec/veh (LOS C));

Route 15 and Williams Street/Clark Street (Northbound and Southbound Left Turns Protected Phasing Only, 2030 Build)

- Delay of 25.4 sec/veh (LOS C) during the AM peak hour and 27.3 sec/veh (LOS C) during the PM peak hour (2030 No-Build delays: AM Peak – 21.7 sec/veh (LOS B), PM Peak – 28.5 sec/veh (LOS C));

It should be noted that although the delays may increase at these three intersections, the improvements address safety benefits at each intersection. For the Continuous Green-T layout, the capacity in the northbound direction is decreased which results in higher delays but an improvement in safety. For Belmont Circle/Peery Drive and Williams Street/Clark Street, changing the phasing from permitted/protected to protected adds to the delay but there are corresponding safety benefits. The delay increases are minor at these intersections.

Table 16. Future 2030 Build AM and PM Hour Delay and Level of Service (LOS)

Intersection Number and Description	Type of Control	Lane Group	Eastbound				Westbound				Northbound				Southbound				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
1			Griffin Blvd								Route 15				Route 15					
Route 15 and Griffin Blvd	Signal	Left	17.5	B	18.5	B	--	--	--	--	16.4	B	23.9	C	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	0.3	A	0.4	A	14.9	B	16.9	B	11.0	13.9
		Right	17.1	B	19.0	B	--	--	--	--	--	--	--	--	12.7	B	12.1	B	LOS	LOS
		Approach	17.2	B	18.9	B	--	--	--	--	6.3	A	8.2	A	14.8	B	16.5	B	B	B
2			Sanford St								Route 15				Route 15					
Route 15 and Sanford St	Two-Way Stop	Left	11.3	B	11.9	B	--	--	--	--	1.3	A	2.1	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	0.6	0.7
		Right	11.3	B	11.9	B	--	--	--	--	--	--	--	--					LOS	LOS
		Approach	11.3	B	11.9	B	--	--	--	--	0.5	A	0.8	A	0.0	A	0.0	A	A	A
3			Gilliam Dr								Route 15				Route 15					
Route 15 and Gilliam Dr	Signal	Left	17.6	B	22.6	C	--	--	--	--	1.1	A	1.6	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--					3.3	A	5.1	A	2.8	5.3
		Right	16.9	B	19.7	B	--	--	--	--	--	--	--	--					LOS	LOS
		Approach	17.3	B	21.7	C	--	--	--	--	1.1	A	1.6	A	3.3	A	5.1	A	A	A
4							Reed St				Route 15				Route 15					
Route 15 and Reed St	Signal	Left	--	--	--	--	18.1	B	22.1	C	--	--	--	--	1.0	A	1.2	A	Delay	Delay
		Through	--	--	--	--	--	--	--	--	3.9	A	4.7	A					3.5	3.9
		Right	--	--	--	--	16.7	B	19.4	B					--	--	--	--	LOS	LOS
		Approach	--	--	--	--	17.6	B	21.7	C	3.9	A	4.7	A	1.0	A	1.2	A	A	A
5			Spottswood Dr				Spottswood Dr				Route 15				Route 15					
Route 15 and Spottswood Dr	Signal	Left	18.9	B	23.1	C	12.9	B	21.1	C	1.4	A	3.1	A	0.4	A	0.2	A	Delay	Delay
		Through									0.0	A	0.0	A	0.0	A	0.0	A	0.7	1.2
		Right	9.7	A	10.7	B													LOS	LOS
		Approach	13.0	B	12.1	B	12.9	B	21.1	C	0.7	A	1.6	A	0.2	A	0.1	A	A	A
6			Milnwood Rd				Milnwood Rd				Route 15				Route 15					
Route 15 and Milnwood Rd	Signal	Left	31.5	C	40.2	D	29.3	C	52.0	D	15.1	B	27.2	C	16.9	B	27.8	C	Delay	Delay
		Through	34.4	C	177.2	F	28.3	C	27.7	C	18.1	B	26.2	C	17.4	B	30.4	C	19.6	37.1
		Right									14.9	B	20.8	C	14.6	B	18.2	B	LOS	LOS
		Approach	33.7	C	155.7	F	28.9	C	45.4	D	17.4	B	24.7	C	17.4	B	30.2	C	B	D
7			Peery Dr				Belmont Cir				Route 15				Route 15					
Route 15 and Belmont Cir/ Peery Dr	Signal	Left	23.8	C	43.8	D	36.5	D	235.6	F	30.6	C	109.2	F	41.4	D	205.2	F	Delay	Delay
		Through	19.8	B	23.2	C	31.6	C	51.9	D	15.0	B	19.9	B	15.6	B	27.2	C	16.5	28.5
		Right									11.9	B	15.6	B	10.7	B	5.0	A	LOS	LOS
		Approach	23.2	C	40.4	D	33.0	C	116.0	F	16.2	B	29.7	C	14.2	B	21.1	C	B	C
8			Williams St				Clark St				Route 15				Route 15					
Route 15 and Williams St/ Clark St	Signal	Left	29.9	C	38.6	D	41.4	D	56.1	E	51.7	D	59.0	E	110.8	F	51.3	D	Delay	Delay
		Through									16.1	B	15.9	B	15.6	B	24.3	C	25.4	27.3
		Right	27.9	C	36.8	D	27.0	C	34.5	C	13.2	B	13.0	B	13.9	B	0.0	A	LOS	LOS
		Approach	28.4	C	37.2	D	32.1	C	48.1	D	20.9	C	22.1	C	29.8	C	24.5	C	C	C

Figure 40. Future 2030 Build AM(PM) Peak LOS

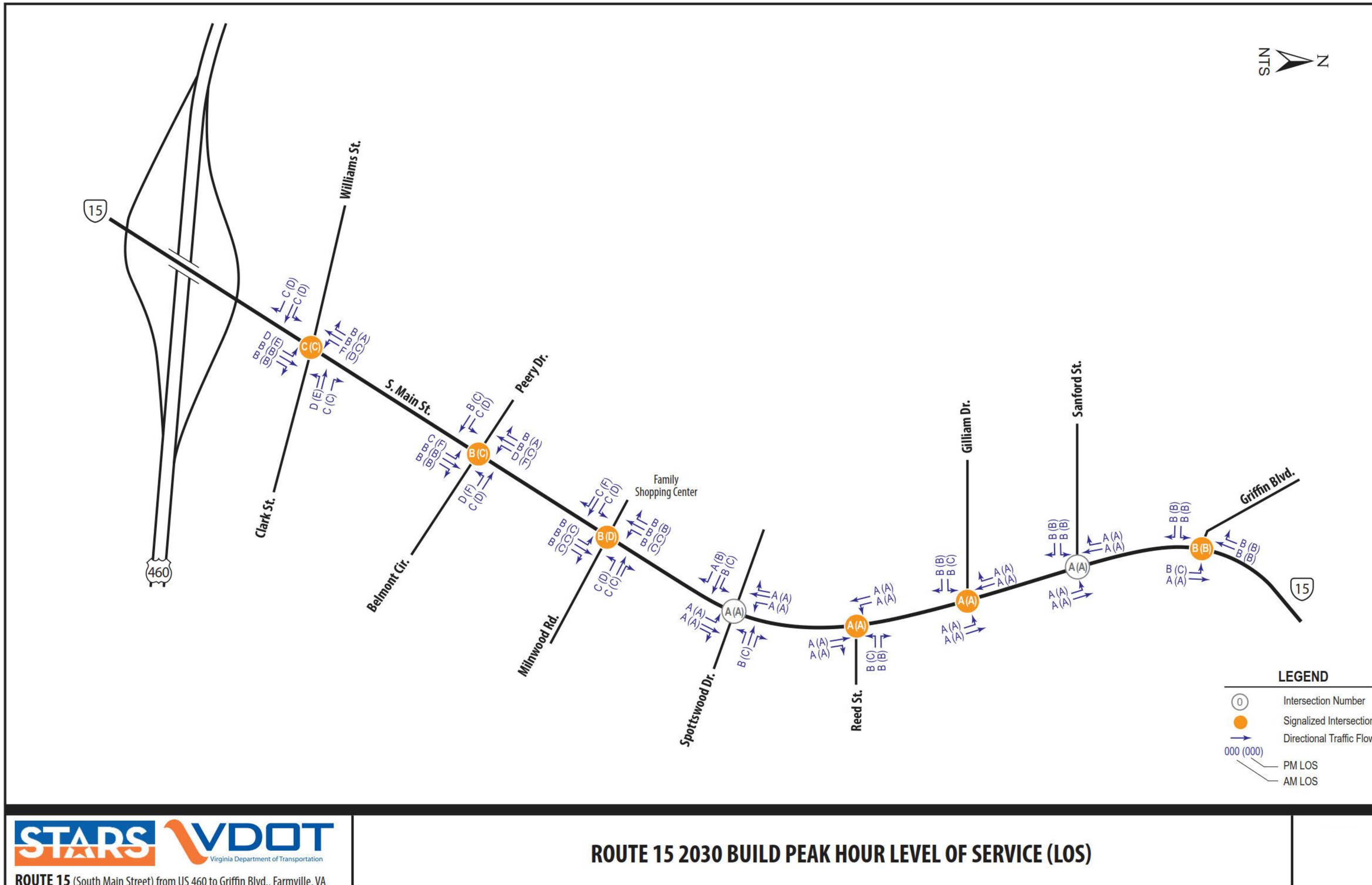


Table 17. Future 2030 Build Summary of Intersection Queues (95th Percentile Queue, feet)

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
1 Route 15 and Griffin Blvd			Griffin Blvd						Route 15			Route 15		
	Signal	Left	155	33	45	--	--	--	--	122	#222	--	--	--
		Through	--	--	--	--	--	--	--	0	0	--	95	188
		Right	--	40	61	--	--	--	--	--	--	250	13	24
2 Route 15 and Sanford St			Sanford St						Route 15			Route 15		
	Signal	Left	--	6	10	--	--	--	--	2	5	--	--	--
		Through	--	--	--	--	--	--	--			--	0	0
		Right	--	6	10	--	--	--	--	--	--	--		
3 Route 15 and Gilliam Dr			Gilliam Dr						Route 15			Route 15		
	Signal	Left	--	27	79	--	--	--	--	15	17	--	--	--
		Through	--	--	--	--	--	--	--			--	57	173
		Right	175	14	25	--	--	--	--	--	--	--		
4 Route 15 and Reed St						Reed St			Route 15			Route 15		
	Signal	Left	--	--	--	50	40	76	--	--	--	--	14	26
		Through	--	--	--	--	--	--	--	68	106	--		
		Right	--	--	--	--	17	13	--			--	--	--
5 Route 15 and Spottswood Dr			Spottswood Dr			Spottswood Dr			Route 15			Route 15		
	Signal	Left	--	3	4	--	0	2	--	3	9	--	1	1
		Through	--			--			--			--		
		Right	--	2	9	--			--	3	9	--	1	1
6 Route 15 and Milnwood Rd			Milnwood Rd			Milnwood Rd			Route 15			Route 15		
	Signal	Left	--	33	40	--	113	#396	--	31	41	--	50	#76
		Through	--	69	#214	--	87	129	--	200	281	--	174	389
		Right	--			--			190	22	56	--	0	0
7 Route 15 and Belmont Cir/ Peery Dr			Peery Dr			Belmont Cir			Route 15			Route 15		
	Two-Way Stop	Left	--	114	313	--	20	29	150	62	#155	115	15	28
		Through	--	19	33	--	31	36	--	190	275	--	126	#432
		Right	100			125			1000	0	0	380	28	42
8 Route 15 and Williams St/ Clark St			Williams St			Clark St			Route 15			Route 15		
	Signal	Left	--	27	61	--	#65	#152	130	#97	#158	120	#64	16
		Through	--			--			--	157	189	--	92	299
		Right	75	0	#64	--	0	0	220	0	0	1000	0	0

NOTE: Lane configurations with a shared through lane shown as "through" lane group; with shared left-right lane shown as "left" lane group.
'--' Storage Bay Length not provided or the movements do not exist.
Red text indicates queue lengths that exceed the available storage lengths.

7 Crash Reduction Analysis

A crash reduction analysis was conducted for Route 15 from Griffin Boulevard to US 460. As part of the crash reduction methodology, the *Crash Mitigation Factor Clearinghouse*[2] and *FHWA Desktop Reference for Crash Reduction Factors*[3] were utilized to calculate the Crash Reduction Factors (CRFs) associated with each proposed alternative along Route 15 in Farmville, Virginia. The CRFs were applied to the crash history data from the *VDOT Crashtools Database*[4] to determine the expected number of crashes and the percent reduction in crashes per alternative. Expected crashes were projected to the year 2030 (base build year) and then calculated over a 20-year life cycle to Year 2050. The expected crashes were then utilized to compare the *No Build* and *Build* conditions based on the 20-year projection to evaluate the efficacy of the proposed alternative.

7.1 Analysis Methodology

The following sections describe the methodology that was used to determine the crash expectancy and cost savings associated with the proposed modifications.

7.1.1 Proposed Roadway Modifications and CRFs

The CRFs were selected based on the improvements designated for the *2030 Build* conditions. **Appendix** includes the following: 1) the countermeasures proposed, 2) categories of countermeasures obtained from the *CMF Clearinghouse* or *FHWA Desktop Reference* source, 3) applicable crash type and severity, 4) percent of applicable crashes, and 5) notes for selected CRFs. It should be noted that CRFs are not provided for all roadway modifications in *the Crash Mitigation Factor Clearinghouse or FHWA Desktop Reference for Crash Reduction Factors.* Roadway modifications without designated CRFs were not given a CRF for this analysis; therefore, those improvements did not have any impact on the expected crashes.

In some instances, CRF values were applicable to the intersection or segment as a whole and often involved multiple CRF values. To accurately calculate CRFs for some alternatives, a combined CRF was calculated using **Equation 1**. Some alternatives required combined CRFs and/or individual CRFs, depending on the specific improvements.

Equation 1. Combined CRF Calculation

$$Combined\ CRF = 1 - [(1 - CRF_1) * (1 - CRF_2) * \ldots * (1 - CRF_i)]$$

7.1.2 Applicable Crash Calculations

To properly determine how the improvements impact the 2030 and 2050 expected crashes, a detailed evaluation was conducted of historical crash data (2012-2017). Not every crash at a specific location would be eliminated due to an improvement. For example, when extending the grass median along Route 15 at the intersection of William Street/Clark Street, crashes due to left turning vehicles entering and exiting the commercial driveways would be expected to be reduced. Therefore, the CRF should only be applied to the specific crashes that would be affected by the improvement. So, for each improvement with a known CRF, the number of crashes impacted by the improvement were determined by analyzing each crash within the *VDOT Crashtools Database* from the five (5) most recent calendar years of crash data (2012-2017). Then, the percent of applicable crashes (i.e., number of applicable crashes across the five calendar years divided by the total number of crashes across the five calendar years) was determined for each improvement with a known CRF, as shown in **Equation 2**.

Equation 2. Percentage of Applicable Crashes Calculation

$$Percentage\ of\ Applicable\ Crashes = \frac{Number\ of\ Applicable\ Crashes}{Total\ Number\ of\ Crashes} * 100$$

7.1.3 Crash Reduction Evaluation

Based on the 2012-2017 crash data within the *VDOT Crashtools Database*, the average numbers of property damage only (PDO/O), Visible and Non-Visible Injury (B+C), and fatal or ambulatory injury (K+A) over the most recent five years were calculated. The existing average crashes were then projected to Year 2030 (i.e., 13-year projection based on the 2.0% growth rate) to which a base build year was established. These estimates were then projected out to the year 2050 (i.e., 20-year projection) to estimate the expected number of (PDO/O), (B+C), and (K+A) crashes for the *Build* conditions over the 20-year life cycle, assuming a 2.0% growth rate from Griffin Boulevard to US 460.

To calculate the expected number of (PDO/O), (B+C), and (K+A) crashes for the *Build* conditions where 100% of the crashes were applicable, the appropriate combined CRFs were implemented where improvements were proposed, as shown in **Equation 3**.

Equation 3. Expected Crashes for the 2030 Build Conditions (100% Applicable Crashes)

$$2030\ Build\ Expected\ Crashes = 2030\ No\ Build\ Expected\ Crashes - (2030\ No\ Build\ Expected\ Crashes * \ CRF)$$

To calculate the expected number of (PDO/O), (B+C), and (K+A) crashes for the *Build* conditions where only a portion of the crashes were applicable, the appropriate combined CRFs were implemented where improvements were proposed, as shown in **Equation 4**.

Equation 4. Expected Crashes for the 2030 Build Conditions (<100% Applicable Crashes)

$$\begin{aligned}&2030\ Build\ Expected\ Crashes\\&\quad = [2030\ No\ Build\ Expected\ Crashes - [2030\ No\ Build\ Expected\ Crashes\ * \%\ Applicable\ Crashes * (CRF)]\end{aligned}$$

The percent reduction in (PDO/O), (B+C), and (K+A) crashes between the *2050 No-Build* and *Build* conditions per package was calculated for each intersection and segment along the Route 15 corridor over the 20-year cycle life.

Projected crashes and crash reductions to the base build year (2030) is provided in the **Appendix**. This base condition was then projected each year over the 20-year life cycle to determine the crash reductions through 2050.

7.2 Analysis Results

The total crash reduction values over the 20-year cycle life (i.e., from 2030 to 2050) and percentages for each alternative are provided in **Table 18**.

[2] Federal Highway Administration. (2017). Crash Modification Factors Clearinghouse. Washington, DC. Retrieved from http://www.cmfclearinghouse.org/.

[3] Federal Highway Administration. (2014). *Desktop Reference for Crash Reduction Factors*. Washington, DC. Retrieved from https://safety.fhwa.dot.gov/tools/crf/resources/fhwasa08011/.

[4] Virginia Department of Transportation. (2017). *Crash Analysis Tool*. Retrieved from https://public.tableau.com/.

Table 18. Percent Crash Reduction per Alternative (20-Year Cycle Life)

Location	Alternative	PDO/O Crashes (Reduction)	B+C Crashes (Reduction)	K+A Crashes (Reduction)
Griffin Boulevard at Route 15	1	8.48	6.66	0.00
Gilliam Drive/Reed Street at Route 15	2	1.19	1.19	0.15
Belmont Circle/Peery Drive at Route 15	3	9.54	3.67	0.00
William Street/Clark Street at Route 15	4	13.21	5.28	1.32
Route 15 Corridor-Wide Improvements	5	156.82	77.46	5.82

[1] Crash Rate reduction percentages are assumed to remain the same over the 13-year and 20-year projections due to the assumed constant growth rate over the corridor.

8 Improvement Prioritization

The Improvement Prioritization process involved development of planning level cost estimates for the preferred alternatives, development of 20-year life-cycle operational and safety benefits for each improvement alternative and calculation of the Benefit-Cost ratios. These elements are described in the following sections.

8.1 Planning Level Cost Estimates

Planning level cost estimates were developed for all the preferred improvement alternatives using the *VDOT Project Cost Estimating System (PCES), Version 7.10* for VDOT Lynchburg District. The 2018 costs obtained from the PCES tool were inflated to future year 2030 at a discount rate of 3% per year. The cost estimates included Construction (CN), Right-of-Way and Utilities Relocation (ROW) and Preliminary Engineering (PE) costs. **Table 19** summarizes the cost estimates for each improvement alternative proposed and are expressed in year 2030 dollars.

Table 19. Planning Level Cost Estimates (Year 2030 US Dollars)

Alternative/Location	Cost Estimate			
	Preliminary Engineering (PE)	Right-of-Way/Utilities (ROW)	Construction (CN)	Total
ALTERNATIVE 1: Route 15/Griffin Blvd Intersection	$185,742	$441,657	$1,043,201	$1,670,600
ALTERNATIVE 2: Route 15/Gilliam Dr/Reed St Intersection	$83,456	$395,410	$450,145	$929,011
ALTERNATIVE 3: Route 15/Belmont Circle/Peery Dr Intersection	$44,647	$0.00	$237,442	$282,089
ALTERNATIVE 4: Route 15/Williams St/Clark St Intersection	$8,453	$0.00	$44,391	$52,844
ALTERNATIVE 5: Corridor-Wide Improvements	$118,291	$123,839	$646,524	$888,654
			Sum	**$3,823,198**

The planning level cost estimates were developed to get a preliminary idea of the funding requirements for the proposed improvements along the corridor.

8.2 Planning Level Schedule Estimates

Planning level schedules were developed for all improvement alternatives. Schedule estimates were based on familiarity with complexity of projects within the Lynchburg District as well as discussions with the SWG. **Table 20** summarizes schedules by phases of project: Preliminary Engineering (PE), ROW and Utility Relocation (ROW) and Construction (CN).

Table 20. Planning Level Schedules (months)

Alternative/Location	Schedule Estimate			
	Preliminary Engineering (PE)[1]	Right-of-Way/Utilities (ROW)	Construction (CN)[2]	Total
ALTERNATIVE 1: Route 15/Griffin Blvd Intersection	10	18	6	34
ALTERNATIVE 2: Route 15/Gilliam Dr/Reed St Intersection	9	18	4	31
ALTERNATIVE 3: Route 15/Belmont Circle/Peery Dr Intersection	9	0	3.5	12.5
ALTERNATIVE 4: Route 15/Williams St/Clark St Intersection	9	0	5	14
ALTERNATIVE 5: Corridor-Wide Improvements	9	0	6	15

Notes:

1. PE durations assume 3 design submittals with 3-week review period
2. Construction includes pre-submittals (1.5) and close out/punch list items (1)
3. ROW for access management includes permit modifications

8.3 Benefit-Cost Analysis

A Benefit-Cost (B/C) analysis was conducted for the candidate projects to evaluate their cost effectiveness. An analysis period of 20-years was used to evaluate the life cycle benefits. 20-year period is typically used for small to medium size transportation projects. The following factors were considered in the B/C calculations for each of the improvement alternatives evaluated:

8.3.1 Operational Benefit

The determination of operational benefit for each improvement alternative was based on the methodology of calculating reduction in travel delay because of the proposed improvements. This methodology converts the vehicle delay into person delays by accounting for the vehicle occupancy. Consistent with the *2009 National Household Travel Survey (NHTS)*[5], average vehicle occupancies of 1.13 and 1.74 were assumed for work trips and non-work trips, respectively, assuming 250 work days per year and 60% of peak hour volumes are work trips.

Similarly, USDOT's *"Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis, 2016"*[6], *Table 4* was used to determine the hourly values for travel time savings for each occupant in a vehicle as $25.40/hour and $13.60/hour for work and non-work trips, respectively.

[5] FHWA Report No. FHWA-PL-11-022, Summary of Travel Trends: 2009 National Household Travel Survey

[6] USDOT Guidance: "The Value of Travel Time Savings: Departmental Guidance for Conducting Economic Evaluations, Revision 2 (2016 Update)"

To determine annual peak hour delay savings, the calculated delay reduction per vehicle in each respective peak hour was multiplied by the peak hour traffic volume at each intersection to obtain a compounded delay. Using the compounded delay savings and identified values for travel time savings, the annual cost benefits for each alternative were determined. The Present Value of Benefits (PVB_D) of the annual delay reduction benefits over a 20-year life-cycle was calculated using **Equation 5**:

Equation 5. Present Value of Benefits (PVB_D)

$$(P/A, i, n) = \frac{(1+i)^n - 1}{i(1+i)^n}$$

Where,

$(P/A, i, n)$ = Factor that converts a series of uniform annual amounts to its present value
i = Minimum attractive rate of return or discount rate = 3%
n = Years in the service life of the improvements = 20 years

8.3.2 Safety Benefit

As part of the crash analysis, the differences in crashes between the *2050 No-Build* and *Build* conditions were calculated for PDO/O, (B+C), and (K+A) crashes over the 20-year life cycle. To further analyze the impact of the proposed alternatives, societal costs were applied to the crash reduction values, as provided by the VDOT Highway Safety Improvement Program (HSIP)[7]. Cost savings per crash type are provided below:

- K+A = $923,829
- B+C = $82,111
- PDO/O = $10,549

Total cost savings per alternative are provided in **Table 211.** Additionally, the breakdown of the crash reduction and cost savings (PVB_S) over the 20-year life cycle are provided in the **Appendix**.

Table 21. Crash Cost Savings Analysis (PVB_S Over 20-Year Life Cycle)

Location	Alternative	PDO/O (NPV)	B+C (NPV)	K+A (NPV)	Total Cost Savings (NPV)
Griffin Boulevard at Route 15	1	$66,200	$404,872	$0.00	$471,072
Gilliam Drive/Reed Street at Route 15	2	$9,312	$72,487	$101,944	$183,745
Belmont Circle/Peery Drive at Route 15	3	$74,470	$222,947	$0.00	$297,418
William Street/Clark Street at Route 15	4	$103,113	$321,044	$903,015	$1,327,173
Route 15 Corridor-Wide Improvements	5	$1,224,257	$4,706,867	$3,976,918	$9,908,043

Values shown represent savings over a 20-year life cycle, from 2030 to 2050, assuming 2030 is the base build year.

8.3.3 Benefit-Cost Ratio (BCR)

The 2030 cost estimate for each alternative as summarized in Table 19 was used in the calculation of B/C ratios. The following equation was used to develop the B/C ratios:

Equation 6. Benefit/Cost Ratio (BCR)

$$BCR = PVB/PVC$$

Where,

PVB = Present Value of Combined Benefits = $PVB_D + PVB_S$

PVC = Present Value of Costs = 2027 cost estimates

Table 22 summarizes the calculated BCR for each of the improvement alternatives.

Table 22. BCR per Improvement Alternative

Alternative	Delay Reduction Benefit (PVB_D)	Safety Benefit (PVB_S)	Present Value of Costs (PVC)	Benefit-Cost Ratio (BCR)
Alternative 1	-$157,018.00	$471,073.54	$1,670,600.00	0.19
Alternative 2	$43,780.00	$183,743.17	$929,011.00	0.24
Alternative 3	-$234,018.00	$297,418.28	$282,089.00	0.22
Alternative 4	-$69,385.00	$1,327,173.62	$52,844.00	23.80
Alternative 5	$0.00	$9,908,043	$888,654	11.15

8.3.4 Project Prioritization

Improvement projects should be prioritized at a regional level. The following factors should be considered while evaluating the proposed improvement alternatives to be advanced further for funding and construction:

- B/C Ratio: Typically, projects with B/C ratios greater than or equal to 1.00 indicate cost effectiveness of the improvements and are preferred by the Agencies;
- Safety Improvements and their Benefits;
- Geometric Improvements;
- No anticipated ROW Impacts: Projects that require additional right-of-way are typically costly, and are not preferred.

Table 23 summarizes these factors for each improvement alternative proposed by this study.

[7] Virginia Department of Transportation (VDOT) Highway Safety Improvement Program (HSIP) VA Specific Crash Cost Table

Table 23. Project Prioritization Criteria

Alternative	B/C Ratio	Safety Improvements	Geometric Improvements	No Anticipated ROW Impacts
Alternative 1	0.19	✓	✓	
Alternative 2	0.24	✓	✓	
Alternative 3	0.22	✓		✓
Alternative 4	23.80	✓	✓	✓
Alternative 5	11.15	✓	✓	✓

✓ Indicates the criteria for the corresponding improvement alternative is fulfilled

Based on the review of the criteria, the following alternatives were identified that can potentially be submitted for SMART SCALE or other funding sources:

- Alternative 1 (Route 15/Griffin Blvd Intersection)
- Alternative 4 (Route 15/William Street/Clark Street Intersection)
- Alternative 5 (Corridor-wide)

It should be noted that, although the calculated BCR for Alternative 1 is less than 1, this alternative should be considered for an application for funding, considering the innovative concept and the corresponding safety benefits. The District in coordination with the localities may choose to advance some or all of these projects with their discretion.

9 Conclusions And Recommendations

The STARS Route 15 (South Main Street) Corridor Study identifies operational, safety, access management and congestion issues along the corridor. This study also evaluates potential mitigation measures and improvement alternatives to address those issues. This study should be used as a planning level document to establish the next steps of planning, programming, designing and constructing the identified safety, operational and access management improvements within the corridor. Following are the specific steps that may be followed:

Gain Consensus and Prioritize Improvements

It is recommended to conduct outreach meetings with stakeholders who were not part of the SWG of this study to gain their consensus on the proposed candidate improvement alternatives. Prioritization of the improvements is suggested by considering the following factors:

- Benefit-Cost
- Local/District Preference
- Safety Benefits
- Geometric Improvements
- ROW Impacts

Prepare Projects for Advancement

Upon identifying and prioritizing the improvements at the regional level, the projects with the highest priority should be advanced to be included in the following plans:

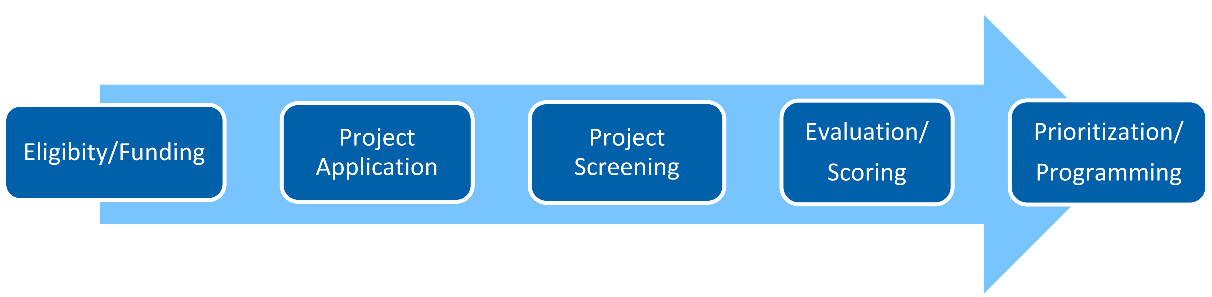
- Constrained Long Range Transportation Plan (CLRP)
- Transportation Improvement Plan (TIP)
- Statewide Transportation Improvement Plan (STIP)
- VDOT Six-Year Improvement Program (SYIP)

Secure Funding

There are several funding sources or revenue sharing programs that can be tapped into to fund the improvements identified in this study:

SMART SCALE

Virginia's SMART SCALE Process facilitates selecting the right transportation projects for funding and ensuring the best use of limited tax dollars. It includes five overreaching steps as depicted below:



Per the SMART SCALE Technical Guide, the scoring process evaluates, scores and ranks projects based on congestion mitigation, economic development, accessibility, safety, environmental quality and land use factors. The location of the project determines the weight of each of these scoring factors. For the projects in the Lynchburg District, the scoring factors with the highest weight are:

- Economic Development (35%)
- Safety (30%)
- Accessibility (15%)
- Congestion Mitigation (10%)
- Environmental Quality (10%)

All the improvement alternatives identified in this study are candidate projects for SMART SCALE funding. Several of these projects can also be packaged together into one SMART SCALE application to achieve better project score and to recognize cost savings associated with completing the projects concurrently.

The SMART SCALE funding may be accompanied by other sources of funding as listed below:

- Construction District Grants Program (DGP)
- High Priority Projects Program (HPPP)
- Congestion Mitigation and Air Quality Funding (CMAQ)
- Regional Surface Transportation Block Grant Program (RSTBG)
- Revenue Sharing
- Transportation Alternatives (TA) Set-Aside Funds
- Highway Safety Improvement Program (HSIP) and Other Safety Program Funds
- Tele-fees and Unpaved Road Related Funds
- State of Good Repair

SMART SCALE projects can be submitted by regional entities including counties, cities and towns that maintain their own infrastructure. Once the project has been screened, scored and selected for funding by the Commonwealth Transportation Board (CTB), it remains in the SYIP as a funding priority.

Project Completion

Once the funding is secured and improvements are ready for construction, the projects should be advanced and implemented with close coordination among the affected stakeholders in the region.