ROUTE 288 CORRIDOR IMPROVEMENT STUDY

Chesterfield, Goochland, and Powhatan Counties, Virginia

December 2018

STARS VDOT

Route 288 Corridor Improvement Study

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Prepared for

VDOT

Prepared by

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List of Acronyms

AADT – Annual Average Daily Traffic

AASHTO – American Association of State Highway and Transportation Officials

BMP – Best Management Practices

CEI – Construction Engineering and Inspection

CLRP – Constrained Long-Range Transportation Plan

CMAQ – Congestion Mitigation and Air Quality (CMAQ)

DGP – District Grants Program

HPPP – High-Priority Projects Program

HSIP – Highway Safety Improvement Program

ITS – Intelligent Transportation System

LOS – Level of Service

PCES – Project Cost Estimating System

PDO – Property Damage Only

PHF – Peak Hour Factor

RNS – Roadway Network System

SPS – Statewide Planning System

STIP – Statewide Transportation Improvement Plan

SYIP – Six-Year Improvement Program

SWG – Study Work Group

TIP – Transportation Improvement Plan (TIP)

TOC – Traffic Operations Center

TOSAM – Traffic Operations and Safety Analysis Manual

TMC – Turning Movement Count

TRB – Transportation Research Board

VDOT – Virginia Department of Transportation

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1.1 Background

The Virginia Department of Transportation (VDOT) selected Route 288 (World War II Veterans Memorial Highway) in Chesterfield, Goochland, and Powhatan Counties as a 2017 Strategically Targeted and Affordable Roadway Solutions (STARS) project because of identified congestion and safety concerns along the corridor. The STARS program seeks to relieve congestion and bottlenecks by developing comprehensive and innovative transportation solutions. The goals of STARS studies include:

- Develop innovative, cost effective solutions
- Evaluate potential solutions more thoroughly
- Identify potential projects risks and costs
- Build stakeholder consensus
- Improve readiness for project implementation

This study is entitled the Route 288 Corridor Improvement Study and will be referred to as the Study in this report.

1.2 Purpose of Study

The purpose of the Study was to document the existing safety and operational deficiencies in the Route 288 study corridor and develop potential projects to improve safety and operations. The goal of the Study was to identify improvements that can be programmed in the VDOT Six-Year Improvement Program (SYIP). The primary needs for this project included the following:

- Improve throughput and reduce travel times on Route 288 during peak hours
- Reduce congestion and slowdowns on Route 288 that present safety issues

Known operational deficiencies in the study area include the following:

- Northbound Route 288 at the merge from Route 711 (Huguenot Trail)
- Southbound Route 288 at the Route 6 (Patterson Avenue) interchange

Additional operational and safety deficiencies were identified following the existing and future conditions analysis.

1.3 Study Work Group

A study work group (SWG) was formed for the Study to capture input from local stakeholders and to shape the development of improvement concepts. The SWG provided local and institutional knowledge of the corridor; reviewed study methodologies; provided input on key assumptions; and reviewed and approved proposed improvements created through the study process. The SWG included members representing the following organizations:

- VDOT
- Chesterfield County
- Goochland County
- Powhatan County
- Richmond Regional Transportation Planning Organization (RRTPO)
- Kimley-Horn and Associates

1.4 Study Area

The study area for the Route 288 corridor was approximately 12 miles long and is oriented in a north/south direction. The limits of the Study extended along Route 288 from north of US 60 (Midlothian Turnpike) to south of US 250 (W. Broad Street). **Figure 1** shows the limits of the corridor. The study area included four interchanges, 12 study intersections, and two additional ramps. The following corridors, interchange ramps, and intersections were included in the study area:

1.4.1 Corridors

1. Northbound Route 288 from upstream of the on-ramp from the northbound Route 288 C-D road (US 60) to downstream of the on-ramp from westbound Tuckahoe Creek Parkway
2. Southbound Route 288 from upstream of the on-ramp from US 250 to downstream of the on-ramp from Route 711
3. Route 711 from Venita Road to east of the northbound Route 288 ramps
4. Route 6 from West Creek Parkway to Pagebrook Drive
5. West Creek Parkway from west of the southbound Route 288 ramps to Broad Branch Drive
6. Tuckahoe Creek Parkway from Capital One Drive to east of the northbound Route 288 ramps

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2. Off-ramp to Route 711
3. On-ramp from Route 711
4. Off-ramp to eastbound Route 6
5. On-ramp from eastbound Route 6
6. Off-ramp to westbound Route 6
7. On-ramp from westbound Route 6
8. Off-ramp to West Creek Parkway
9. On-ramp from West Creek Parkway
10. Off-ramp to eastbound Tuckahoe Creek Parkway
11. On-ramp from eastbound Tuckahoe Creek Parkway
12. Off-ramp to westbound Tuckahoe Creek Parkway
13. On-ramp from westbound Tuckahoe Creek Parkway
14. On-ramp from Capital One Drive

1.4.3 Southbound Route 288 Interchange Ramps

1. On-ramp from US 250
2. Off-ramp to westbound Tuckahoe Creek Parkway
3. Off-ramp to Capital One Drive
4. On-ramp from westbound Tuckahoe Creek Parkway
5. Off-ramp to eastbound Tuckahoe Creek Parkway
6. On-ramp from eastbound Tuckahoe Creek Parkway
7. Off-ramp to westbound West Creek Parkway
8. Off-ramp to eastbound West Creek Parkway
9. On-ramp from West Creek Parkway
10. On-ramp from westbound Route 6
11. Off-ramp to eastbound Route 6
12. On-ramp from eastbound Route 6
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14. On-ramp from Route 711

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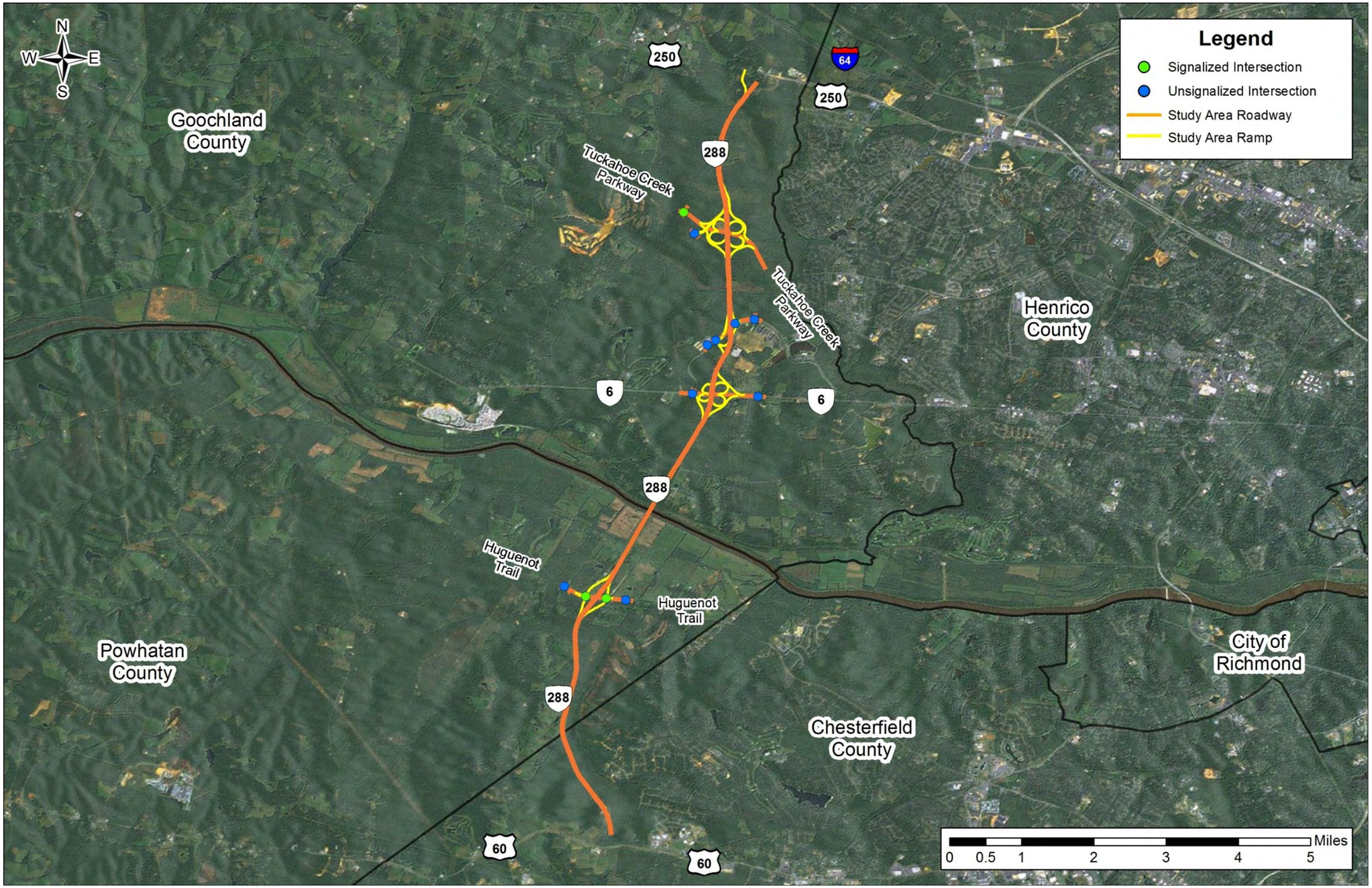
5. West Creek Parkway at Northbound Route 288 Ramps (Unsignalized)
6. West Creek Parkway at Broad Branch Drive (Unsignalized)
7. Route 6 at West Creek Parkway (Unsignalized)
8. Route 6 at Pagebrook Drive (Unsignalized)
9. Route 711 at Venita Road (Unsignalized)
10. Route 711 at Southbound Route 288 Ramps (Signalized)
11. Route 711 at Northbound Route 288 Ramps (Signalized)
12. Route 711 at Huguenot Median Opening #1 (Unsignalized)

Figure 1: Study Area Location Map



2 Data Collection and Inventory

A preliminary field review of the study area was conducted on May 31st and June 1, 2017 to verify existing conditions including traffic control devices, peak hour traffic conditions, and driver behavior. During the evening of May 31, there was utility work along southbound Route 288. During the morning of June 1, there was a disabled vehicle along the shoulder of Route 288. Both of which impacted the field reviews. Therefore, an additional field review was conducted on November 15, 2017 to verify peak hour traffic conditions. In addition to the field review, existing traffic volume data was collected from a combination of turning movement counts and VDOT continuous count stations. VDOT provided crash data, existing traffic signal timing plans, and roadway design plans. The following sections summarize collected data and field review observations.

2.1 Existing and Future Land Use

The existing and future land use maps for Chesterfield County, Goochland County and Powhatan County are presented in **Appendix A**.

The Goochland County existing land use map showed the parcels surrounding Route 288 between Route 6 and US 250 were primarily zoned for industrial uses (M1). The future land use map showed that these parcels surrounding Route 288 were primarily zoned for Prime Economic Development. The definition of "Prime Economic Development Area" provided in the Goochland County 2035 Comprehensive Plan is not specific to a particular land use, just that land uses "should demonstrate a positive impact on the County's tax base" and "shall generally consist of large-tract, diverse, high-quality development phased with the provision of infrastructure improvements. Currently, multiple developments are proposed for this area consisting of residential, commercial, and business land uses.

The Powhatan County existing land use map showed that the parcels surrounding the Route 288 and Route 711 interchange were zoned for agricultural and rural residential uses. The future land use map showed that the parcels on the west side of Route 288 remained zoned for agricultural and rural residential uses; however, the parcels adjacent to the east of the Route 288 and Route 711 interchange were zoned for Village Center and Village Residential. The remaining parcels along the east side of Route 288 at Route 711 were zoned for Village Residential and Natural Conservation.

The Chesterfield County existing land use map showed the parcels in the immediate area of the Route 288 study corridor between US 60 and the Powhatan County line were primarily zoned for commercial (C-3) and industrial uses (I-2) to the west of Route 288. To the east of Route 288, the parcels were primarily zoned for residential (R-9, R-12, and R-25), office (O-2) and industrial uses closer to US 60. In the future land use map, the parcels west of Route 288 were zoned for Low Density Residential and Regional Mixed Use. To the east of Route 288, the parcels were zoned for Low Density Residential, with Medium-High Density Residential and Corporate Office/Research & Development/Light Industrial closer to US 60. Under existing conditions, there is significantly more development to the east of Route 288 than to the west. Most of the area zoned commercial/industrial, outside of the Westchester Commons development, is currently undeveloped to the west of Route 288. The higher population and employment increases to the west of Route 288 shown in **Figure 2** and **Figure 3** are likely due to parcels going from undeveloped to developed, rather than a change in zoning.

The 2040 Richmond Tri-Cities Travel Demand Model indicated a growth in population and employment in the area between 2012 and 2040. A population increase of 6.29 percent annually was projected within the study area compared to 2.07 percent in Chesterfield County, 1.35 percent in Goochland County, and 1.87% in Powhatan County. The growth of the study area with respect to population and employment of the surrounding counties is provided in **Table 1**. *The 2012-2040 Socioeconomic Data Report* states that the West Creek regional activity center, which is located along Route 288 between US 250 and Broad Branch, was expected to have a 64 percent increase in employment between 2012 and 2040. In the same timeframe, the population was expected to increase from change from 176 to 2,644.

Figure 2 and **Figure 3** depict the employment and population changes as reflected in the 2040 Richmond Tri-Cities Travel Demand model in the areas adjacent to the study area between 2012 and 2040, respectively.

Table 1: RRTPO Region Projected Growth

Year	Employment			Population		
	2012	2040	2012-2040	2012	2040	2012-2040
Study Area	10,025	30,884	7.43%	10,777	29,772	6.29%
Chesterfield County	116,434	181,391	1.99%	321,718	508,307	2.07%
Goochland County	12,509	26,450	3.98%	21,942	30,256	1.35%
Powhatan County	5,406	15,307	6.54%	28,410	43,277	1.87%

2.2 Description of the Study Area

The study area within Route 288 is a critical regional connection that serves as the western portion of I-295. The study area includes approximately 12 miles of Route 288 between US 250 to US 60. The following sections provide a summary of Route 288 and four interchanges within the study area.

2.2.1 Route 288

Within the study area, Route 288 is a four-lane, divided freeway with a posted speed limit of 65 mph. The northbound travel lanes are separated from the southbound travel lanes by a variable width grass median. According to the VDOT 2014 Functional Classification Map, Route 288 is classified as an Other Freeway or Expressway.

2.2.2 Tuckahoe Creek Parkway

Within the study area, Tuckahoe Creek Parkway is a four-lane, divided roadway with a posted speed limit of 45 mph. The eastbound travel lanes are separated from the westbound travel lanes by a variable width grass median. Tuckahoe Creek Parkway is classified as a Major Collector within the study area.

2.2.3 West Creek Parkway

Within the study area, West Creek Parkway is a four-lane divided roadway with a posted speed limit of 35 MPH. The eastbound travel lanes are separated from the westbound travel lanes by a variable width grass median. West Creek Parkway classified as a Major Collector within the study area.

2.2.4 Route 6 (Patterson Avenue)

Within the study area, Route 6 is a four-lane, divided roadway with a posted speed limit of 55 mph. The eastbound travel lanes are separated from the westbound travel lanes by a variable width grass median. Route 6 between West Creek Parkway and Pagebrook Drive is classified as an Other Principal Arterial.

2.2.5 Route 711 (Huguenot Trail)

Within the study area, Route 711 is a four-lane, divided roadway with a posted speed limit of 45 mph. The eastbound travel lanes are separated from the westbound travel lanes by a variable width grass median. Route 711 is classified as Minor Arterial within the study area.

Figure 2: Projected Employment Growth 2012 – 2040

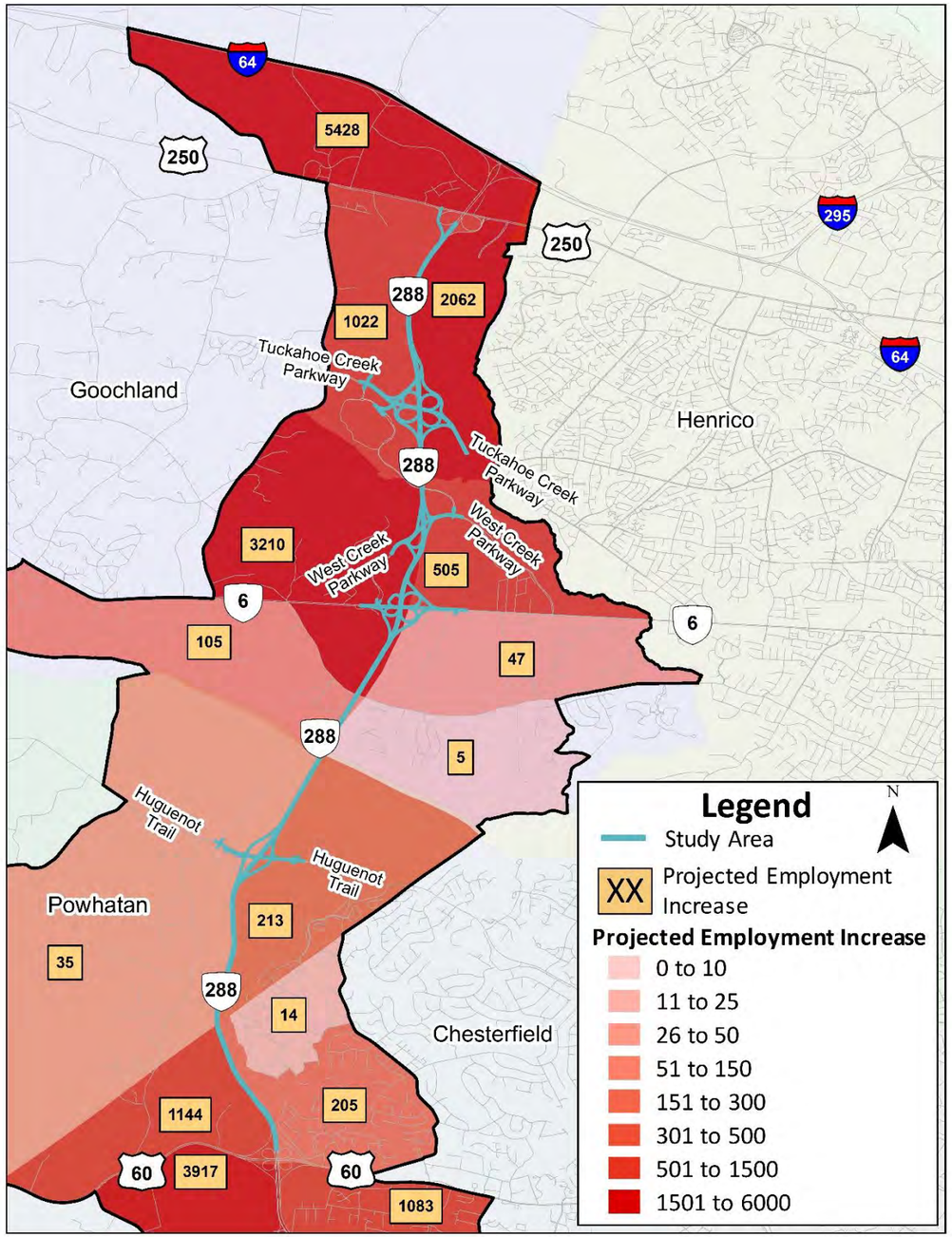
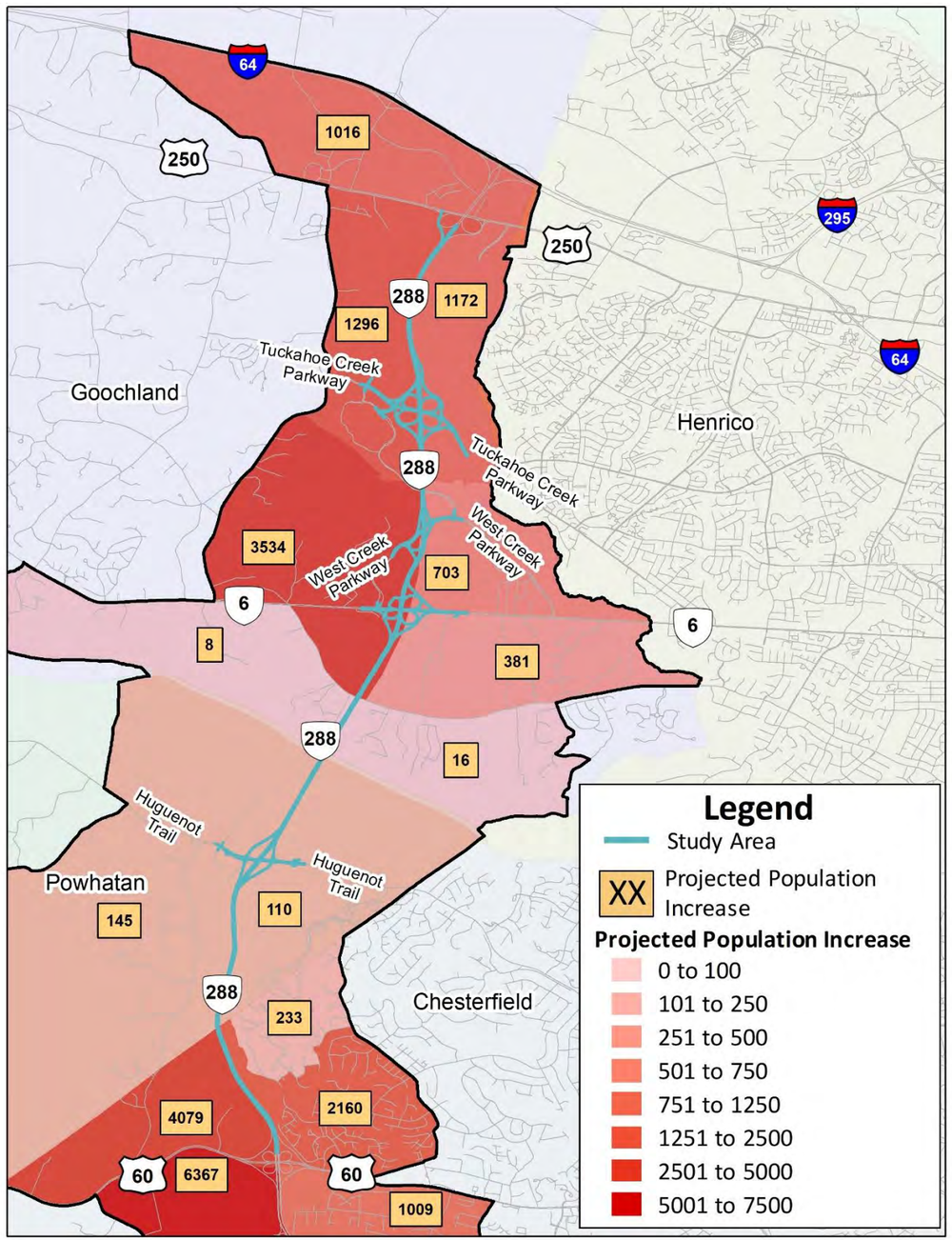


Figure 3: Projected Population Growth 2012 – 2040



2.3 Field Review Observations

During the field review on November 15, 2017 existing conditions and operations were observed, including the following observations:

- During the AM peak hour, congestion occurred at the northbound Route 288 on-ramp from Route 711. Queues extended on mainline northbound Route 288 back towards US 60 for nearly three miles. Along westbound Route 711, there is arterial queueing from the westbound right-turn at Route 711 and the Route 288 northbound ramps that extends near Winterfield Road.
- During PM peak hour, congestion occurred at the southbound Route 288 on-ramp from westbound Route 6. Queues extended on mainline southbound Route 288 from Route 6 to Tuckahoe Creek Parkway.

Queue on the northbound Route 288 on-ramp from Huguenot Trail in the AM peak hour

Queue on southbound Route 288 between Route 6 and Tuckahoe Creek Parkway in the PM peak hour

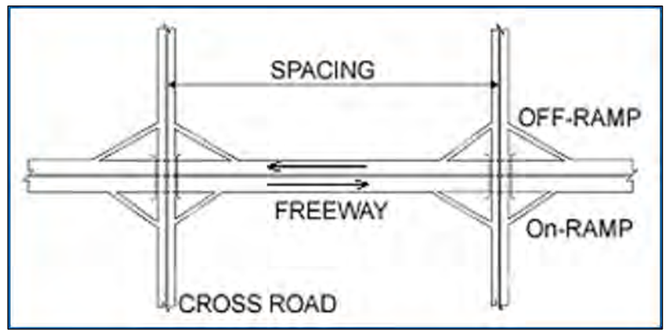
2.4 Existing Roadway Geometry

The existing roadway geometry in the study area was observed and documented during the field review. **Figure 5 s**ummarizes the existing lane configurations. INRIX data, obtained from VDOT, was used to obtain free-flow mainline travel speeds in both directions on Route 288. During the field review, free-flow mainline travel speeds in the northbound and southbound directions from the INRIX data were comparable to the free-flow speeds observed in the field during the peak periods.

2.5 Interchange Spacing

The Route 288 study area includes four full interchanges: Tuckahoe Creek Parkway, West Creek Parkway, Route 6, and Route 711. The study area also includes two ramps from interchanges that are outside the study area: the southbound Route 288 on-ramp from US 250 and the northbound Route 288 on-ramp from the northbound US 60 C-D road. According to the AASHTO Green Book, the general guidance for minimum interchange spacing is one mile for urban freeways. The FHWA Techbrief "Safety Assessment of Interchange Spacing on Urban Freeways" (Publication Number FHWA-HRT-07-031), defines interchange spacing as the distance between interchange crossroads as shown in **Figure 4.**

Figure 4: Interchange Spacing Measurement



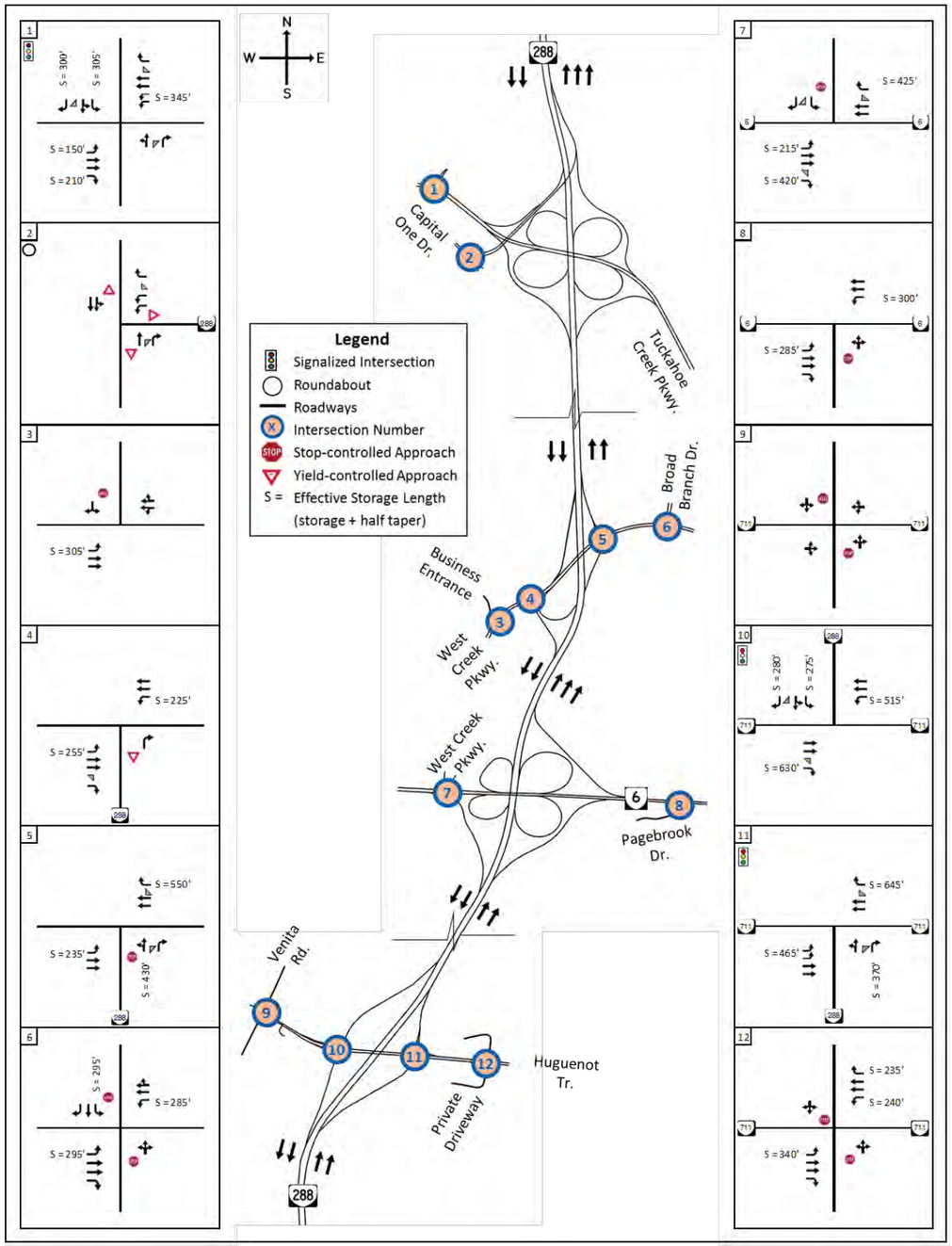
Source: FHWA Techbrief "Safety Assessment of Interchange Spacing on Urban Freeways" (Publication Number: FHWA-HRT-07-031)

Existing interchange spacing between crossroads within the study area is summarized in **Table 2**. The study corridor met the AASHTO one-mile interchange spacing criterion between all interchanges in the study area in both the northbound and southbound travel directions except for the West Creek Parkway, which was 0.05 miles deficient.

Table 2: Interchange Spacing

From	To	Interchange Spacing (mile)	Deficient Distance (mile)
Northbound			
US 60 (Midlothian Turnpike)	Route 711	3.60	-
Route 711	Route 6 (Patterson Avenue)	3.10	-
Route 6 (Patterson Avenue)	West Creek Parkway	0.95	0.05
West Creek Parkway	Tuckahoe Creek Parkway	1.32	-
Tuckahoe Creek Parkway	US 250 (W Broad Street)	2.30	-

Figure 5: Existing (2017) Lane Configurations



2.6 Acceleration/Deceleration Lane Lengths

Ramp design speeds, lengths, and grades were obtained from roadway design plans, where available. Ramp grades not provided on roadway design plans were estimated based on results of the field review and GIS data. The ramp speed, existing lane length, AASHTO standard lane length (based on the AASHTO Green Book), and deficient length were shown for each of the acceleration and deceleration lanes in the study corridor in **Table 3**.

The recommended AASHTO weaving lengths do not apply to cloverleaf interchanges. Acceleration and deceleration lanes that do not meet the AASHTO standard were denoted as deficient. Six of the 14 acceleration lane lengths were deficient, and one of the 12 deceleration ramps were deficient.

2.7 Traffic Volume Data

Collection of turning movement count (TMC) data was conducted at three intersections on Wednesday, May 31, 2017 and the remaining eight study intersections on Thursday, June 1, 2017. TMC data was collected between the hours of 7:00-9:00 AM and 4:00-7:00 PM at all study area intersections. All study area ramp volumes were collected on Thursday, June 1, 2017 except for four ramps that were collected on Wednesday, May 31, 2017. Four out of the VDOT eight continuous count stations within the study area were not in use during the same dates where TMC data was collected and have been out of use since the summer of 2016. Therefore, continuous count station data from May 24, 2016 through May 26, 2016 were used for all continuous count stations after the counts were deemed comparable between the two count years at locations where data was available. **Table** 4 summarizes the date and source of the count data for all locations within the study area. Raw traffic count and INRIX data is provided in **Appendix A**.

VDOT published annual average daily traffic (AADT) volume estimates were also reviewed on Route 288 between Broad Street and Midlothian Turnpike. The 2016 VDOT published AADT volume on Route 288 ranged between 50,000 vehicles per day (vpd) south of Route 711 and 58,000 vpd north of Route 711.

2.7.1 Peak Hour Determination

Based on direction provided in TOSAM, the AM and PM peak hours for each intersection and ramp within the study area were held constant. Traffic volumes during each hour were compared to the traffic volumes during the peak hour at each location. The hour that captured the highest percentage of overall traffic in the network was identified as the study peak hour. The computations for the AM and PM peak hours are provided in **Appendix A**. The AM and PM peak hours were determined to be 7:45-8:45 AM and 4:45-5:45 PM, respectively. The same process was followed to develop a two-hour peak period to be used for VISSIM analyses. The computations for the AM and PM peak periods are also provided in **Appendix A**, which were determined to be 7:15-9:15 AM and 4:15-6:15 PM, respectively.

Table 3: Acceleration/Deceleration Lane Lengths

Ramp	Design Speed (mph)	Length (feet)	Taper Length (feet)	Standard Length (feet)	Deficient Length (feet)
Acceleration Lanes					
Southbound Route 288 on-ramp from eastbound US 250	40	1,225	250	1,000	-
Southbound Route 288 on-ramp from westbound Tuckahoe Creek Parkway	30	1,075	--	1,350	275
Southbound Route 288 on-ramp from eastbound Tuckahoe Creek Parkway	40	1,000	250	1,000	-
Southbound Route 288 on-ramp from West Creek Parkway	40	850	265	1,000	150
Southbound Route 288 on-ramp from westbound Route 6	20	800	--	1,520	720
Southbound Route 288 on-ramp from eastbound Route 6	50	825	350	580	-
Southbound Route 288 on-ramp from Route 711	40	1,175	275	1,000	-
Northbound Route 288 on-ramp from Northbound Route 288 C-D road (US 60)	50	600	275	580	-
Northbound Route 288 on-ramp from Route 711	50	550	175	580	30
Northbound Route 288 on-ramp from eastbound Route 6	30	900	--	1,350	450
Northbound Route 288 on-ramp from westbound Route 6	40	2,500	--	1,000	-
Northbound Route 288 on-ramp from West Creek Parkway	60	1,075	250	580	-
Northbound Route 288 on-ramp from eastbound Tuckahoe Creek Parkway	40	1,050	-	1,000	-
Northbound Route 288 on-ramp from westbound Tuckahoe Creek Parkway	40	900	475	1,000	100
Deceleration Lanes					
Southbound Route 288 off-ramp to westbound Tuckahoe Creek Parkway	40	625	225	440	-
Southbound Route 288 off-ramp to eastbound Tuckahoe Creek Parkway	40	1,075	--	440	-
Southbound Route 288 off-ramp to westbound West Creek Parkway	60	600	250	340	-
Southbound Route 288 off-ramp to eastbound West Creek Parkway	30	400	275	520	120
Southbound Route 288 off-ramp to eastbound Route 6	30	800	--	520	-
Southbound Route 288 off-ramp to Route 711	50	500	200	340	-
Northbound Route 288 off-ramp to Route 711	50	1,275	220	340	-
Northbound Route 288 off-ramp to eastbound Route 6	60	400	250	340	-
Northbound Route 288 off-ramp to westbound Route 6	30	900	--	520	-
Northbound Route 288 off-ramp to West Creek Parkway	30	2,500	--	520	-
Northbound Route 288 off-ramp to eastbound Tuckahoe Creek Parkway	40	475	275	440	-
Northbound Route 288 off-ramp to westbound Tuckahoe Creek Parkway	40	1,050	--	440	-

Table 4: Study Area Intersections, Ramps, and VDOT Continuous Count Station Counts

Location	Count Date (Source)
Study Area Intersections	
1 Tuckahoe Creek Parkway at Capital One Drive	6/1/17
2 Capital One Drive at Route 288	6/1/17
3 West Creek Parkway at West Creek Median Opening #1	6/1/17
4 West Creek Parkway at Southbound Route 288 Ramps	6/1/17
5 West Creek Parkway at Northbound Route 288 Ramps	6/1/17
6 West Creek Parkway at Broad Branch Drive	6/1/17
7 Route 6 at West Creek Parkway	6/1/17
8 Route 6 at Pagebrook Drive	6/1/17
9 Route 711 at Venita Road	5/31/17
10 Route 711 at Southbound Route 288 Ramps	5/31/17
11 Route 711 at Northbound Route 288 Ramps	5/31/17
12 Route 711 at Huguenot Median Opening #1	5/31/17
Ramps	
1 Northbound Route 288 off-ramp to Route 711	5/31/17
2 Northbound Route 288 on-ramp from Route 711	5/31/17
3 Southbound Route 288 off-ramp to Route 711	5/31/17
4 Southbound Route 288 on-ramp from Route 711	5/31/17
5 All other ramps	6/1/17
Continuous Count Stations	
1 Route 288 northbound from Route 711 to Goochland County Line	5/24/16 - 5/26/16
2 Route 288 southbound from Route 711 to Goochland County Line	5/24/16 - 5/26/16
3 Route 288 northbound from US 60 to Powhatan County Line	5/24/16 - 5/26/16
4 Route 288 southbound from US 60 to Powhatan County Line	5/24/16 - 5/26/16
5 Route 288 northbound from US 64 to US 250	5/24/16 - 5/26/16
6 Route 288 southbound from US 64 to US 250	5/24/16 & 5/26/16
7 Route 288 northbound from US 250 to Tuckahoe Creek Parkway	5/24/16 - 5/26/16
8 Route 288 southbound from US 250 to Tuckahoe Creek Parkway	5/24/16 & 5/26/16

2.7.2 Traffic Volume Balancing

Once the AM and PM peak hours and two-hour peak periods were established, traffic volumes were balanced in 15-minute intervals using the following assumptions:

- Raw traffic volumes should not be adjusted by more than 10%, if possible.
- Traffic volumes should not be changed at count locations on southbound Route 288 north of Tuckahoe Creek Parkway, on northbound Route 288 south of Huguenot Trail, and on all study area ramps, unless the 10% threshold cannot be met elsewhere in the network.
- For traffic volume balancing on the arterials, balance along the arterials by holding volumes from the entering and exiting ramps at the interchange of Route 288 and the arterials. If a 10% adjustment cannot correct the imbalance, maintain the 10% change and move backwards to correct remaining imbalance. Carry adjustment throughout network. If 10% adjustments cannot be maintained after moving back toward intersections with Route 288 Ramps, identify if any volume imbalances can be attributed to driveways along roadway.

Balanced AM and PM peak hour traffic volumes are illustrated in **Figure 6** through **Figure 8**.

2.7.3 Heavy Vehicle Percentages and Peak Hour Factors

Heavy vehicle percentages were calculated for each movement at all study area intersections, ramps, and VDOT continuous count stations during the overall study area AM and PM peak hours. **Figure 9** and **Figure 10** summarize the AM and PM peak hour heavy vehicle percentages for each intersection movement, ramp, and continuous count station. Peak hour heavy vehicle percentages were computed by movement at intersections and ramps for use in Synchro. Peak period heavy vehicle percentages were also computed at all entering nodes for use in VISSIM.

AM and PM peak hour factors were calculated for each intersection based on guidance provided in TOSAM. The AM and PM peak hour factors are illustrated in **Figure 9** and **Figure 10**.

Figure 6: Existing (2017) Traffic Volumes – US 250 to Tuckahoe Creek Parkway

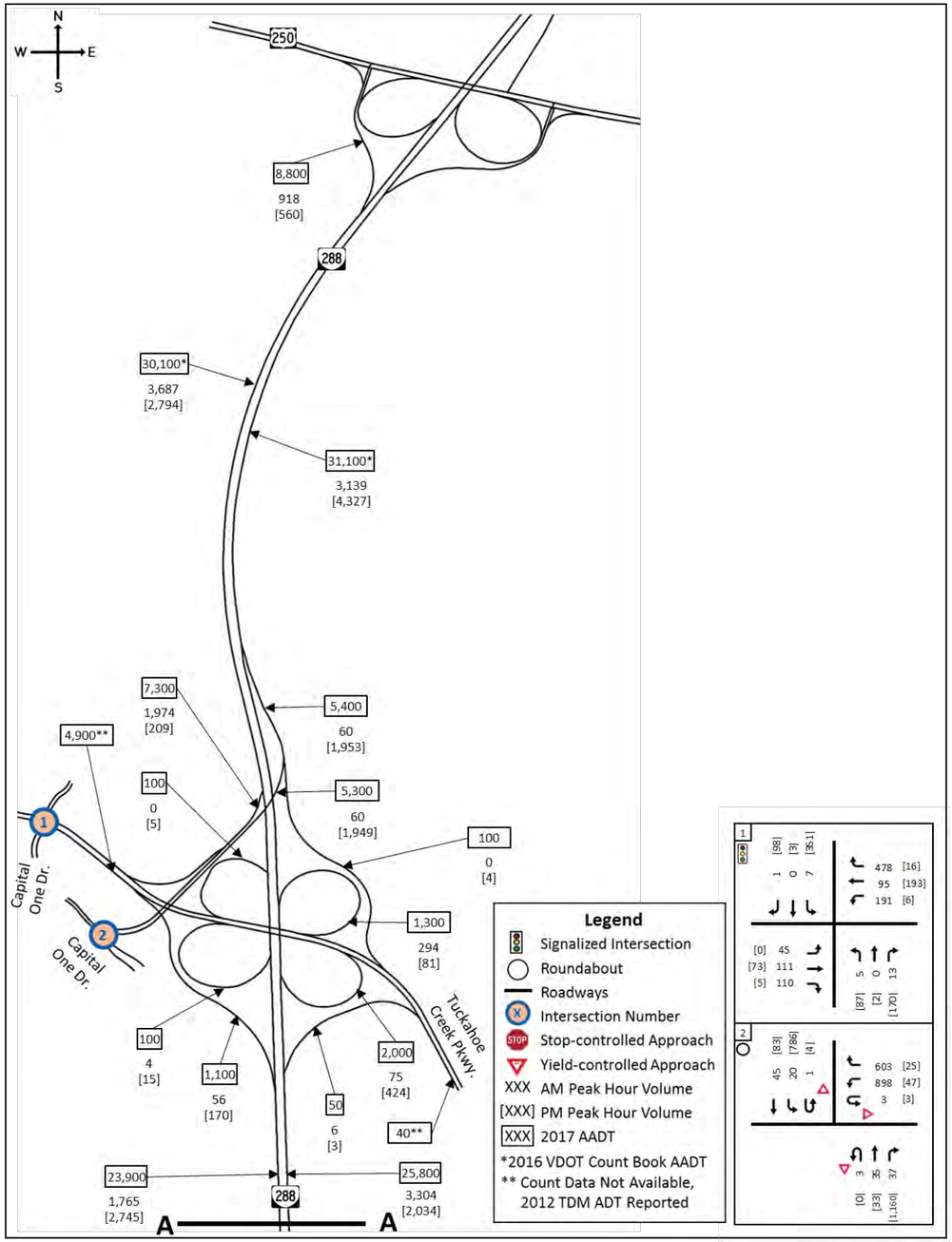


Figure 7: Existing (2017) Traffic Volumes – West Creek Parkway to Route 6

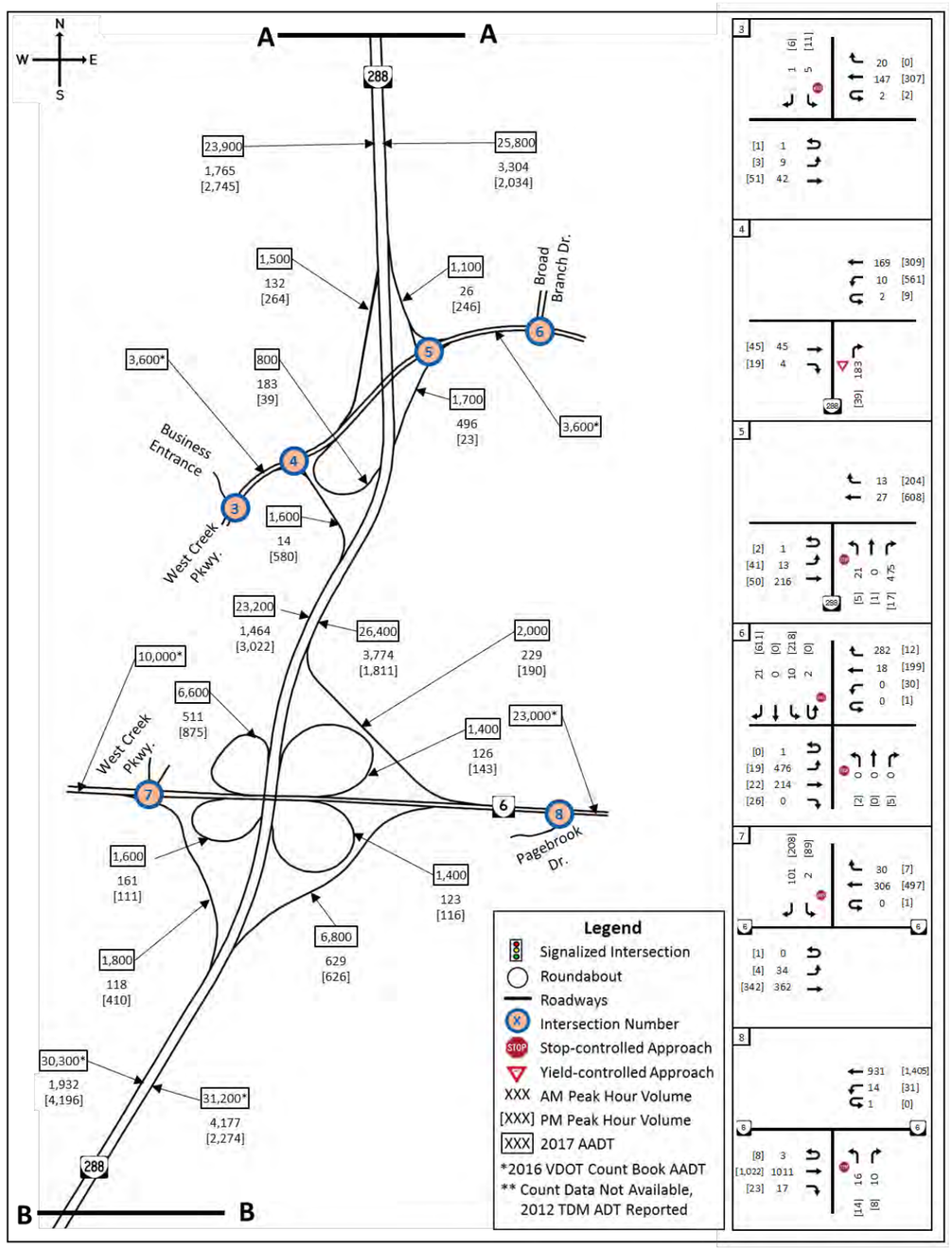


Figure 8: Existing (2017) Traffic Volumes – Route 711 to US 60

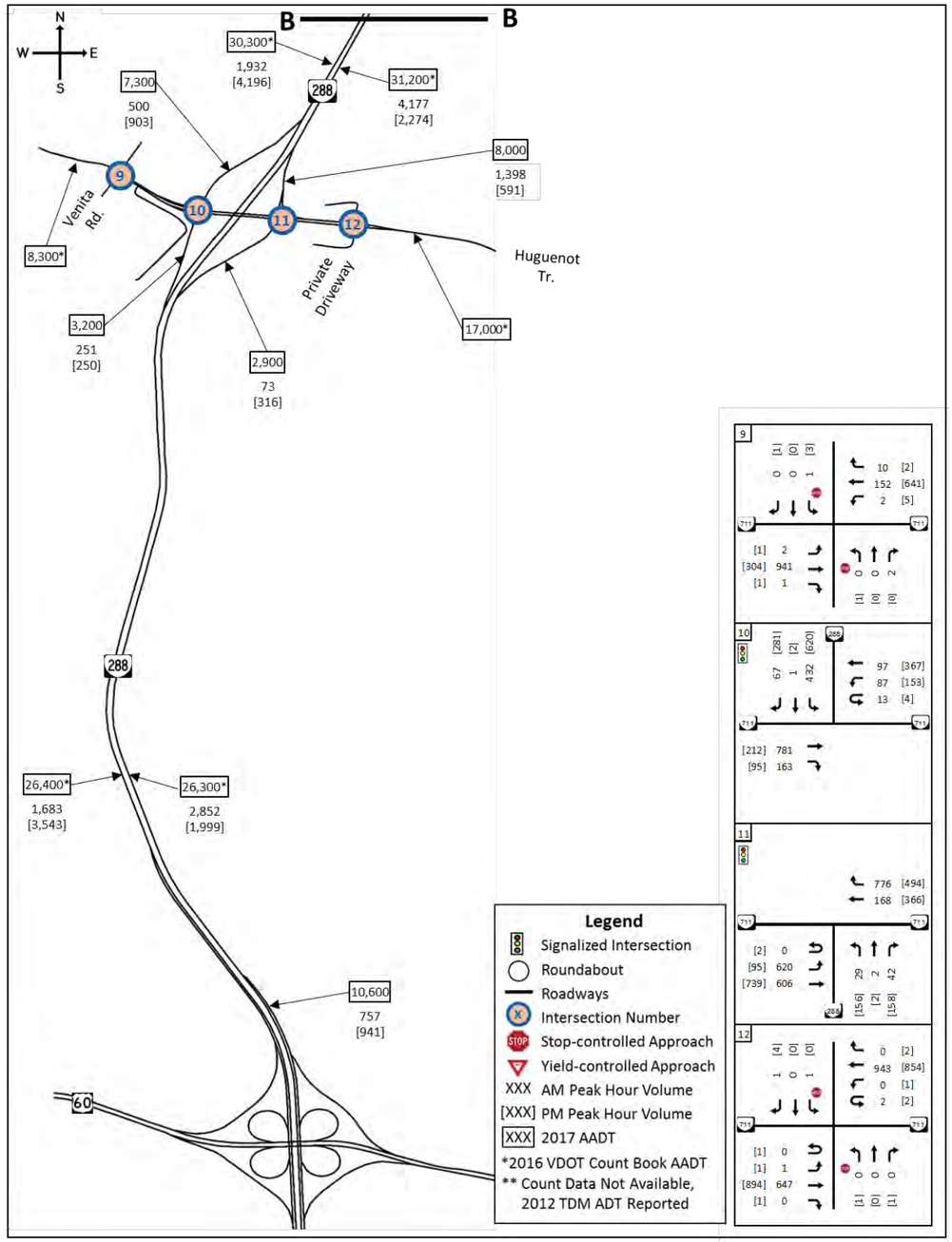


Figure 9: Existing (2017) AM Peak Hour Factors and Heavy Vehicle Percentages

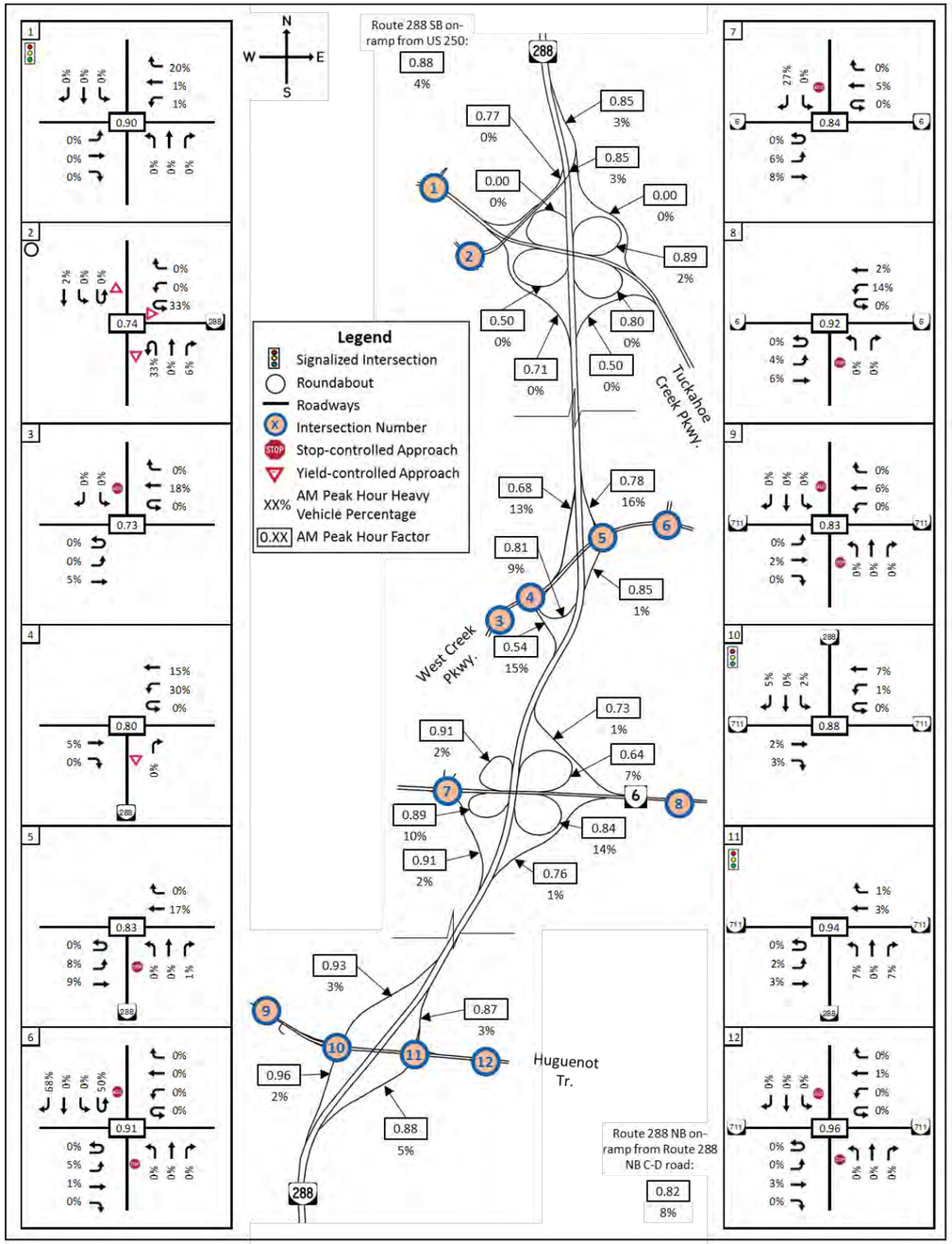
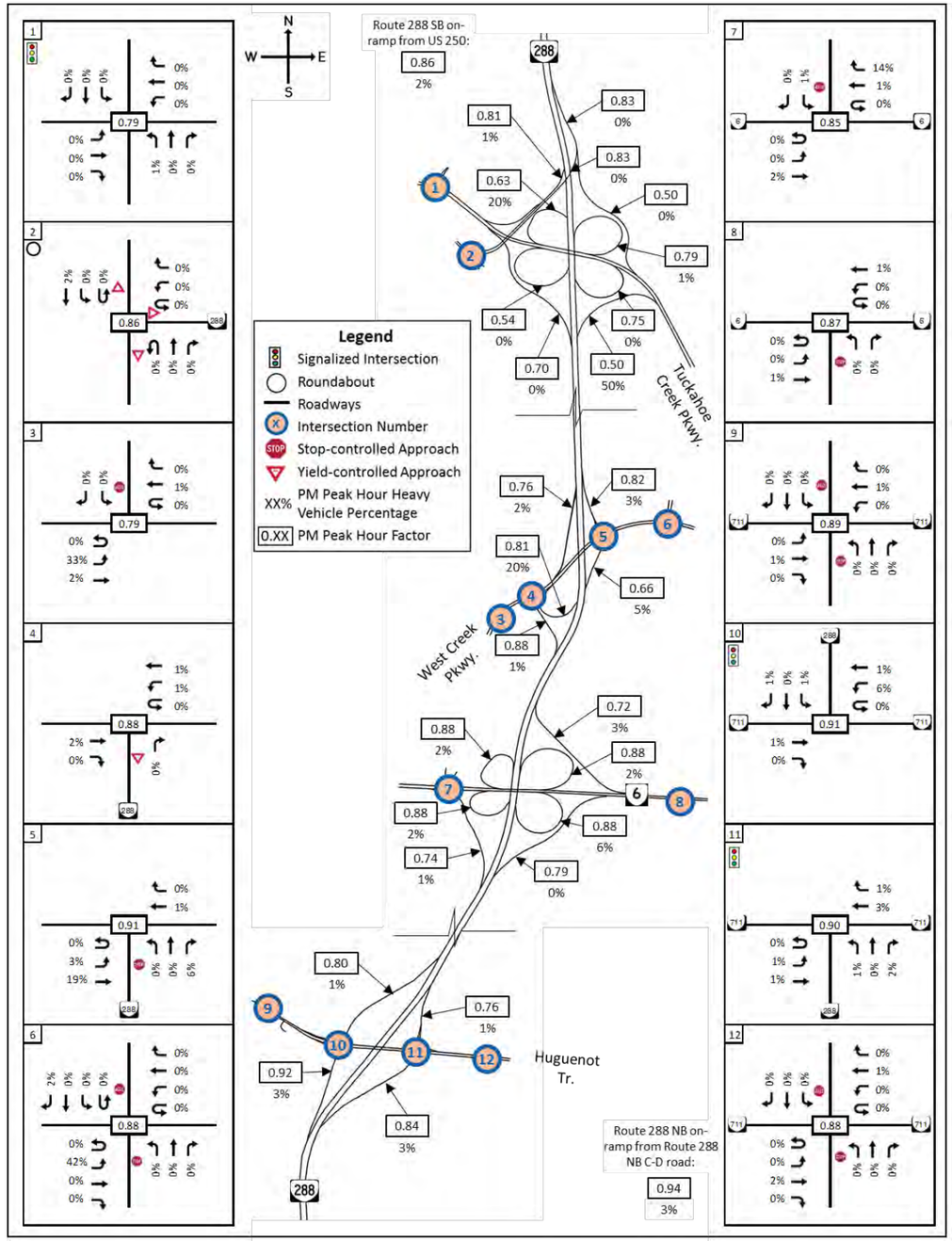


Figure 10: Existing (2017) PM Peak Hour Factors and Heavy Vehicle Percentages



3 Existing Conditions Analysis and Results

VISSIM models were developed to analyze freeway operations on Route 288 and intersection operations on Tuckahoe Creek Parkway, West Creek Parkway, Route 6, and Route 711 within the study area under existing (2017) AM and PM peak hour conditions.

3.1 Modeling Assumptions

The existing AM and PM VISSIM models were developed based on a combination of collected data and visual observations from the field review. Traffic volumes, travel times, speeds, and queue lengths were used as calibration measures for this report. A detailed summary of VISSIM modeling inputs, assumptions, and calibration results is provided in **Appendix B**. The VISSIM calibration tables are also provided in **Appendix B.**

The VDOT Sample Size Determination Tool was used to confirm that ten simulation runs would provide the acceptable 95 percent confidence level for both the AM and PM models. Therefore, ten simulation runs were conducted for both the AM and PM models using different random seeds. The average of these runs was reported.

3.2 Freeway Analysis

Graphical representation of the freeway results is included in **Appendix B**. The schematics present the average density (veh/ln/mi) and average speed (mph) for each freeway link in the network.

3.2.1 AM Peak Hour

During the AM peak hour in the northbound direction, the average speed reduced from 64.8 mph before the on-ramp from northbound Route 288 C-D road at US 60 to 15.2 mph at the on-ramp from Route 711. Similarly, the average link density increased to 95.1 veh/ln/mi at the on-ramp from Route 711. North of Route 711, the average speed increased to 60 mph and was maintained on northbound Route 288. The link densities decreased and remained below 30 veh/ln/mi after the off-ramp to Route 6. The northbound Route 288 freeway schematic between US 60 and Route 711 is illustrated in.

In the southbound direction, all segments operated with average speeds over 55 mph.

3.2.2 PM Peak Hour

During the PM peak hour in the northbound direction, all segments operated with light densities, less than 25 veh/ln/mi, and average speeds at or above 60 mph.

In the southbound direction, the segments on Route 288 between US 250 and the off-ramp to eastbound Tuckahoe Creek Parkway operated with light densities and average speeds over 60 mph. Between the off-ramp to eastbound Tuckahoe Creek Parkway and the off-ramp to eastbound Route 6, the freeway operated with heavy densities, reaching a maximum of 79.0 veh/ln/mi, and slow average speeds, reaching a minimum of 12.6 mph. South of the off-ramp to eastbound Route 6, the freeway was projected to operate with average speeds above 50 mph and densities below 40 veh/ln/mi. The southbound Route 288 freeway schematics between US 250 and Route 6 are illustrated in **Figure 12** and **Figure 13**.

3.3 Intersection Analysis

The existing AM and PM VISSIM intersection delay results are presented in **Figure 14** and **Figure 15**, and the maximum queues are provided in **Table 6**. VISSIM intersection results are summarized in **Appendix B**.

3.3.1 AM Peak Hour

In the AM peak hour, all intersections operated with acceptable overall intersection delays. At the intersection of Route 711 and northbound Route 288 ramps, the northbound through-left movements experienced excessive delays of 68.4 s/veh and the westbound right experienced excessive delays of 72.3 s/veh. At this intersection, the westbound right queue extended for approximately 4,500 feet to the east toward Winterfield Road.

3.3.2 PM Peak Hour

In the PM peak hour, all intersections operated with acceptable overall intersection delays. At the intersection of West Creek Parkway and Broad Branch Drive, the southbound approach operated with occasional delays that average 54.1 s/veh. The southbound right experienced excessive delays of 65.4 s/veh and queues that extended for approximately 1,129 feet. At the Capitol One Drive and Route 288 roundabout, the northbound through movement operated with excessive delays that average 98.6 s/veh.

3.4 Crash Analysis

A crash analysis was conducted to review and document crash patterns and trends within the study area roadway network. The most recent five years of crash data—from January 1, 2012 to December 31, 2016—were obtained from the VDOT Traffic Engineering Division (TED) Roadway Network System (RNS) database. The crash analysis was completed on Route 288 from MP 20.75 to MP 31.75 and the interchange ramps within the study area. The following sections of the report summarize the crashes that occurred within the study corridor during the five-year crash analysis period. **Appendix A** includes a full summary of the crash data.

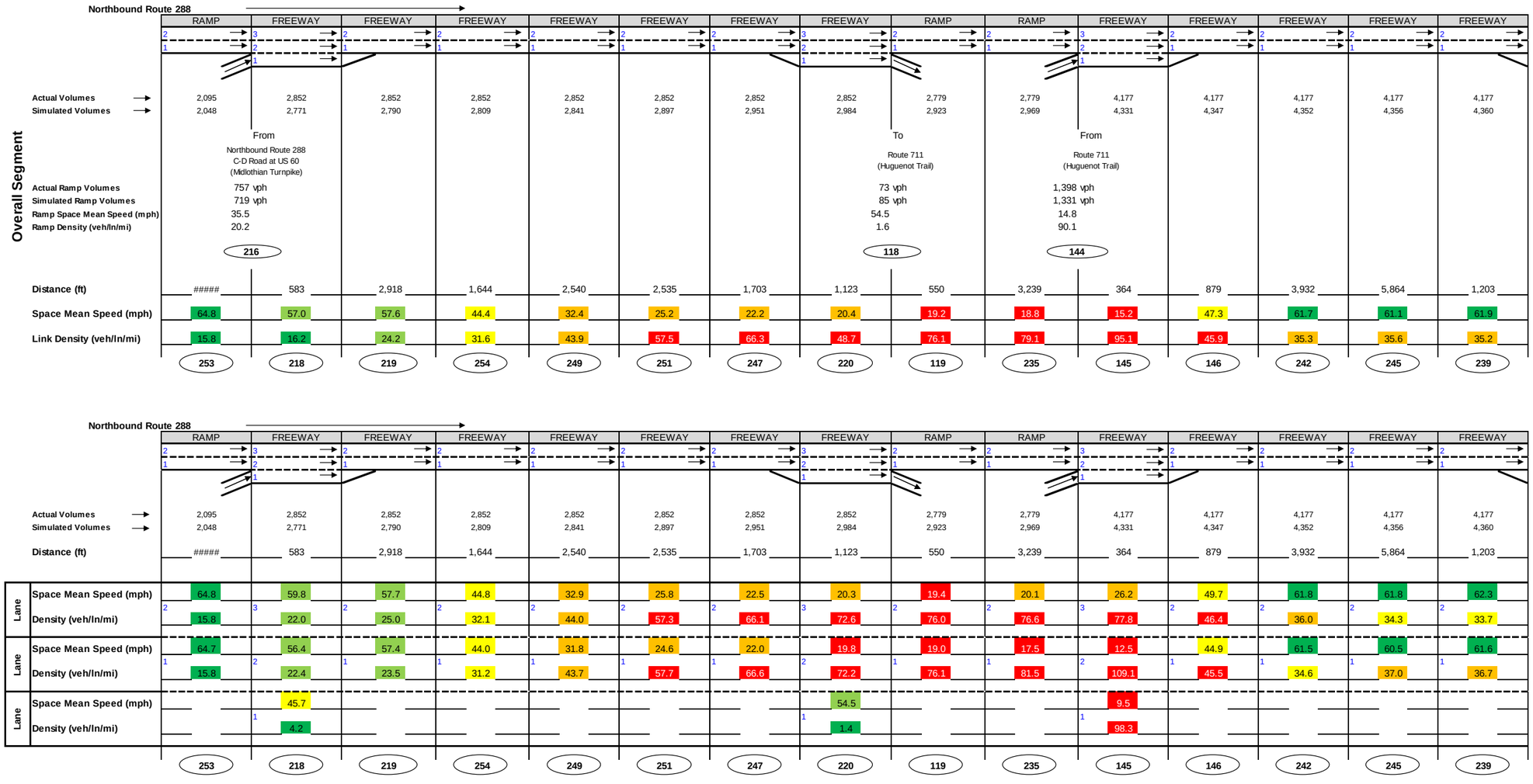
3.4.1 Summary of Study Area Crashes

Over the five-year crash analysis period, 318 total crashes were reported within the study area. Of the reported crashes, there was one fatal crash, 99 injury crashes, and 218 property damage only (PDO) crashes. A summary of the study area crashes is shown in **Table 5**. Additional details are provided in the following sections of the report.

Table 5: Crash Summary

	Number of Crashes			
Year	**Fatal**	**Injury**	**PDO**	**Total**
2012	1	20	44	65
2013	0	28	42	70
2014	0	19	45	64
2015	0	15	37	52
2016	0	17	50	67
Total	**1**	**99**	**218**	**318**
% of Total	**<1%**	**31%**	**69%**	**--**

Figure 11: Existing (2017) AM VISSIM Schematic – Northbound Route 288 from US 60 to Route 711



NOTE: numbers in chart are provided for illustrative purposes only

LEGEND

100 Link Number

Average Density (veh/ln/mi)
45 and above
35 to 45
26 to 35
18 to 26
0 to 18

Average Speed (mph)
0 to 20
20 to 35
35 to 50
50 to 60
60 and above

***The results shown are the average results across 10 microsimulation runs.**

Figure 12: Existing (2017) PM VISSIM Schematic – Southbound Route 288 from US 250 to Tuckahoe Creek Parkway

NOTE: numbers in chart are provided for illustrative purposes only

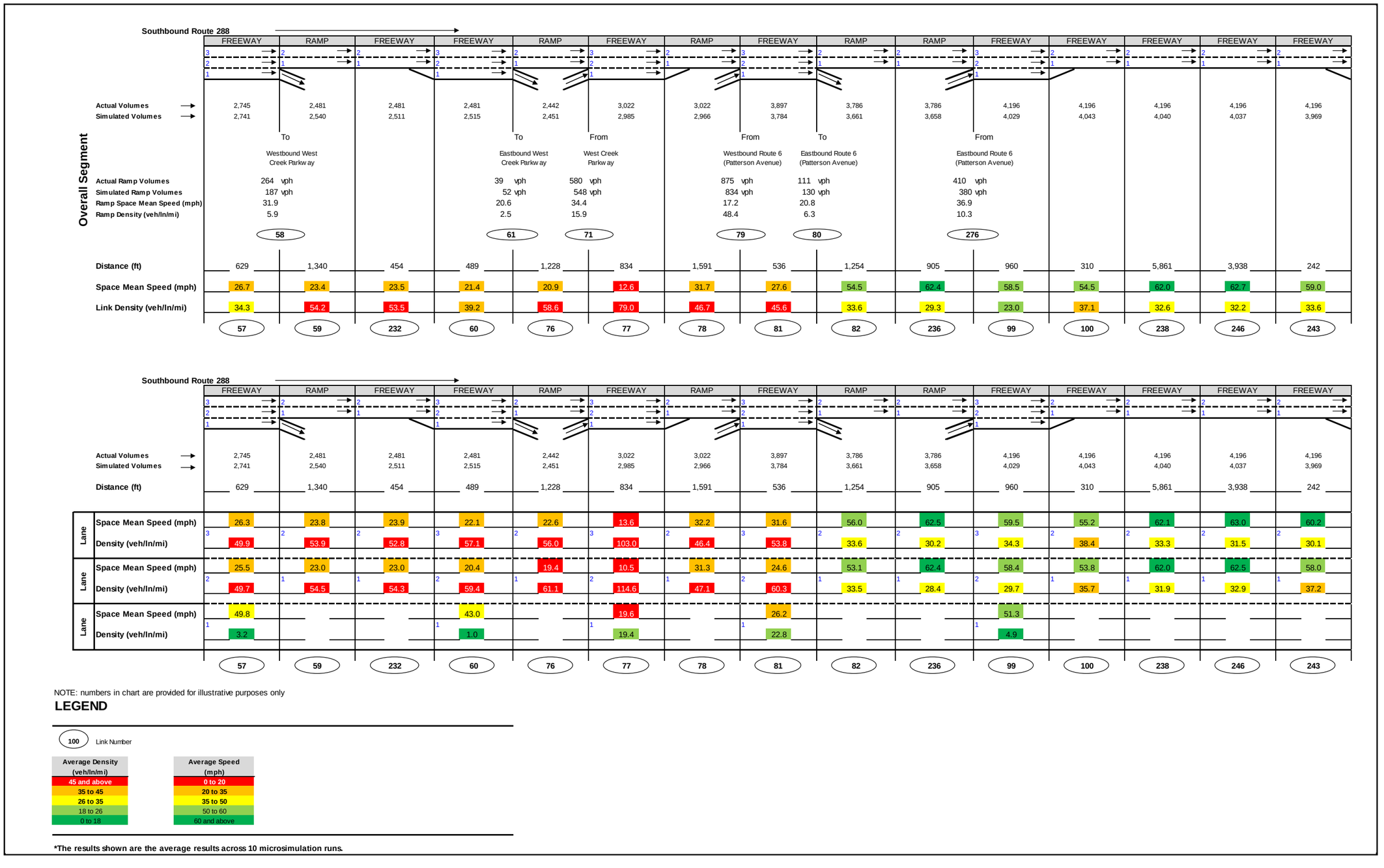
LEGEND

100 Link Number

Average Density (veh/ln/mi)	Average Speed (mph)
45 and above	0 to 20
35 to 45	20 to 35
26 to 35	35 to 50
18 to 26	50 to 60
0 to 18	60 and above

***The results shown are the average results across 10 microsimulation runs.**

Figure 13: Existing (2017) PM VISSIM Schematic – Southbound Route 288 from West Creek Parkway to Route 6



NOTE: numbers in chart are provided for illustrative purposes only

LEGEND

100 Link Number

Average Density (veh/ln/mi)
45 and above
35 to 45
26 to 35
18 to 26
0 to 18

Average Speed (mph)
0 to 20
20 to 35
35 to 50
50 to 60
60 and above

***The results shown are the average results across 10 microsimulation runs.**

Figure 14: Existing (2017) AM VISSIM Intersection Delays

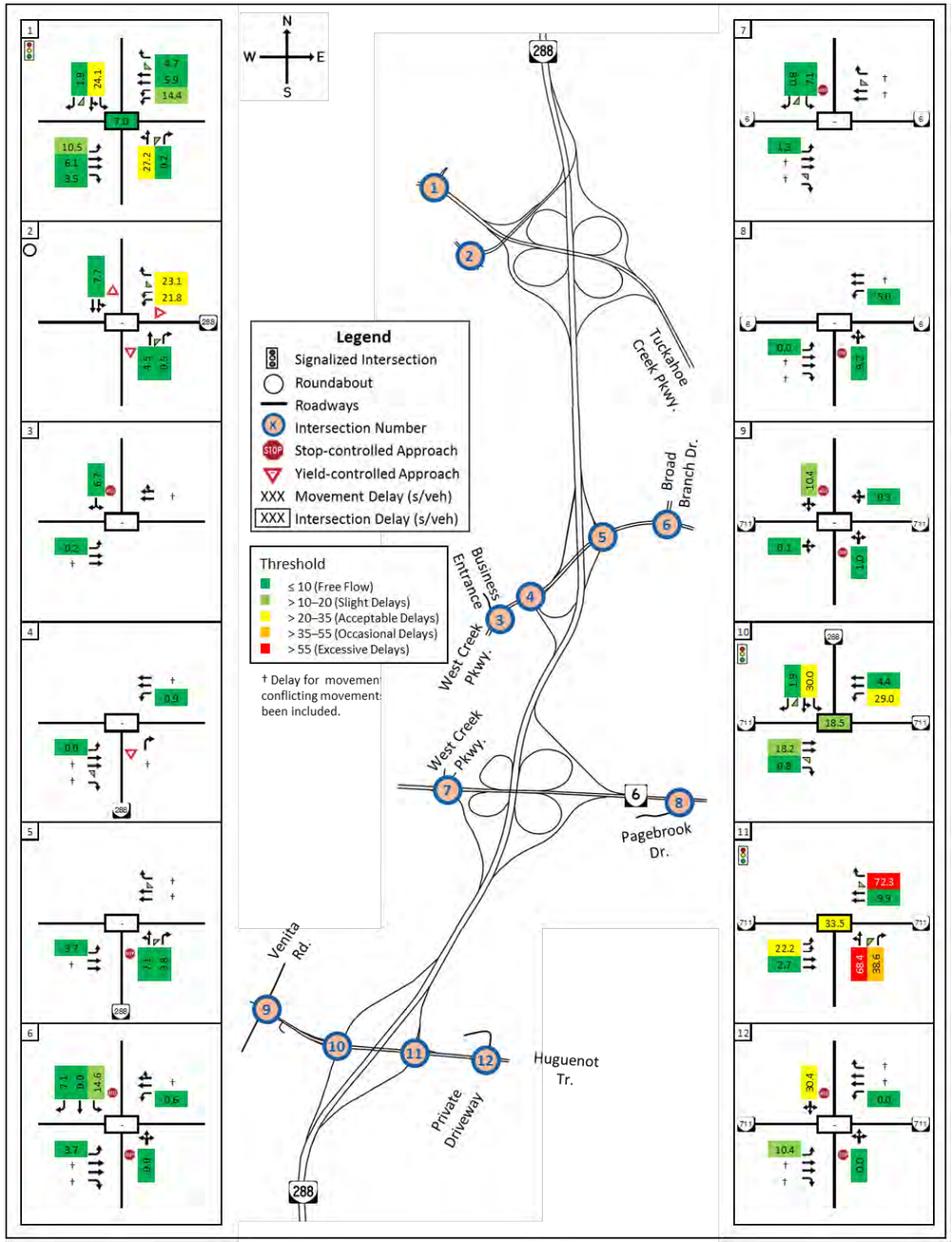


Figure 15: Existing (2017) PM VISSIM Intersection Delays

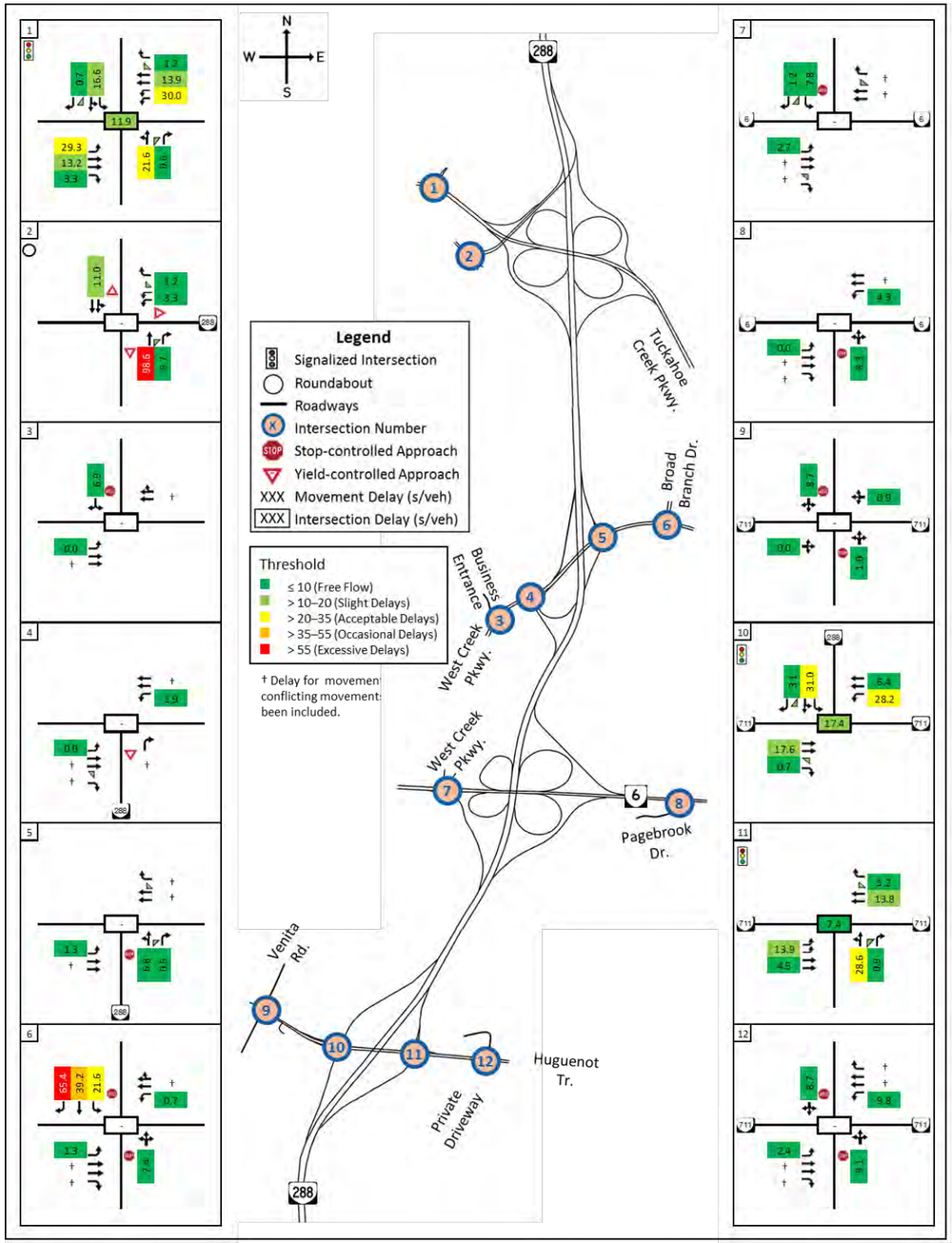


Table 6: Existing AM and PM VISSIM Intersection Queues

Intersection		Type of Control	Lane Group	Northbound			Southbound			Eastbound			Westbound		
				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	Tuckahoe Creek Parkway and Capital One Drive	Signal		Capital One Drive			CarMax			Tuckahoe Creek Parkway			Tuckahoe Creek Parkway		
			Left	-	33	114	305	28	163	150	50	18	345	85	30
			Through							-	49	52	-	40	82
			Right	-	0	5	300	6	34	210	108	64	-	0	0
2	Route 288 and Capital One Drive	Roundabout		Capital One Drive			Capital One Drive			--			Route 288 Ramps		
			Left				-	53	333				-	20	0
			Through	-	27	350									
			Right	-	27	388							-	0	0
3	West Creek Parkway and Eastern Median Opening	One-Way Stop		--			Business Drive			West Creek Parkway			West Creek Parkway		
			Left				-	36	50	305	3	0			
			Through							-	†	†	-	†	†
			Right										-	†	†
4	West Creek Parkway and Route 288 SB On-Ramps	One-Way Stop		Route 288 SB On-Ramp			--			West Creek Parkway			West Creek Parkway		
			Left							255	0	0	225	0	73
			Through							-	†	†	-	†	†
			Right	-	†	†				-	†	†	-	-	-
5	West Creek Parkway and Route 288 NB Off/On-Ramps	One-Way Stop		Route 288 NB Off-Ramp			Route 288 NB On-Ramp			West Creek Parkway			West Creek Parkway		
			Left	430	40	41				235	10	57			
			Through							-	†	†	-	†	†
			Right	-	0	0				-	†	†	550	†	†
6	West Creek Parkway and Broad Branch Drive	Two-Way Stop		Sports Complex			Broad Branch Drive			West Creek Parkway			West Creek Parkway		
			Left				295	71	173	295	168	41	295	9	12
			Through	-	0	44	-	0	44	-	†	†	-	†	†
			Right				-	108	1,129	285	†	†	-	†	†
7	Route 6 (Patterson Avenue) and West Creek Parkway	One-Way Stop		--			West Creek Parkway			Route 6			Route 6		
			Left				-	43	83	215	30	22			
			Through							-	†	†	-	†	†
			Right				-	41	47	420	†	†	425	†	†
8	Route 6 (Patterson Avenue) and Pagebrook Drive	One-Way Stop		Pagebrook Drive			--			Route 6			Route 6		
			Left							285	0	0	300	35	47
			Through	-	64	58				-	†	†	-	†	†
			Right							-	†	†	-	-	-
9	Route 711 (Huguenot Trail) and Venita Road	Two-Way Stop		Venita Road			Venita Road			Route 711			Route 711		
			Left												
			Through	-	1	1	-	27	35	-	10	0	-	0	0
			Right												
10	Route 711 (Huguenot Trail) and Route 288 SB Ramps	Signal		--			Route 288 SB Off-Ramp			Route 711			Route 711		
			Left				275	218	264				515	169	214
			Through							-	329	120	-	60	125
			Right				280	0	0	630	0	0			
11	Route 711 (Huguenot Trail) and Route 288 NB Ramps	Signal		Route 288 NB Off-Ramp			--			Route 711			Route 711		
			Left	-	78	154				465	281	79			
			Through							-	196	240	-	84	146
			Right	370	0	0							645	**4,500**	0
12	Route 711 (Huguenot Trail) and Private Driveways	Two-Way Stop		Private Driveway			Private Driveway			Route 711			Route 711		
			Left							340	14	8	240	0	17
			Through	-	0	72	-	57	77	-	†	†	-	†	†
			Right							-	†	†	235	†	†

NOTE: Shared lane results are shown as one value that corresponds to all movements in the lane.

† Queues for movements with no conflicting movements have not been included.

Bold values indicate queues that exceed storage bay length

3.4.2 Route 288 Mainline Crash Summary

A summary of crashes that occurred on Route 288 within the study area from 2012 to 2016 is shown in **Table 7**. The number of crashes along northbound and southbound Route 288 were relatively stable over the five-year period.

Table 7: Route 288 Crash Summary, 2012 - 2016

Route	Number of Crashes					
	2012	2013	2014	2015	2016	Total
Northbound Route 288	29	28	30	21	29	137
Southbound Route 288	27	32	22	23	30	134
Total	**56**	**60**	**52**	**44**	**59**	**271**

3.4.2.1 Northbound Route 288 Crash Summary

During the five-year crash analysis period, the following crashes were reported on northbound Route 288 in the study area:

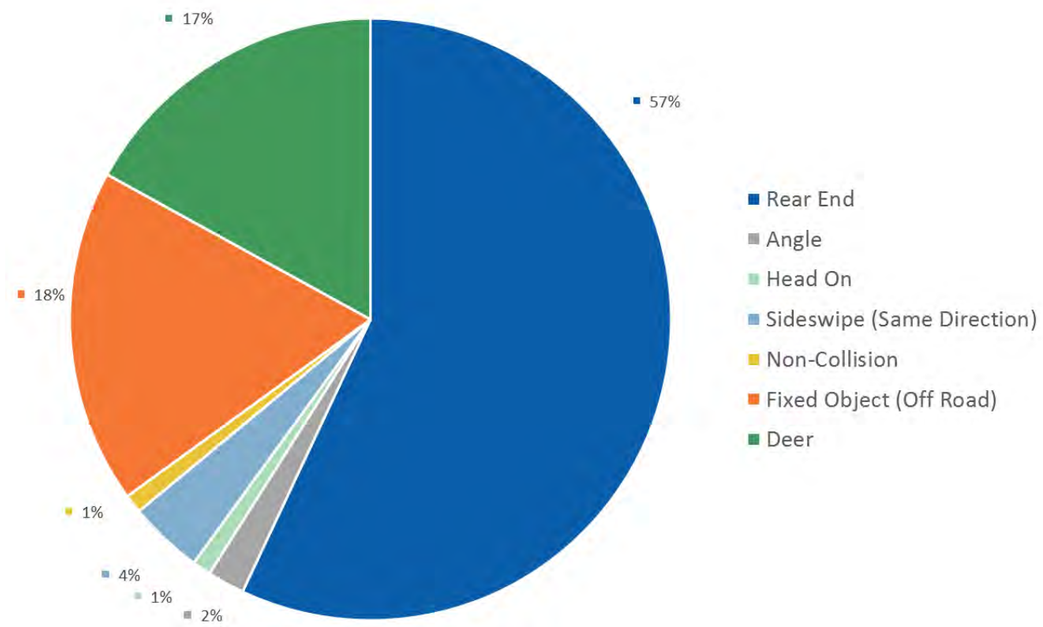
- Total number of reported crashes: 137
- Total number of reported fatality crashes: 1
- Total number of reported injury crashes: 39

A summary of the northbound Route 288 crashes by crash type is provided in **Figure 16**. Crash activity by quarter-mile segments of roadway, or crash density, for the entire Route 288 study area were also created and illustrated in histograms in **Appendix A**. The histograms illustrate the frequency and types of crashes that occurred in each quarter-mile segment. On northbound Route 288, the predominant crash type was rear end, which accounted for 57% of all reported crashes in the northbound direction. Rear-ends are typical crash types on congested facilities. **Figure 18** includes the histogram for the section of Route 288 at Huguenot Trail and shows a high concentration of rear-end crashes that correspond to the existing congestion issues on northbound Route 288, which this study aims to improve.

Most northbound crashes occurred during daylight, 59% of all reported crashes in the northbound direction. This is likely due to the most severe northbound congestion occurring between 7 AM and 9 AM, which are daylight hours year-round. In addition to northbound mainline congestion, there is also a safety issue on northbound Route 288 where the queue from the off-ramp to the US 250 terminal extends onto mainline Route 288 in the PM peak period that likely relates to a number of crashes on northbound Route 288 between Tuckahoe Creek Parkway and US 250. This likely accounts for the equal percentage of AM and PM peak period crashes on northbound Route 288. This issue will not be addressed by this study as the ramp terminal is currently being redesigned under a different project.

The next most frequent crash type was fixed object (off road), which accounted for 18% of all reported northbound crashes. One fatal crash occurred on northbound Route 288 over the five-year period. The crash was in 2012 and categorized as head-on. A sports utility vehicle (SUV) traveling on southbound Route 288, just south of the Huguenot Trail ramps, ran off the road to the left, crossed the median and had a head-on collision with a tractor-trailer on northbound Route 288. There were no other vehicles involved or any other reported injuries. The crash occurred during clear weather conditions at 11:00 AM on a Monday. It was found that the driver of the SUV was distracted at the time of the crash, and it is unknown if the driver was under the influence of alcohol. The SUV driver was not exceeding the safe speed or the speed limit.

Figure 16: Northbound Route 288 Crashes, 2012-2016



Other crash trends on northbound Route 288 included:

- 39% of the reported crashes occurred during the AM peak period from 6 AM to 10 AM, and 39% occurred during the PM peak period from 3 PM to 7 PM
- 85% of the reported crashes occurred on a weekday (Monday to Friday)
- 59% of the reported crashes occurred in daylight conditions
- 75% of the reported crashes occurred in clear weather conditions

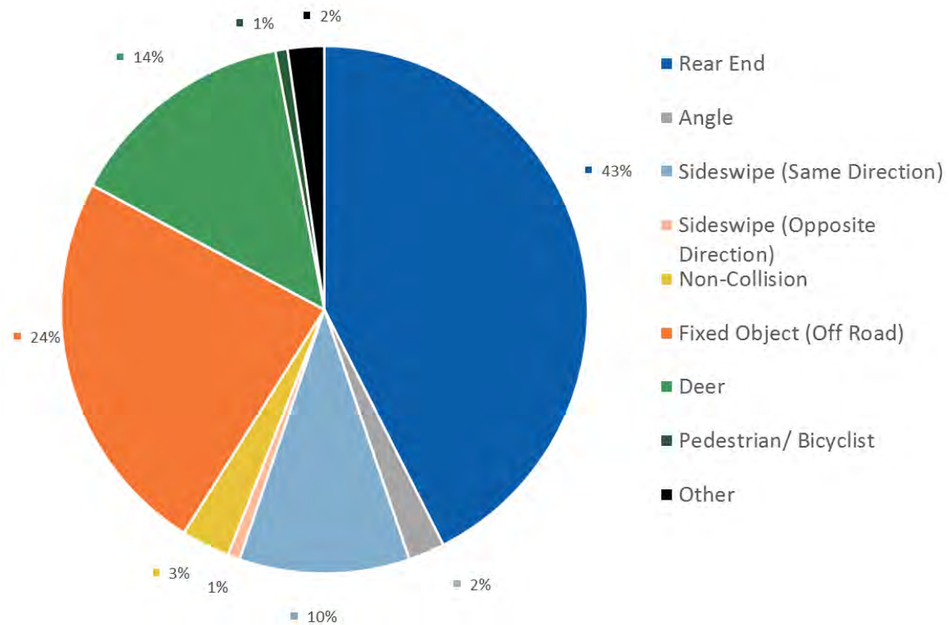
3.4.2.2 Southbound Route 288 Crash Summary

During the five-year crash analysis period, the following crashes were reported on southbound Route 288 in the study area:

- Total number of reported crashes: 134
- Total number of reported injury crashes: 46

A summary of the southbound Route 288 crashes by crash type is provided in **Figure 17.** The predominant crash type was rear end, which accounted for 43% of all reported crashes in the southbound direction. A higher concentration of rear-end crashes is also present on southbound Route 288 between the Route 6 and Tuckahoe Creek Parkway interchanges, as illustrated in **Figure 19** through **Figure 21,** which corresponds to the existing congestion in the southbound direction. This study aims to improve congestion and safety within this section of Route 288. The next most frequent crash type was fixed object (off road), which accounted for 24% of all reported southbound crashes. Most of crashes on southbound Route 288, 60%, also occurred during non-daylight hours, likely due to southbound Route 288 congestion occurring between 5 PM and 7 PM which are non-daylight hours for half of the year.

Figure 17: Southbound Route 288 Crashes, 2012-2016



Other crash trends on southbound Route 288 included:

- 14% of the reported crashes occurred during the AM peak period from 6 AM to 10 AM, and 34% occurred during the PM peak period from 3 PM to 7 PM
- 82% of the reported crashes occurred on a weekday (Monday to Friday)
- 60% of the reported crashes occurred in non-daylight conditions
- 75% of the reported crashes occurred in clear weather conditions

Figure 18: Crash Type Histogram – Route 288 from MP 22.75 to MP 24.75

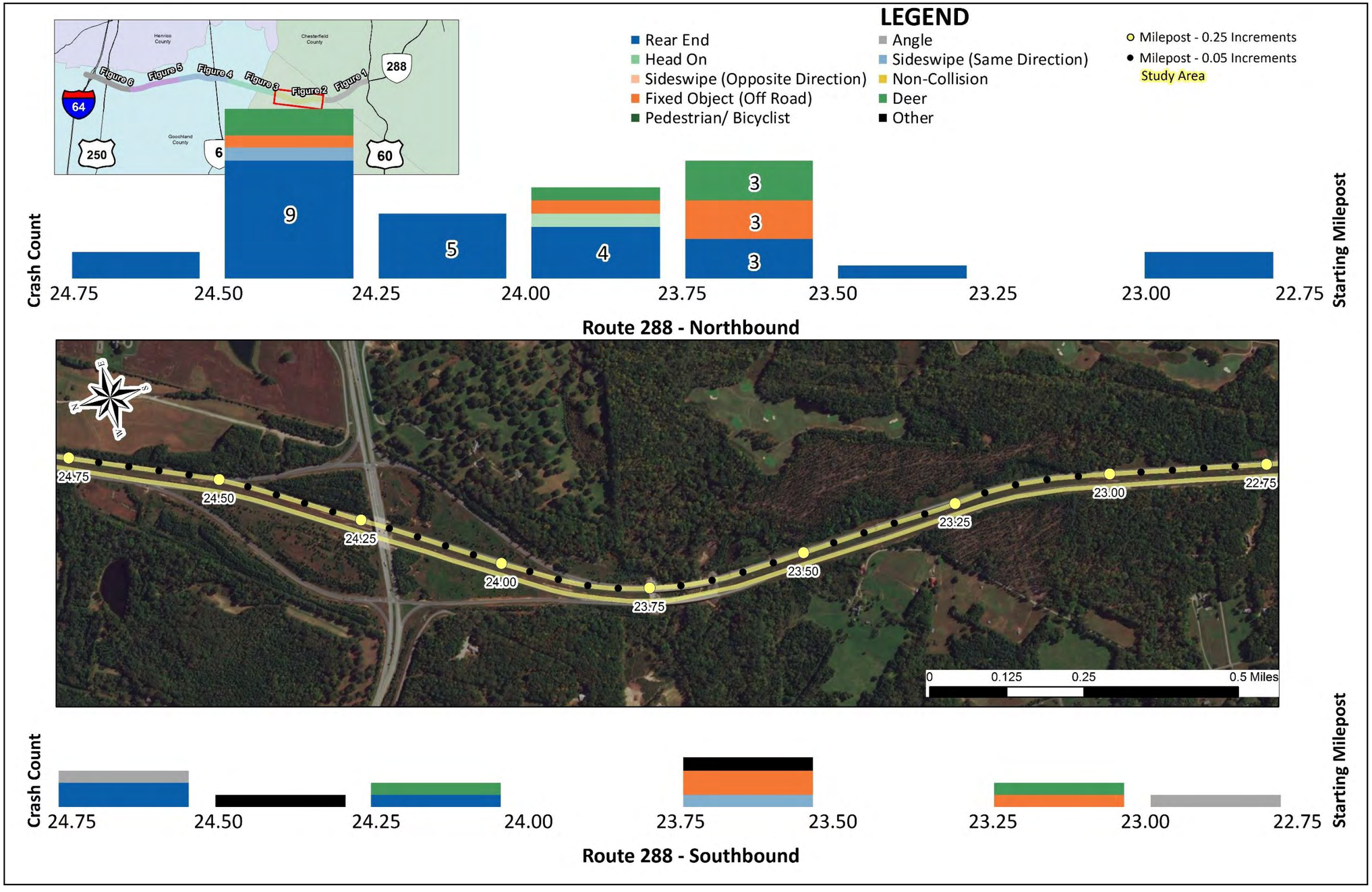


Figure 19: Crash Type Histogram – Route 288 from MP 26.75 to MP 28.75

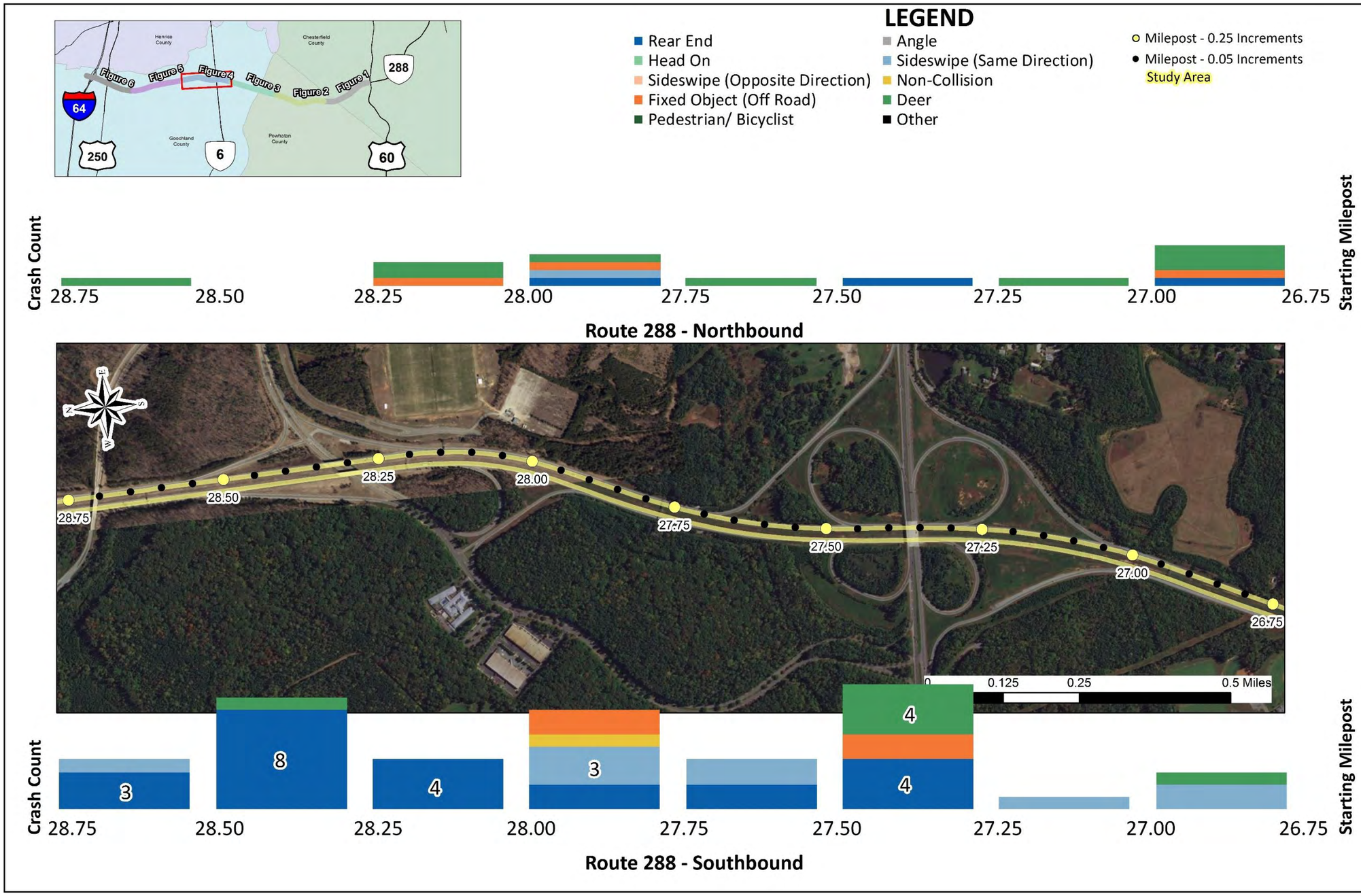


Figure 20: Crash Type Histogram – Route 288 from MP 28.75 to MP 30.75

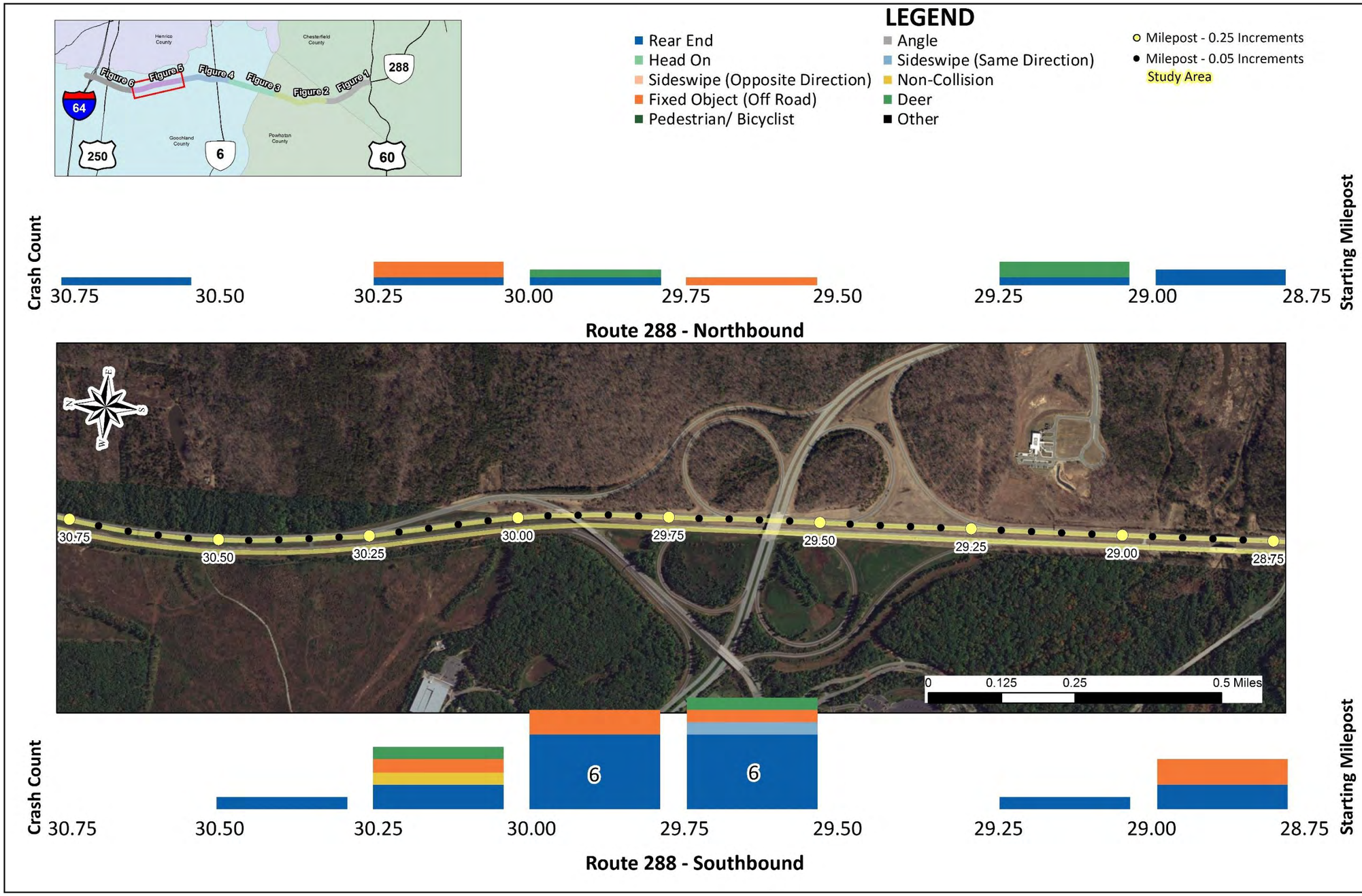
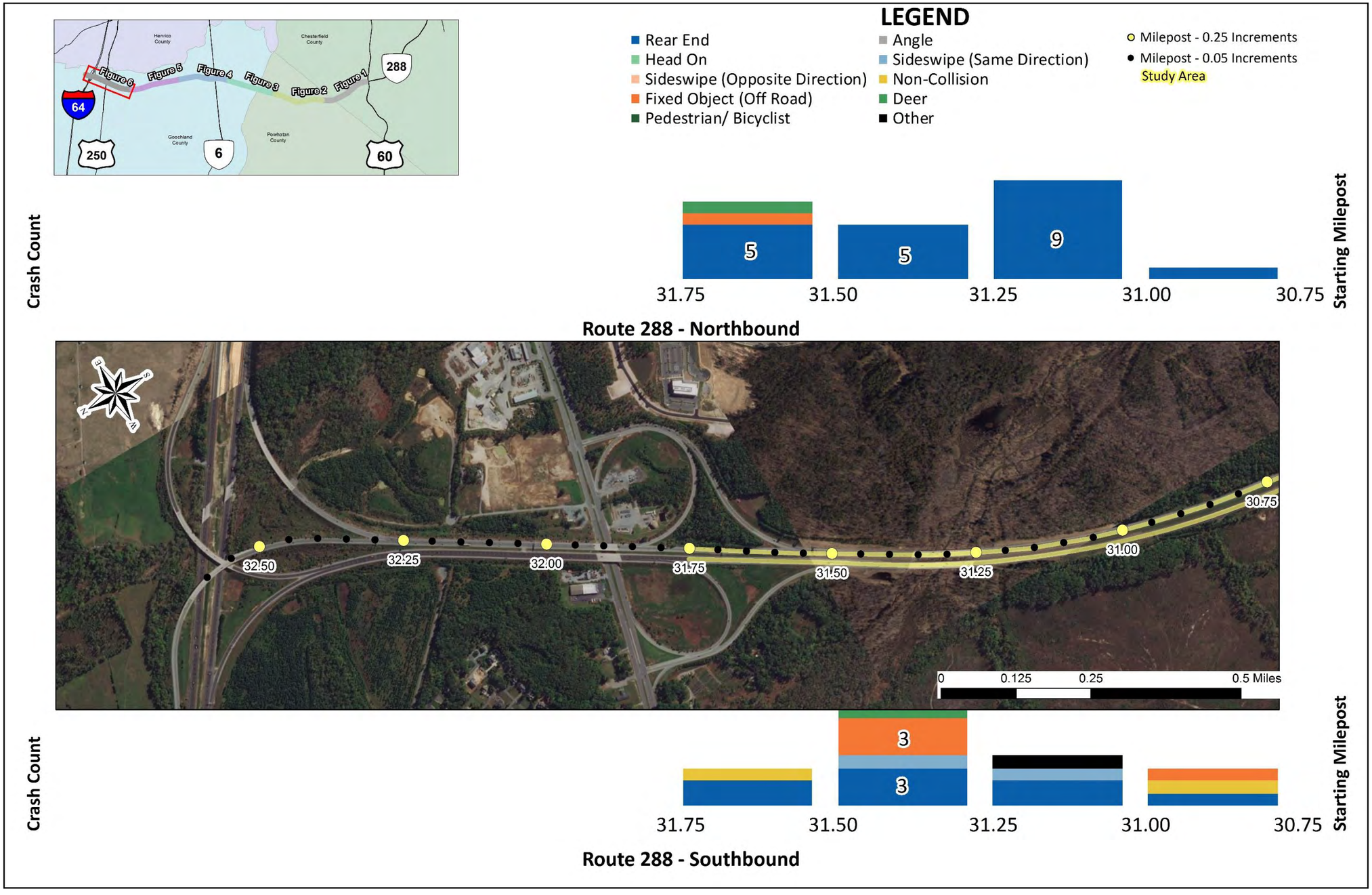


Figure 21: Crash Type Histogram – Route 288 from MP 30.75 to MP 31.75



4 Traffic Forecasting

To assess future traffic conditions in the study area and evaluate the long-term benefits of proposed improvements, traffic volumes were forecasted for 2025 and 2040 traffic conditions. The following sections describe the methodology for developing traffic growth rates and projecting future traffic volumes for the study area.

4.1 Traffic Growth Rate Development and Forecasting Methodology

The following sources were reviewed to determine growth rates to apply to existing traffic volumes to forecast future volumes:

- 2040 Richmond Tri-Cities Travel Demand Model
- VDOT Statewide Planning System (SPS) database
- Other relevant studies related to development within or near the study area

Significant development is expected in coming years within or near the study area, particularly along West Creek Parkway, Tuckahoe Creek Parkway, and Route 6. Multiple developments with a variety of land uses are planned or proposed. The Existing and Future Land Use chapter details the land use changes within the study area. Existing and future land use maps show many parcels being rezoned to higher density uses. This resulted in high growth projections within the study area and was reflected in the regional travel demand model. The regional travel demand model projected high growth in both employment and population within the study area. Growth rates derived from traffic projections in the travel demand model included in **Appendix C** showed similarly high growth. However, growth rates derived from the SPS database showed less traffic growth on Route 288 compared to the regional travel demand model. The project traffic growth from both the SPS database and the regional travel demand model are summarized in **Figure 22**.

The SWG reviewed the traffic forecasts and reached a consensus to use the following methodology to develop future (2040) traffic volumes within the study area:

- Apply the 1.3 percent linear growth rate from SPS to existing Route 288 volumes as the baseline growth;
- Use travel demand model projections to develop annual, linear growth rates for study area ramps and arterial turning movement volumes; and
- Balance the additional projected growth on the ramps and arterials onto mainline Route 288.

2025 No-Build volumes were developed linearly based on 2040 No-Build volumes. Traffic volumes were balanced through the study network throughout the study area, holding grown ramp volumes constant.

4.2 Projected 2025 and 2040 Volumes

The projected 2025 and 2040 AM and PM peak hour traffic volumes are summarized in **Figure 23** through **Figure 28**.

Figure 22: Travel Demand Model and SPS Projected Growth

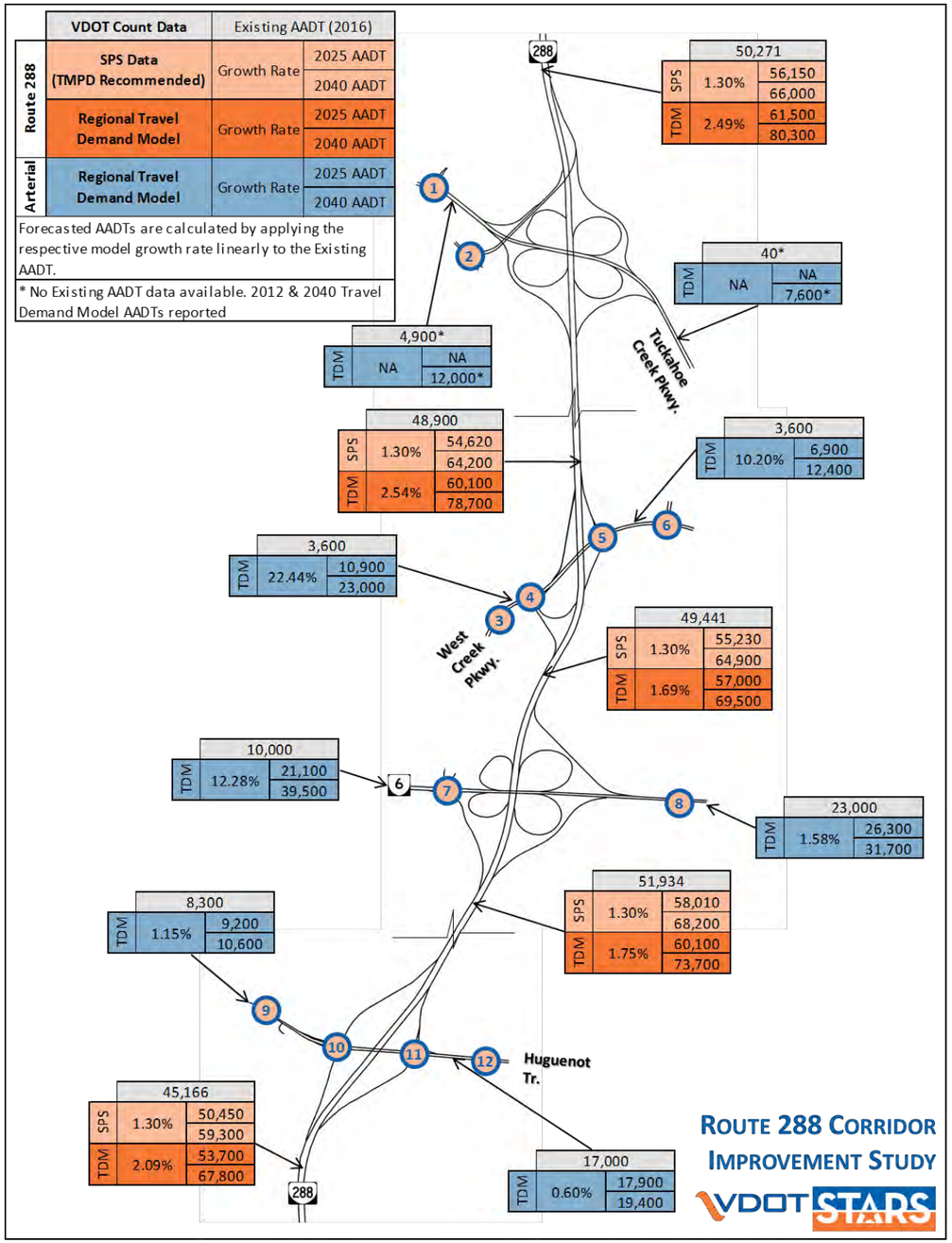


Figure 23: No-Build (2025) Traffic Volumes – US 250 to Tuckahoe Creek Parkway

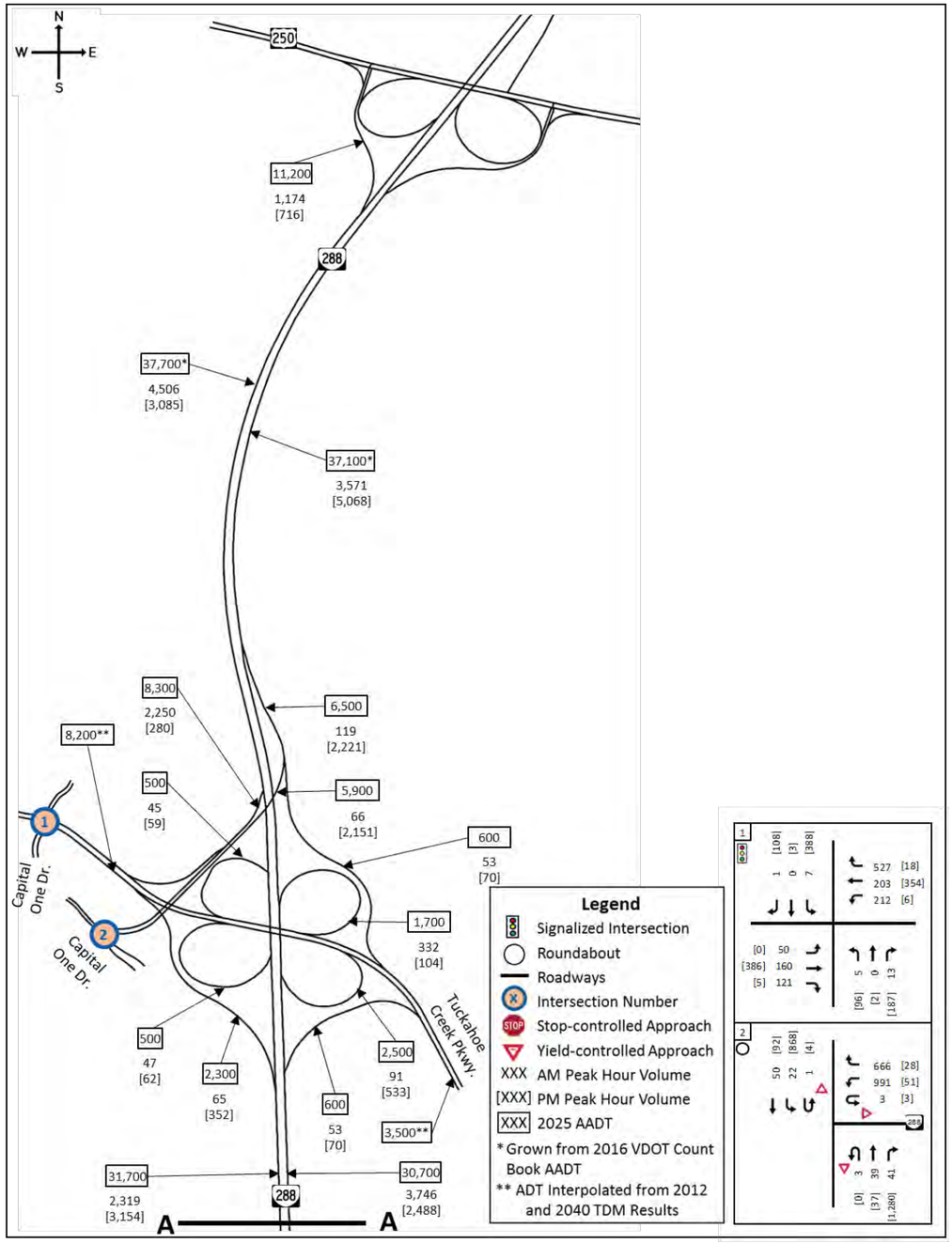


Figure 24: No-Build (2025) Traffic Volumes – West Creek Parkway to Route 6

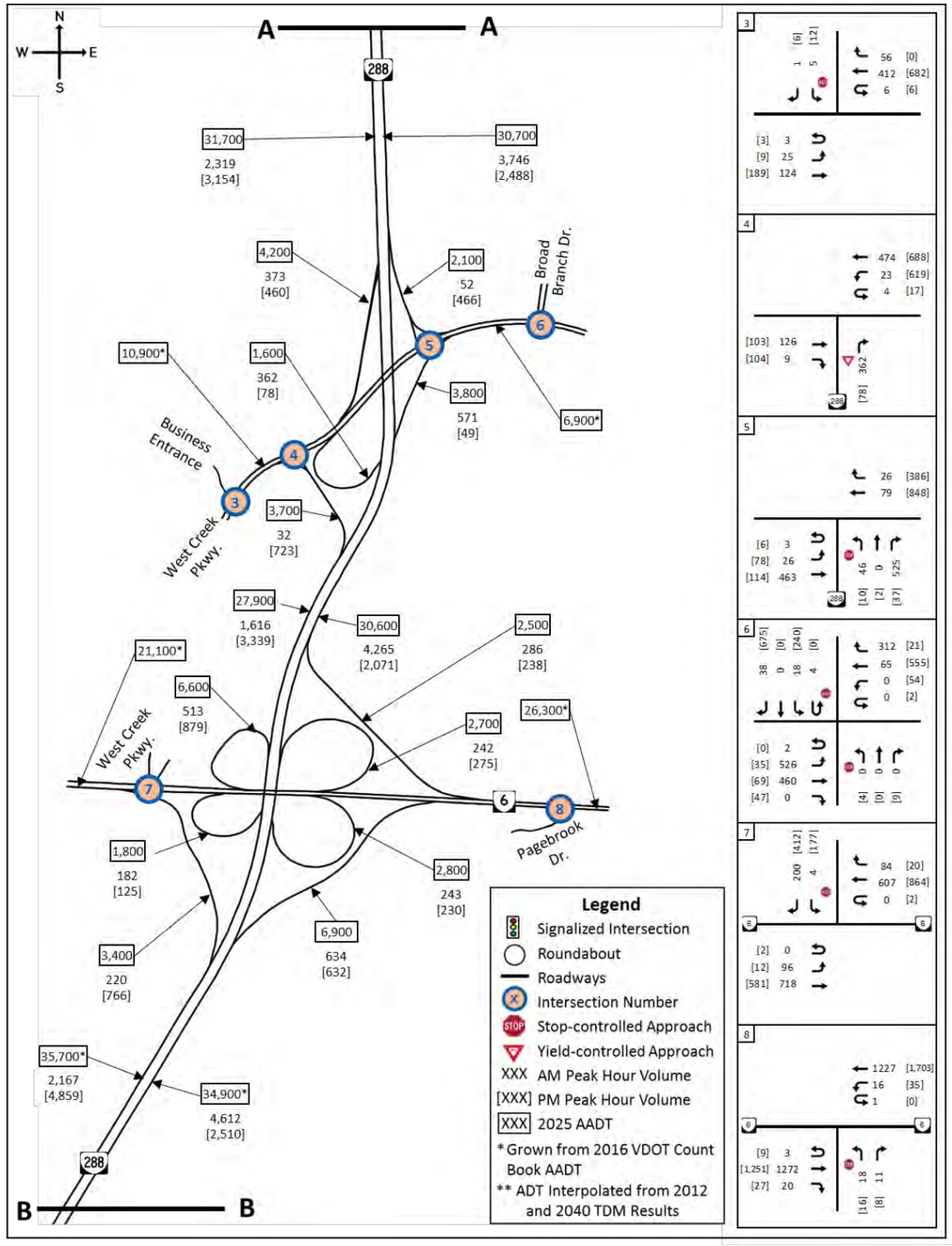


Figure 25: No-Build (2025) Traffic Volumes – Route 711 to US 60

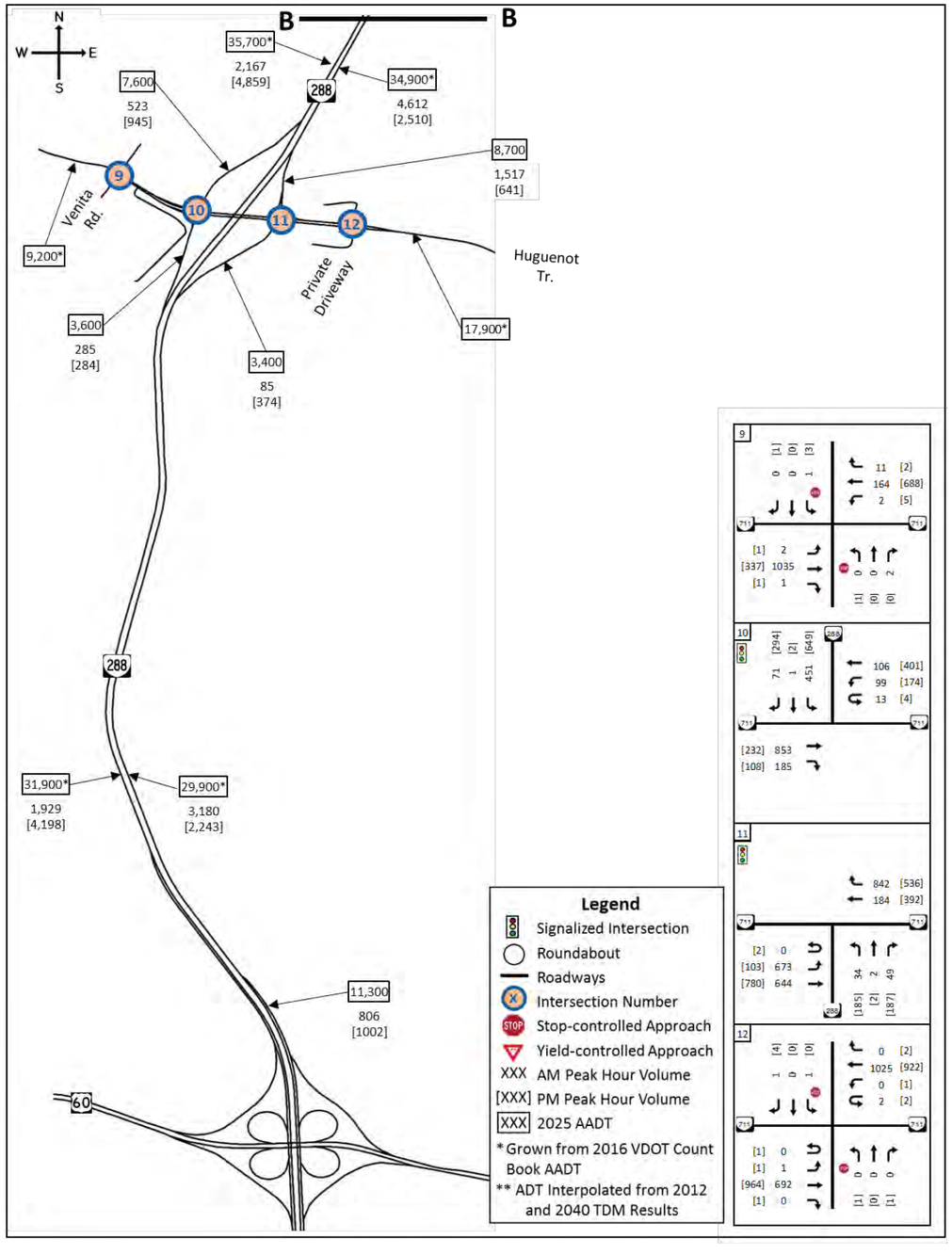


Figure 26: No-Build (2040) Traffic Volumes – US 250 to Tuckahoe Creek Parkway

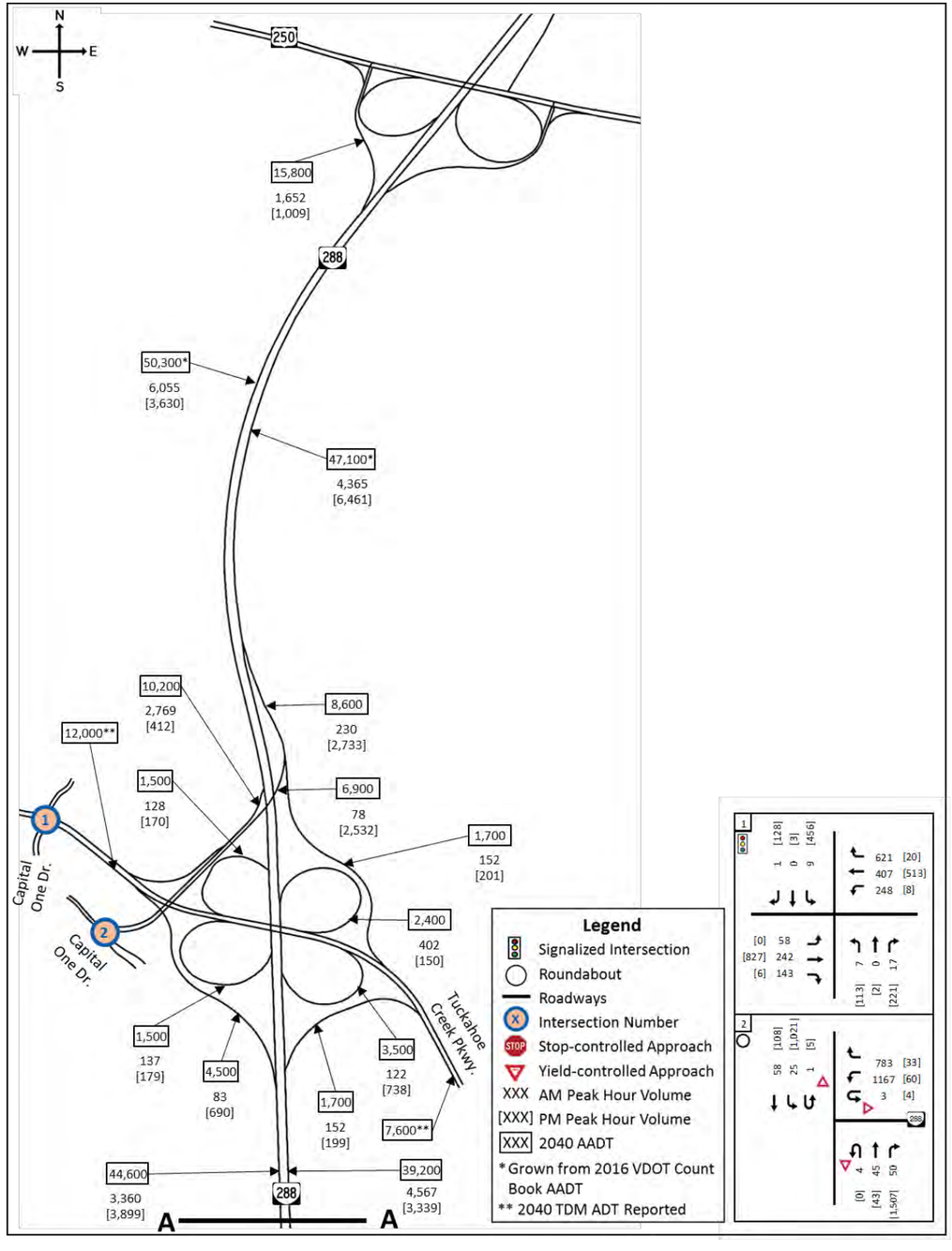


Figure 27: No-Build (2040) Traffic Volumes – West Creek Parkway to Route 6

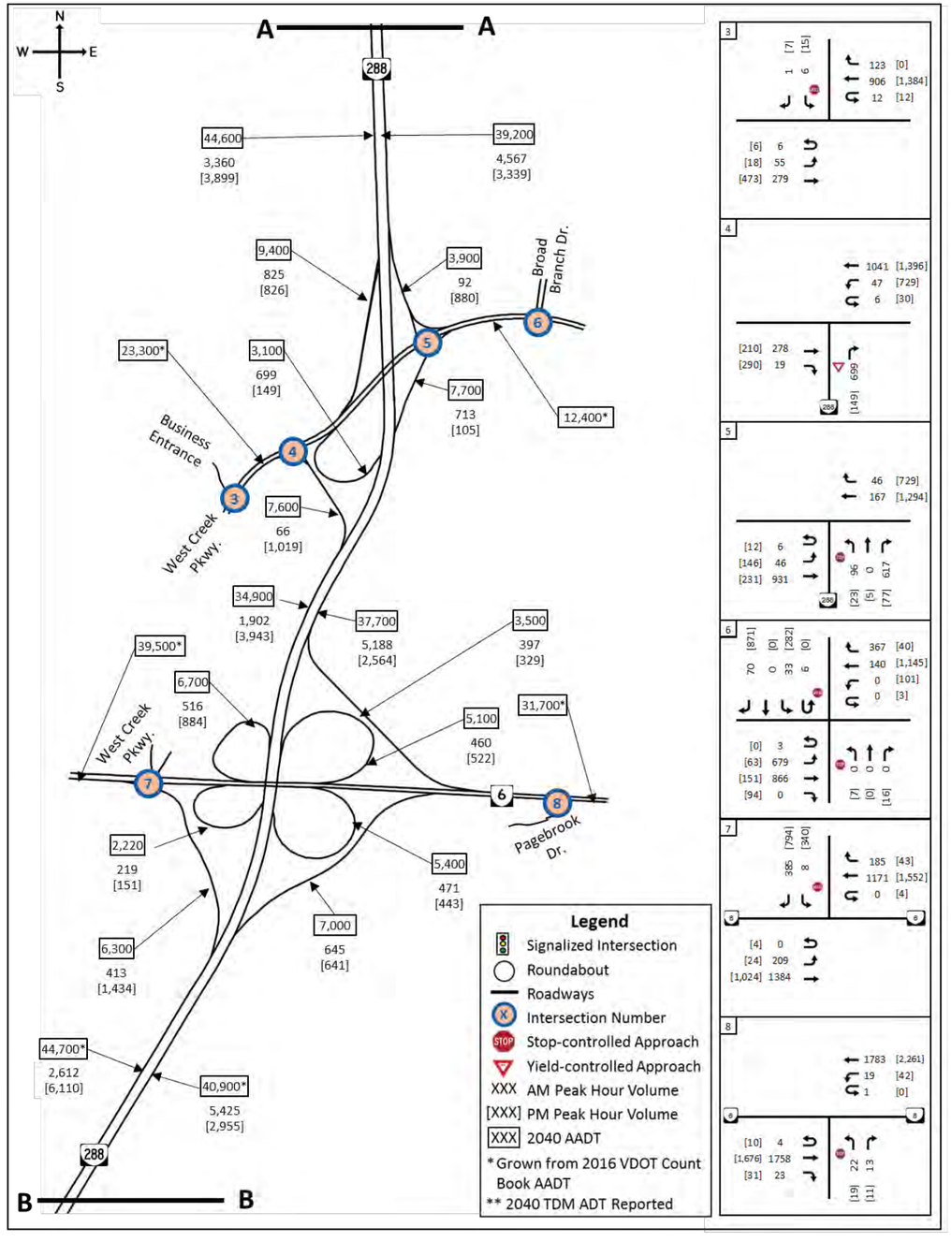
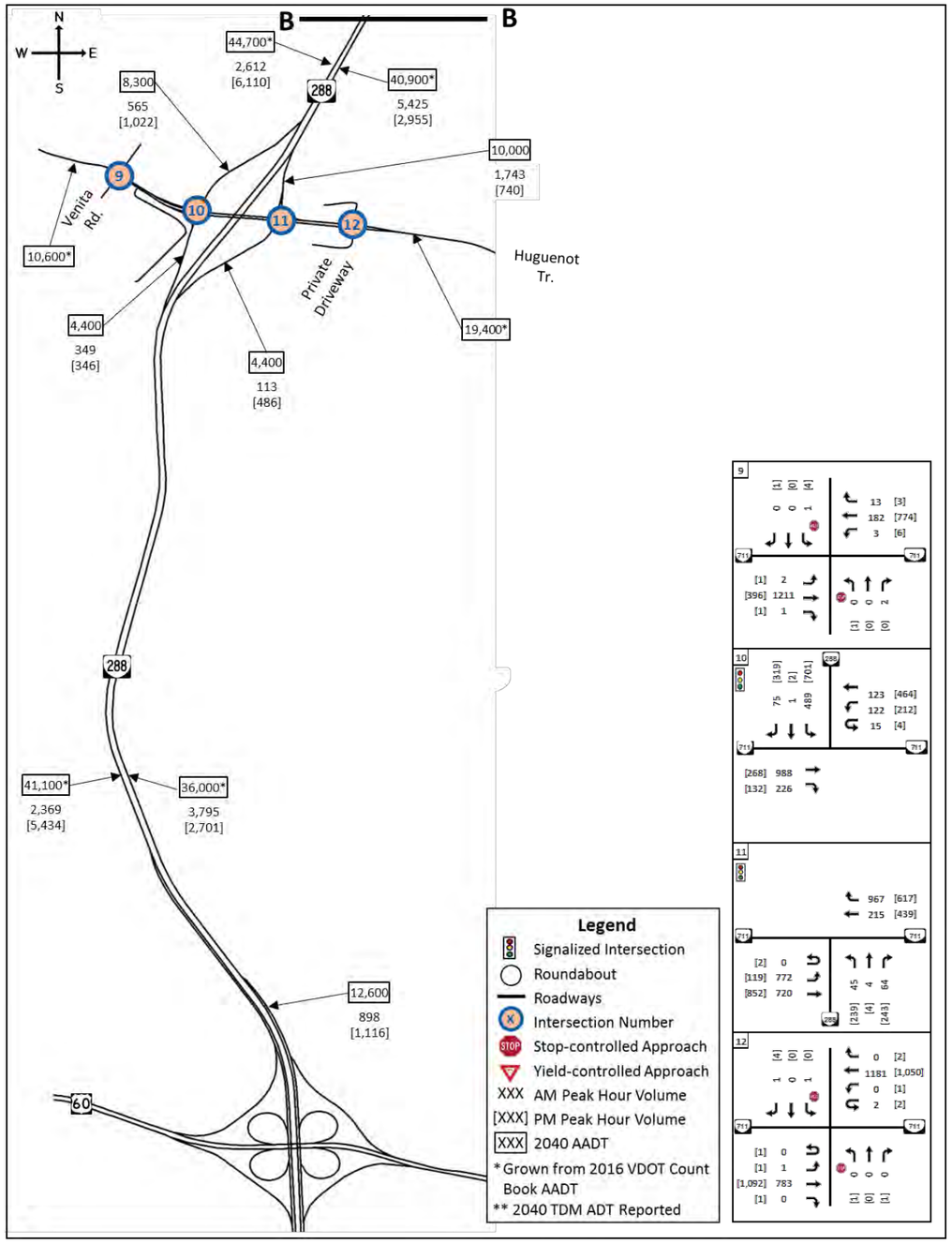


Figure 28: No-Build (2040) Traffic Volumes – Route 711 to US 60



5 No-Build Conditions Analysis and Results

VISSIM models were developed to analyze freeway operations on Route 288 and intersection operations on Tuckahoe Creek Parkway, West Creek Parkway, Route 6, and Route 711 within the study area under No-Build (2025) AM and PM peak hour conditions.

5.1 Background Improvements

There is one planned improvement within the project study area. Route 711 is currently under construction to be widened from two lanes to four lanes between Route 288 and the Chesterfield/Powhatan County line. The widening project is estimated to be completed in Summer 2019 and was included as a background improvement in the 2025 No-Build VISSIM model.

5.2 Modeling Assumptions

The 2017 existing VISSIM models were used as a basis to develop No-Build VISSIM models. The planned background improvements were coded into the calibrated existing AM and PM VISSIM models separately to maintain existing calibration adjustments. A detailed summary of VISSIM modeling inputs and assumptions is provided in **Appendix B**.

The VDOT Sample Size Determination Tool was used to confirm that ten simulation runs would provide the acceptable 95 percent confidence level for both the AM and PM No-Build models. Therefore, ten simulation runs were conducted for both the AM and PM models using different random seeds. The average of these runs was reported.

5.3 Freeway Analysis

Graphical representation of the freeway results is included in **Appendix D**. The schematics present the average density (veh/ln/mi) and average speed (mph) for each freeway link in the network.

5.3.1 AM Peak Hour

During the AM peak hour in the northbound direction under No-Build conditions, congestion worsened significantly upstream of the on-ramp from Route 711. Under existing conditions, average speeds were above 20 mph south of the off-ramp to Route 711; however, under No-Build conditions, all segments south of the on-ramp from Route 711 were projected to operate with average speeds below 20 mph. In addition, the average link density for the on-ramp from Route 711 was projected to increase from 95.1 veh/ln/mi in existing conditions to 102.9 veh/ln/mi in No-Build conditions. North of Route 711, the average speed was projected to increase to 60 mph on Route 288. The link densities decreased and remained below 30 veh/ln/mi after the off-ramp to eastbound Route 6, similar to existing conditions. The northbound Route 288 freeway schematic between US 60 and Route 711 is illustrated in **Figure 29**.

In the southbound direction during the AM peak hour, congestion was projected on Route 288 at the on-ramp from US 250. Average speeds were expected to drop from around 60 mph under existing conditions to around 32 mph under No-Build conditions within the merge area. Average link density also increased to greater than 45 veh/ln/mi within, before, and after the merge area. This was primarily a result of the projected increase in traffic volumes to West Creek Commons and development west of Route 288 along Tuckahoe Creek Parkway. South of the off-ramp to westbound Tuckahoe Creek Parkway, the average speeds and link densities were projected to be similar to existing conditions. The southbound Route 288 freeway schematic between US 250 and Tuckahoe Creek Parkway is illustrated in **Figure 30**.

5.3.2 PM Peak Hour

During the PM peak hour in the northbound direction under No-Build conditions, all segments were projected to operate with light-to-moderate densities, less than 27 veh/ln/mi, and average speeds at or above over 60 mph. This was similar to the existing conditions results.

Congestion was expected to worsen in the southbound direction during the PM peak hour under No-Build conditions because of the projected increase in traffic. Beginning at the on-ramp from eastbound Route 6 to the on-ramp from US 250, average speeds were projected to be below 20 mph for the majority of the segments. Under existing conditions, congestion only extended from the on-ramp from eastbound Route 6 to Tuckahoe Creek Parkway. South of Route 6, average speeds and densities were projected to be comparable to existing conditions. The southbound Route 288 freeway schematics between US 250 and Route 6 are illustrated in **Figure 31** and **Figure 32**.

5.4 Intersection Analysis

The No-Build AM and PM VISSIM intersection delay results are presented in **Figure 33** and **Figure 34**, and the maximum queues are provided in **Table 8**. VISSIM intersection results are summarized in **Appendix D**.

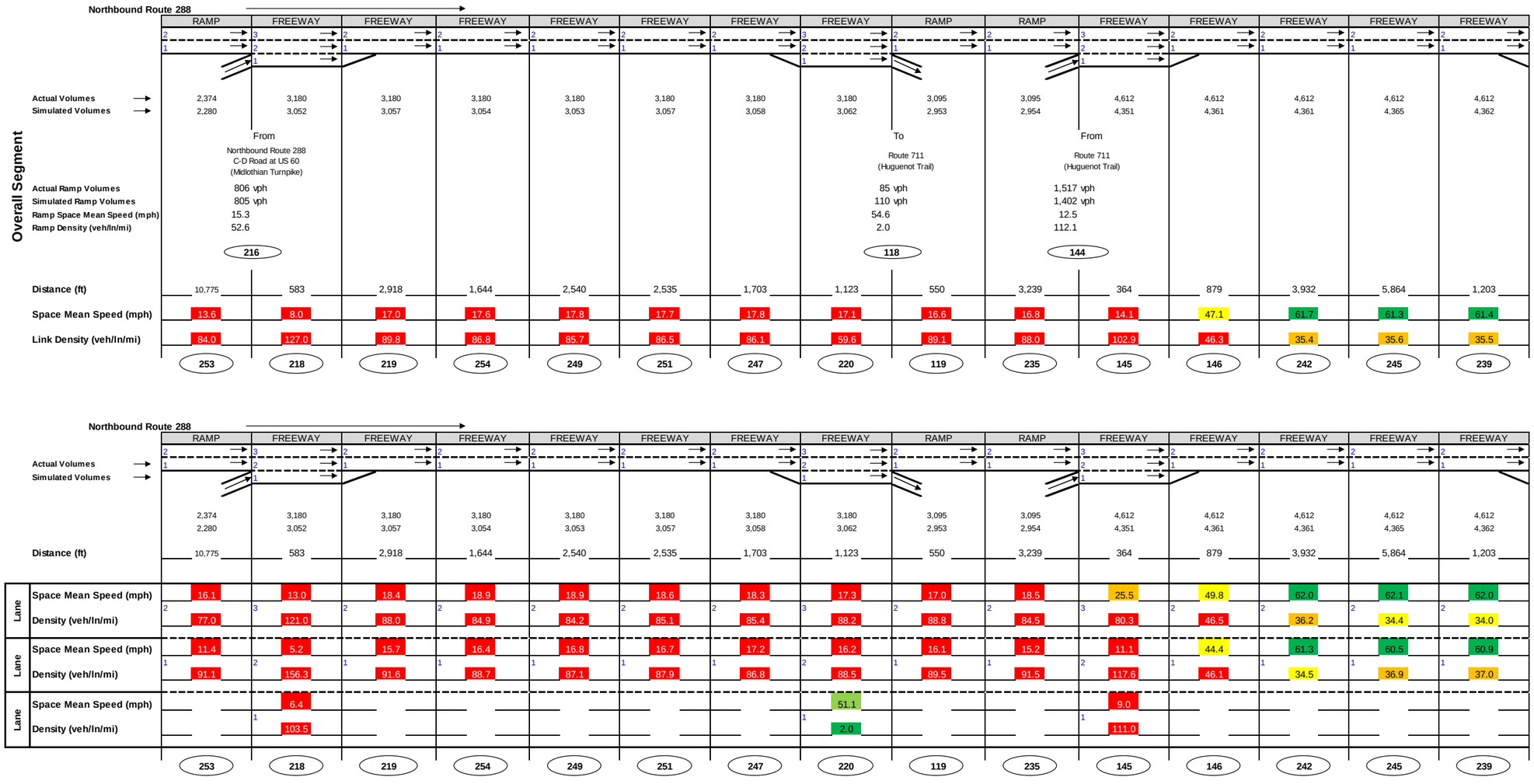
5.4.1 AM Peak Hour

In the AM peak hour under No-Build conditions, all but one intersection was projected to operate with acceptable overall delays. The intersection of Route 711 and northbound Route 288 ramps was projected to operate with occasional overall delays—the overall intersection delay increased from 33.5 s/veh under existing conditions to 53.3 s/veh under No-Build conditions. The westbound right-turn queue at this intersection remained similar to existing conditions at 4,050 feet. The southbound approach delay at the intersection of Route 711 and Private Driveway, east of Route 288, was projected to increase to 46.9 s/veh.

5.4.2 PM Peak Hour

In the PM peak hour under No-Build conditions, all intersections were expected to operate with acceptable overall intersections delays. At the intersection of West Creek Parkway and Broad Branch Drive, the southbound approach was expected to experience excessive delays averaging 123.8 s/veh. The corresponding queue for the southbound approach was expected to increase by approximately 725 feet compared to existing conditions. At the Capital One Drive and Route 288 roundabout, the northbound through, westbound left, and westbound right movements were projected to operate with excessive delays. The northbound through movement operated with an average delay of 294.5 s/veh, compared to 98.6 s/veh under existing conditions.

Figure 29: No-Build (2025) AM VISSIM Schematic – Northbound Route 288 from US 60 to Route 711



NOTE: numbers in chart are provided for illustrative purposes only

LEGEND

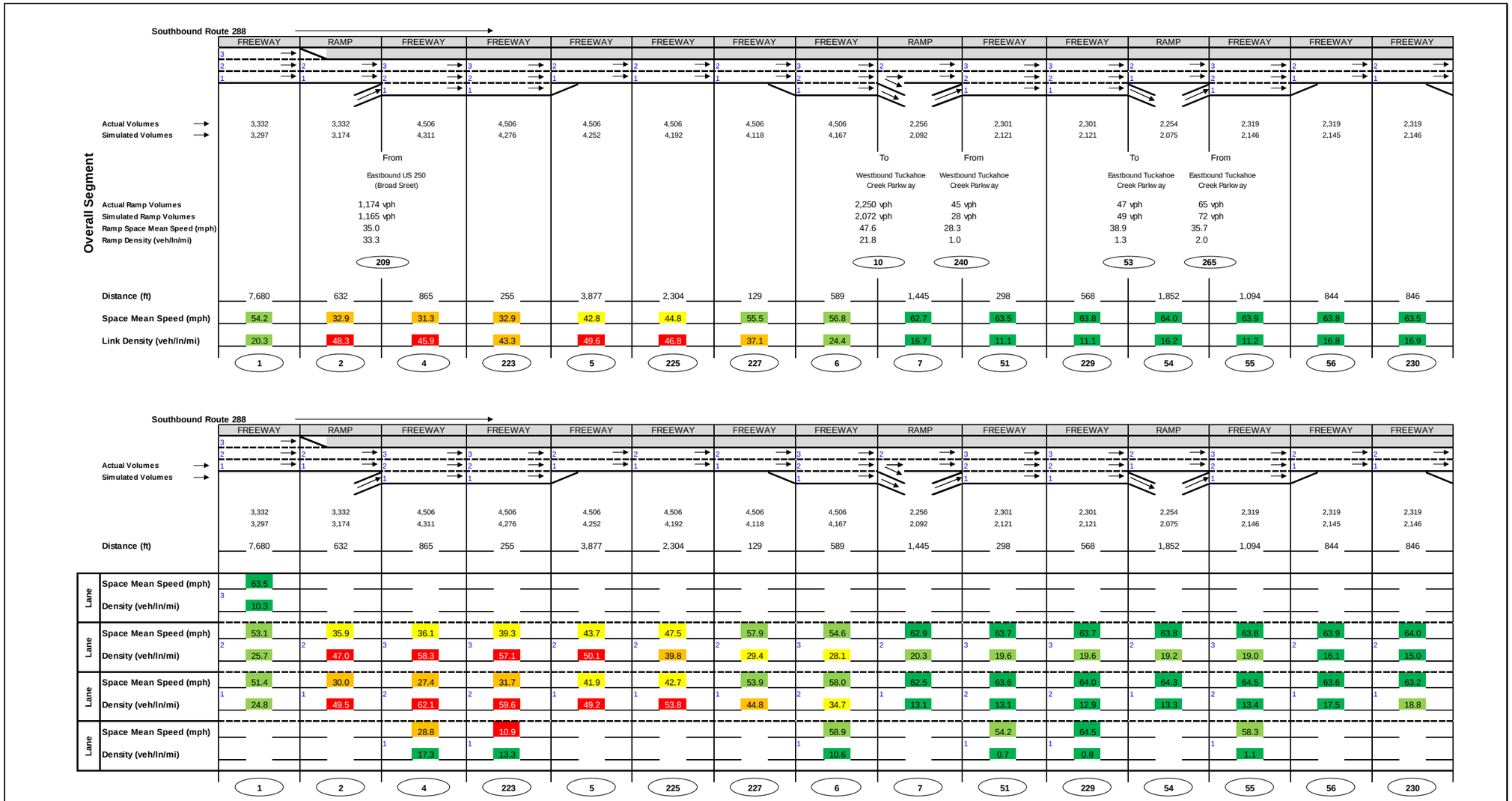
100 Link Number

Average Density (veh/ln/mi)
45 and above
35 to 45
26 to 35
18 to 26
0 to 18

Average Speed (mph)
0 to 20
20 to 35
35 to 50
50 to 60
60 and above

***The results shown are the average results across 10 microsimulation runs.**

Figure 30: No-Build (2025) AM VISSIM Schematic – Southbound Route 288 from US 250 to Tuckahoe Creek Parkway



NOTE: numbers in chart are provided for illustrative purposes only

LEGEND

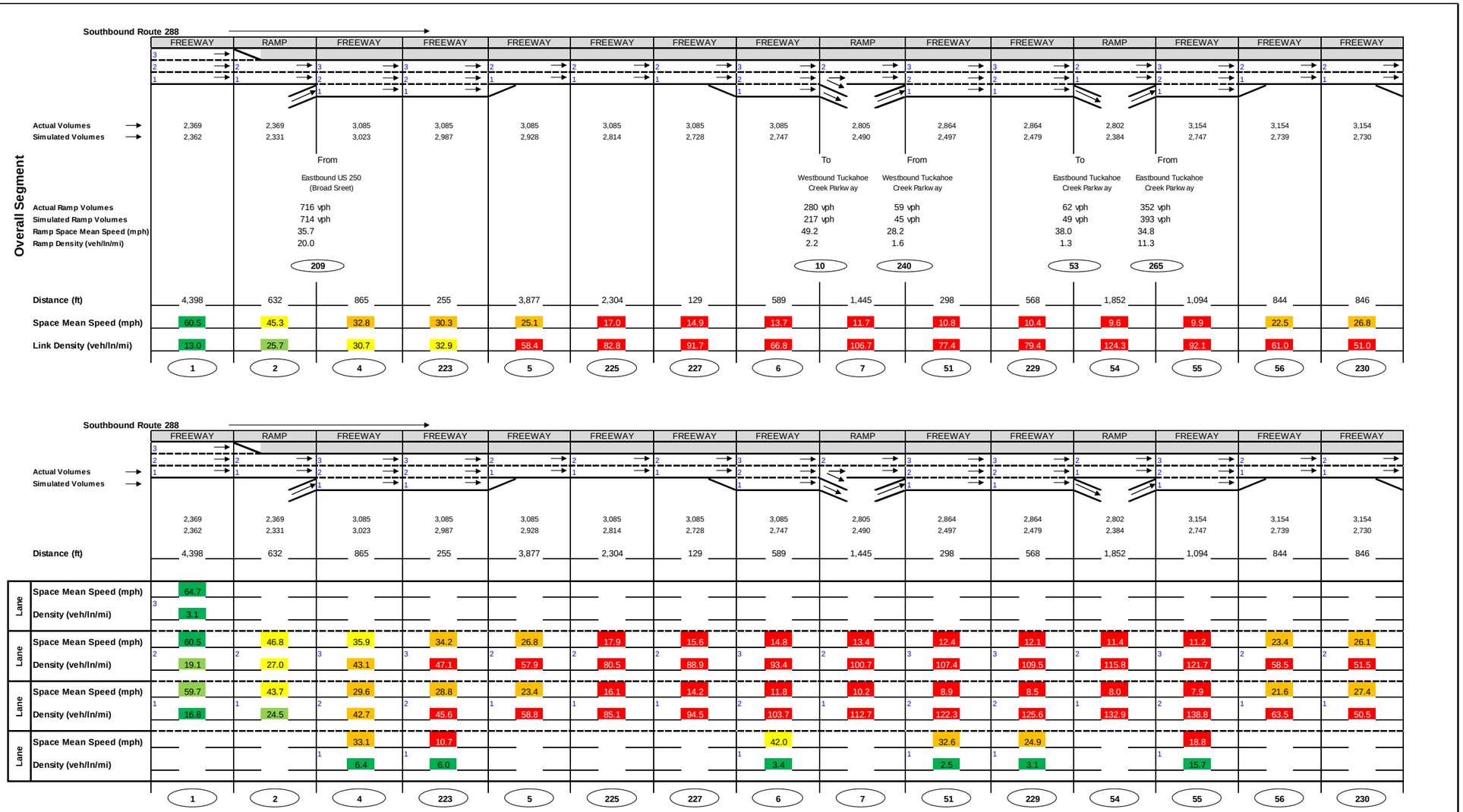
100 Link Number

Average Density (veh/ln/mi)
45 and above
35 to 45
26 to 35
18 to 26
0 to 18

Average Speed (mph)
0 to 20
20 to 35
35 to 50
50 to 60
60 and above

***The results shown are the average results across 10 microsimulation runs.**

Figure 31: No-Build (2025) PM VISSIM Schematic – Southbound Route 288 from US 250 to Tuckahoe Creek Parkway



NOTE: numbers in chart are provided for illustrative purposes only

LEGEND

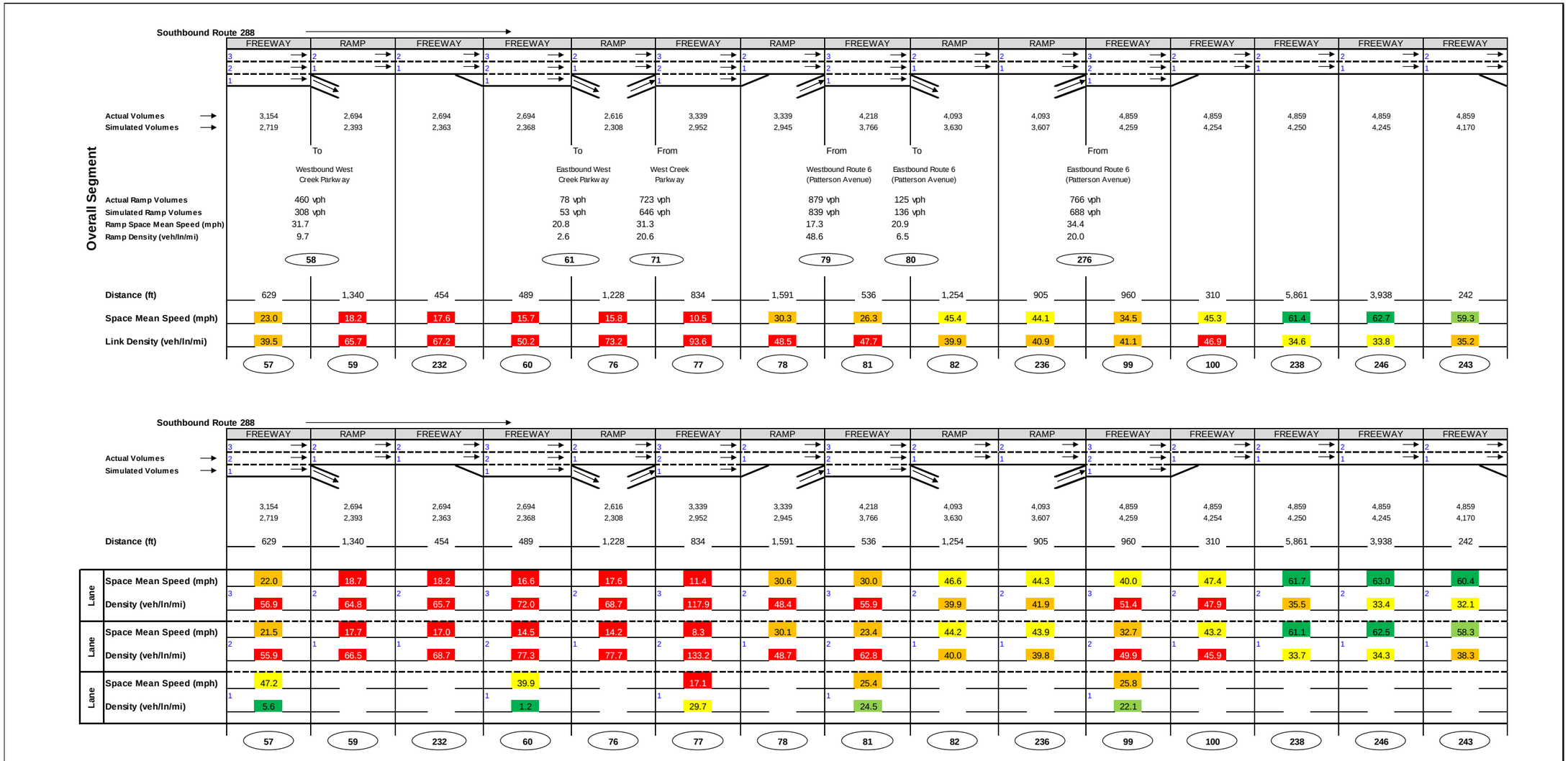
100 Link Number

Average Density (veh/ln/mi)
45 and above
35 to 45
26 to 35
18 to 26
0 to 18

Average Speed (mph)
0 to 20
20 to 35
35 to 50
50 to 60
60 and above

***The results shown are the average results across 10 microsimulation runs.**

Figure 32: No-Build (2025) PM VISSIM Schematic – Southbound Route 288 from West Creek Parkway to Route 6



NOTE: numbers in chart are provided for illustrative purposes only

LEGEND

100 Link Number

Average Density (veh/ln/mi)
45 and above
35 to 45
26 to 35
18 to 26
0 to 18

Average Speed (mph)
0 to 20
20 to 35
35 to 50
50 to 60
60 and above

***The results shown are the average results across 10 microsimulation runs.**

Figure 33: No-Build (2025) AM VISSIM Intersection Delays

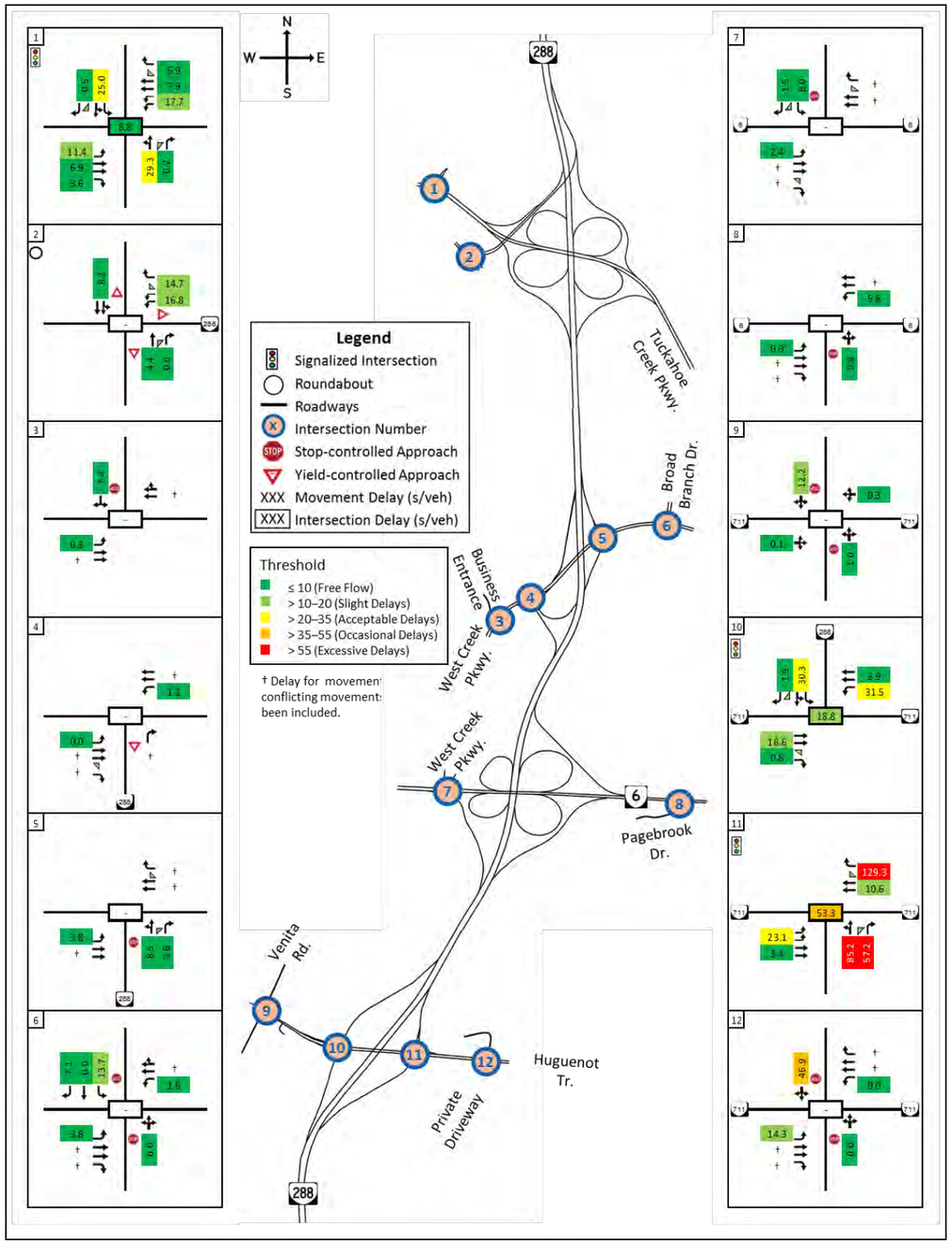


Figure 34: No-Build (2025) PM VISSIM Intersection Delays

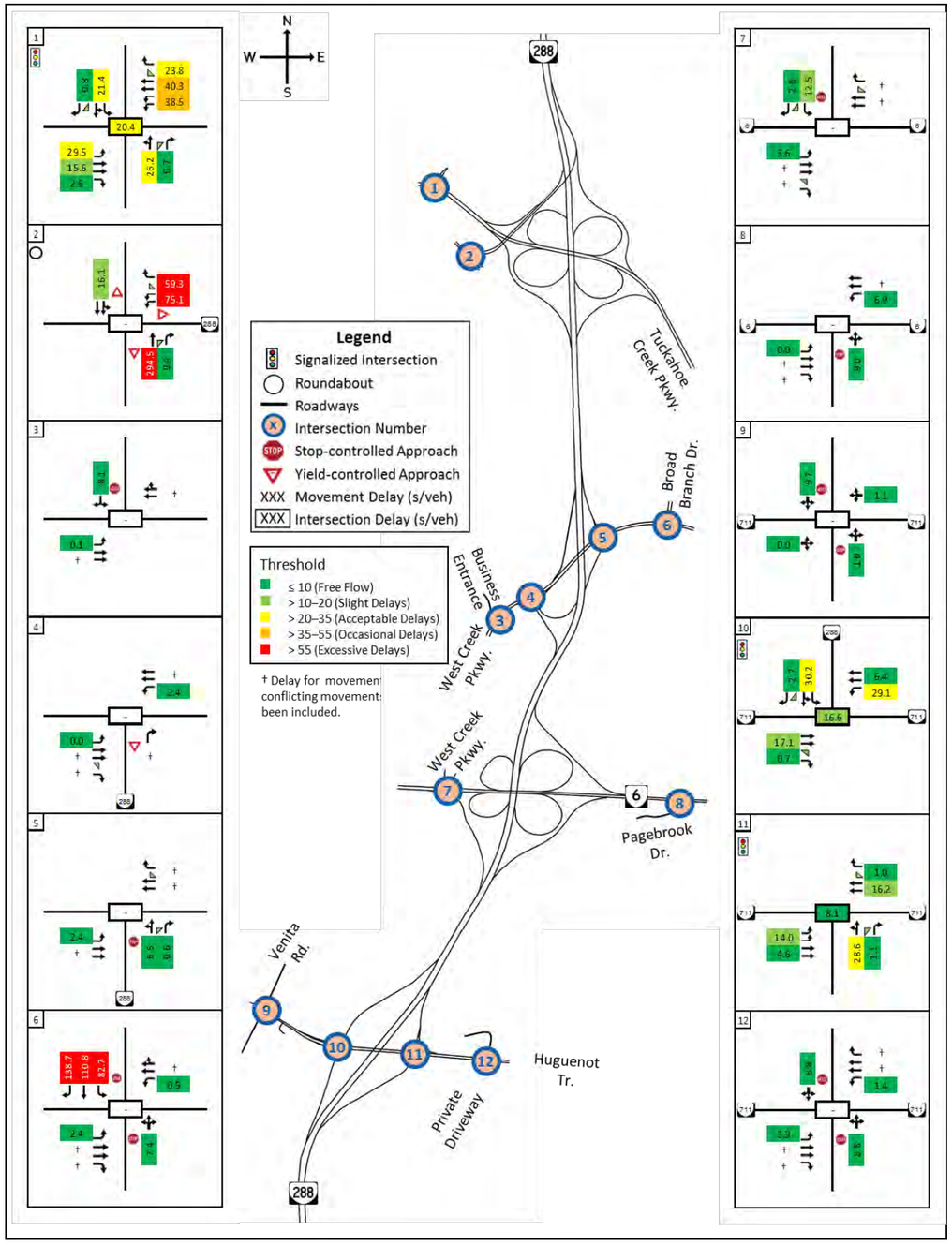


Table 8: No-Build AM and PM VISSIM Intersection Queues

Intersection		Type of Control	Lane Group	Northbound			Southbound			Eastbound			Westbound		
				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	Tuckahoe Creek Parkway and Capital One Drive	Signal		Capital One Drive			CarMax			Tuckahoe Creek Parkway			Tuckahoe Creek Parkway		
			Left	-	31	121	305	30	212	150	62	23	345	91	29
			Through							-	69	139	-	56	126
			Right	-	0	5	300	0	32	210	115	63	-	0	0
2	Route 288 and Capital One Drive	Roundabout		Capital One Drive			Capital One Drive			--			Route 288 Ramps		
			Left				-	55	393				-	50	0
			Through	-	36	668									
			Right	-	36	687							-	0	0
3	West Creek Parkway and Eastern Median Opening	One-Way Stop		--			Business Drive			West Creek Parkway			West Creek Parkway		
			Left				-	35	51	305	6	1			
			Through							-	†	†	-	†	†
			Right										-	†	†
4	West Creek Parkway and Route 288 SB On-Ramps	One-Way Stop		Route 288 SB On-Ramp			--			West Creek Parkway			West Creek Parkway		
			Left							255	0	0	225	25	130
			Through							-	†	†	-	†	†
			Right	-	†	†				-	†	†	-	-	-
5	West Creek Parkway and Route 288 NB Off/On-Ramps	One-Way Stop		Route 288 NB Off-Ramp			Route 288 NB On-Ramp			West Creek Parkway			West Creek Parkway		
			Left	430	51	48				235	36	75			
			Through							-	†	†	-	†	†
			Right	-	0	0				-	†	†	550	†	†
6	West Creek Parkway and Broad Branch Drive	Two-Way Stop		Sports Complex			Broad Branch Drive			West Creek Parkway			West Creek Parkway		
			Left				295	89	223	295	179	48	295	13	50
			Through	-	0	47	-	0	39	-	†	†	-	†	†
			Right				-	116	1,846	285	†	†	-	†	†
7	Route 6 (Patterson Avenue) and West Creek Parkway	One-Way Stop		--			West Creek Parkway			Route 6			Route 6		
			Left				-	55	152	215	58	37			
			Through							-	†	†	-	†	†
			Right				-	65	179	420	†	†	425	†	†
8	Route 6 (Patterson Avenue) and Pagebrook Drive	One-Way Stop		Pagebrook Drive			--			Route 6			Route 6		
			Left							285	0	0	300	38	48
			Through	-	62	62				-	†	†	-	†	†
			Right							-	†	†	-	-	-
9	Route 711 (Huguenot Trail) and Venita Road	Two-Way Stop		Venita Road			Venita Road			Route 711			Route 711		
			Left												
			Through	-	1	1	-	27	35	-	15	0	-	0	0
			Right												
10	Route 711 (Huguenot Trail) and Route 288 SB Ramps	Signal		--			Route 288 SB Off-Ramp			Route 711			Route 711		
			Left				275	238	221				515	233	225
			Through							-	329	130	-	70	147
			Right				280	0	0	630	0	0			
11	Route 711 (Huguenot Trail) and Route 288 NB Ramps	Signal		Route 288 NB Off-Ramp			--			Route 711			Route 711		
			Left	-	98	185				465	306	77			
			Through							-	199	214	-	123	151
			Right	370	0	0							645	**4,049**	0
12	Route 711 (Huguenot Trail) and Private Driveways	Two-Way Stop		Private Driveway			Private Driveway			Route 711			Route 711		
			Left							340	15	7	240	0	4
			Through	-	0	70	-	57	77	-	†	†	-	†	†
			Right							-	†	†	235	†	†

NOTE: Shared lane results are shown as one value that corresponds to all movements in the lane.

† Queues for movements with no conflicting movements have not been included.

Bold values indicate queues that exceed storage bay length

6 Concept Development

6.1 Initial Testing

The calibrated existing conditions VISSIM models were used as a basis for initial concept testing. The main purpose of the initial concept testing was to achieve two goals:

- Identify concepts that will be analyzed in more detail during the concept screening phase
- Perform high level sensitivity testing to determine if the concepts demonstrated significant improvement compared to the existing condition (indicating it would demonstrate improvement in future conditions)

The concepts identified during initial concept testing were geared towards targeting existing mainline Route 288 congestion issues. Specifically, northbound Route 288 congestion at the merge from Route 711 in the AM peak hour, and southbound Route 288 congestion just downstream of the Route 6 weave and within the weaving segment itself in the PM peak hour. The following concepts were considered as singular improvements and in tandem.

6.1.1 AM Peak Hour

- Extend the acceleration lane for the northbound Route 288 on-ramp from Route 711
- Add northbound Route 288 auxiliary lane between the on-ramp from Route 711 and the off-ramp to eastbound Route 6 (through hard shoulder running (HSR) lanes or widening)
- Install ramp metering system on the northbound Route 288 on-ramp from Route 711

6.1.2 PM Peak Hour

- Remove the southbound Route 288 off-ramp to eastbound Route 6 and reroute traffic to the southbound Route 288 off-ramp to westbound West Creek Parkway and extend the acceleration lane for the southbound Route 288 on-ramp from westbound Route 6
- Extend the acceleration lane for the southbound Route 288 on-ramp from West Creek Parkway
- Add southbound auxiliary lane between the on-ramp from westbound Route 6 to the off-ramp to Route 711 (through HSR lanes or widening)

In the AM peak hour, the initial concept testing results indicated that acceleration lane extensions and ramp metering were not sufficient to solve existing congestion issues and that a continuous auxiliary lane (in the form of HSR or widening) would be necessary.

In the PM peak hour, the initial concept testing results indicated that removing the southbound Route 288 off-ramp to eastbound Route 6 showed potential to solve existing PM peak hour congestion issues; however, the results showed this option had a short life span. The option to combine removing the southbound Route 288 off-ramp to eastbound Route 6 and adding a southbound auxiliary lane (in the form of HSR or widening) between the on-ramp from westbound Route 6 to the off-ramp to Route 711 showed promise for benefits beyond the existing year.

6.2 Concepts Considered

The initial concept testing served as the baseline for concept screening under No-Build conditions. The No-Build conditions analysis was used to identify additional improvements that may be necessary to solve future traffic operations issues in addition to the existing issues. The following concepts were developed to address existing and future operations and safety issues on mainline Route 288 and were moved forward for detailed concept screening. Conceptual sketches of each concept are provided in **Appendix E**. All northbound and southbound concepts include an HSR lane between the Route 711 and Route 6 interchanges. Traditional widening of Route 288 was screened out because of the high costs associated with the necessary right-of-way acquisition, widening of the James River Bridge, building full-depth lanes, and constructing necessary stormwater management features. HSR lanes address the purpose and need of this study by creating additional peak period capacity at a significantly lower cost than traditional widening. However, HSR lanes require additional design considerations that are detailed in **Section 8.2**. As future development occurs in the area around the Route 288 corridor, consideration should be given to additional parallel routes to Route 288 to reduce demand on the limited access facility.

6.2.1 Northbound Route 288

6.2.1.1 Concept 1

Northbound Route 288 Concept 1 utilizes the existing paved shoulder as an HSR lane during the AM peak period. The HSR lane starts at the northbound Route 288 on-ramp from Route 711 as a continuation of the acceleration lane and ends at beginning of the deceleration lane of the northbound Route 288 off-ramp to eastbound Route 6. In addition, the northbound Route 288 acceleration lane from Route 711 is permanently extended by 220 feet to meet AASHTO standard.

6.2.1.2 Concept 2

Northbound Route 288 Concept 2 also utilizes the existing paved shoulder as an HSR lane starting at the end of the northbound Route 288 acceleration lane from Route 711 during the AM peak period. This concept also extends the northbound Route 288 acceleration lane from Route 711 by 220 feet. The HSR lane ends at the northbound Route 288 on-ramp loop from eastbound Route 6. At the northbound Route 288 off-ramp to eastbound Route 6, the deceleration lane is reconstructed to create a two-lane off ramp. Approaching the northbound Route 288 weave at Route 6, the two mainline through lanes and HSR lane are shifted to the inside of Route 288 to accommodate four lanes within the weave (three through lanes and one auxiliary lane) under the Route 6 bridge. The HSR lane ends within the Route 6 weave and becomes the rightmost mainline through lane. The additional lane to the inside of northbound Route 288 starts at the Route 6 weave and continues until the off-ramp to West Creek Parkway. To the north of the West Creek Parkway off-ramp gore point, the two inside lanes are shifted back to the outside to match the existing two mainline lanes and the outside lane is dropped using a taper. Northbound Route 288 rejoins the two existing mainline through lanes at the Route 288 bridge over West Creek Parkway.

6.2.2 Southbound Route 288

6.2.2.1 Concept 1

Southbound Route 288 Concept 1 utilizes the existing paved shoulder as an HSR lane during the PM peak period. The southbound Route 288 off-ramp loop to eastbound Route 6 is removed, eliminating the weave area on southbound Route 288 at Route 6. The resulting acceleration lane from the southbound Route 288 on-ramp from westbound Route 6 is constructed to be 1,420-feet. The HSR lane begins as an extension of the lengthened acceleration lane, prior to the southbound Route 288 on-ramp from eastbound Route 6. The HSR lane continues over the James River Bridge and ends at the deceleration lane of the southbound Route 288 off-ramp to Route 711. To maintain traffic in the HSR lane through the Route 6 interchange, the southbound Route 288 on-ramp from eastbound Route 6 and the ramp acceleration lane is shifted outside of the existing shoulder and proposed HSR lane. This shift can be accommodated without any widening, as this on-ramp was originally constructed as two full lanes. Southbound Concept 1 also includes a 475-foot extension of the southbound on-ramp acceleration lane from West Creek Parkway.

6.2.2.2 Concept 2

Southbound Route 288 Concept 2 also includes a 475-foot extension of the southbound on-ramp acceleration lane from West Creek Parkway. The southbound Concept 2 HSR lane begins as an extension of the lengthened acceleration lane from the southbound Route 288 on-ramp from West Creek Parkway. The HSR lane continues

through the weave area at the Route 6 interchange where it is a full width lane. To accommodate the additional lane in the weave area, the through lanes and HSR lane are shifted to the inside of Route 288 by traditional widening. Four total lanes (three through lanes and one auxiliary lane) are present in the weave area. Just after the southbound Route 288 off-ramp loop to eastbound Route 6, the through lanes shift back the outside to align with the existing through lanes. The resulting HSR lane shift aligns with the outside existing paved shoulder. South of the southbound Route 288 on-ramp from eastbound Route 6, southbound Concept 2 is identical to southbound Concept 1.

6.2.2.3 Concept 3

Southbound Route 288 Concept 3 is identical to southbound Route 288 Concept 1 except the southbound Route 288 off-ramp loop to eastbound Route 6 remains in place. A diverging "choice" lane—splitting right to the off-ramp towards eastbound Route 6 and left into an additional through lane—is created at the end of the existing southbound Route 288 weave at Route 6. The additional through lane in the weave area functions as a 1420-foot acceleration lane for vehicles entering Route 288 from the westbound Route 6 on-ramp loop. The HSR lane begins as an extension of this acceleration lane, 1,000 feet upstream of the southbound Route 288 on-ramp from eastbound Route 6. Southbound Route 288 Concepts 1, 2, and 3 are identical south of the choice lane.

6.3 Preferred Build Selection

All concepts considered were evaluated based on safety, operations, access, and construction cost. One northbound and one southbound concept was selected for project advancement and input into the preferred build traffic model.

6.3.1 Northbound Route 288

The northbound concepts were analyzed in VISSIM under 2025 AM peak hour conditions to determine their operational longevity. The AM peak hour travel times are illustrated in **Figure 35**. Both northbound Route 288 concepts are projected to provide significant traffic operations benefits compared to No-Build conditions along northbound Route 288 in the AM peak period, specifically between the US 60 and Route 711 interchanges; however, minimal traffic operations benefits were projected by extending the HSR lane in northbound Concept 2 further to the north. Travel times between Route 711 and Route 6 interchanges are nearly identical for Concept 1 and 2. Since northbound Concept 2 provided minimal traffic operations benefits but required widening through and to the north of the Route 6 interchange, the SWG decided that the marginal benefits did not outweigh the additional costs and risk associated with extending the HSR lane to West Creek Parkway. Therefore, northbound Route 288 Concept 1 was selected as the preferred northbound concept at the No-Build Conditions and Build Concepts meeting on March 30, 2018. A conceptual sketch of the preferred concept is shown in **Figure 36**. The full conceptual sketch is provided in **Appendix F**. The concept screening traffic analysis results presented at that meeting are provided in **Appendix E**.

Figure 35: Northbound Route 288 AM Peak Hour 2025 VISSIM Travel Times

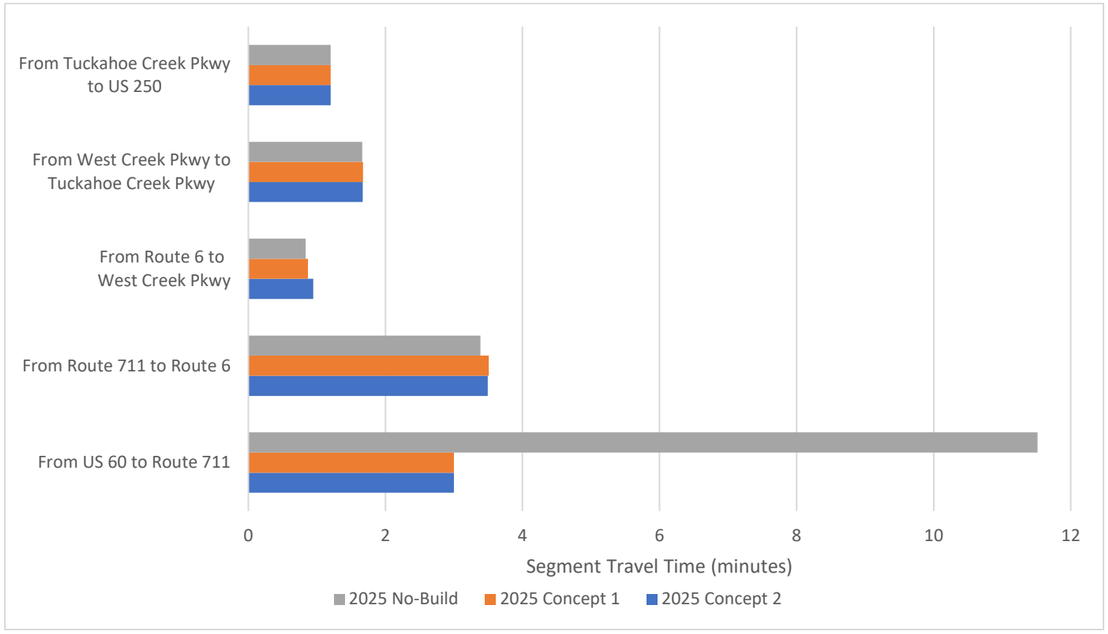
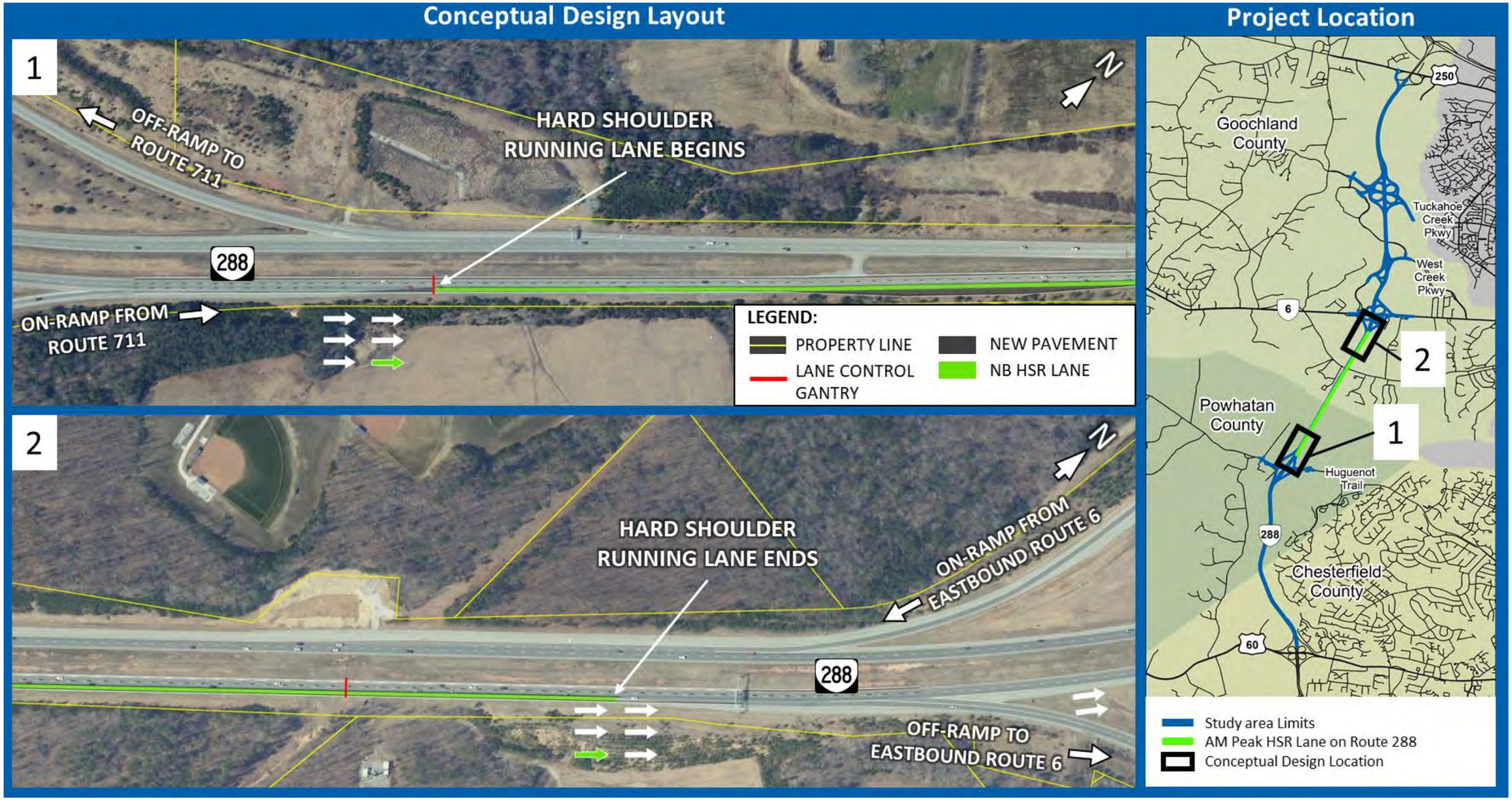


Figure 36: Preferred Northbound Route 288 Concept Diagram from Route 711 to Route 6



6.3.2 Southbound Route 288

The southbound concepts were analyzed in HCS and VISSIM under 2025 and 2040 PM peak conditions to determine their operational longevity. This section focuses primarily on the VISSIM results because of limitations found in the HCS facilities module. The PM peak hour travel times are illustrated in **Figure 37** and **Figure 38**. All three concepts are projected to provide similar significant traffic operations benefits along southbound Route 288 in the 2025 PM peak period. Southbound Concept 1, which removes the southbound Route 288 off-ramp loop to eastbound Route 6, showed long term traffic operations and safety benefits by removing the weaving area on southbound Route 288 at Route 6. However, removing the off-ramp would require drivers to reroute through the arterial network on West Creek Parkway and Route 6, which are projected to experience significant development. Removing the off-ramp would also require the completion of an Interchange Modification Report (IMR). The SWG determined that the benefits of southbound Concept 1 did not outweigh the risks of removing the ramp, limiting access to Route 288, and rerouting vehicles to West Creek Parkway. Southbound Concepts 2 and 3 do not present these risks; however, neither concept removes the existing weaving area at Route 6.

The VISSIM analysis of Concept 2 and 3 under 2040 conditions showed significant benefits for both concepts; however, there were reduced speeds and queuing within the choice-lane weave segment present in Concept 3. This is illustrated by the slightly higher travel times for Concept 3 between Tuckahoe Creek Parkway and Route 6. The SWG determined that the additional peak period capacity created by extending the HSR lane to the north to West Creek Parkway provided additional long-term traffic operations and safety benefits; therefore, southbound Concept 2 was selected as the preferred southbound concept at a meeting on July 13, 2018. A conceptual sketch of the preferred concept is shown in **Figure 39**. The full conceptual sketch is provided in **Appendix F**. The concept screening traffic analysis results that were presented at that meeting are provided in **Appendix E**.

An additional improvement concept was also identified for southbound Route 288 during the screening process. Testing of 2025 No-Build AM peak hour conditions revealed reduced speeds and queueing between the on-ramp from US 250 and the off-ramp to westbound Tuckahoe Creek Parkway/Capital One. It was noted by the SWG at the No-Build Conditions and Build Concepts meeting on March 30, 2018 that this issue is not present under existing conditions. A traditional auxiliary lane connecting the ramps was tested under 2025 conditions and showed long term traffic operations and safety benefits by reducing congestion between the US 250 and Tuckahoe Creek Parkway interchanges. A conceptual sketch of this concept is shown in **Figure 40**. The full conceptual sketch is provided in **Appendix F**. This concept will be pursued as a preferred build concept and is included in the final build traffic model.

Figure 37: Southbound Route 288 PM Peak Hour 2025 VISSIM Travel Times

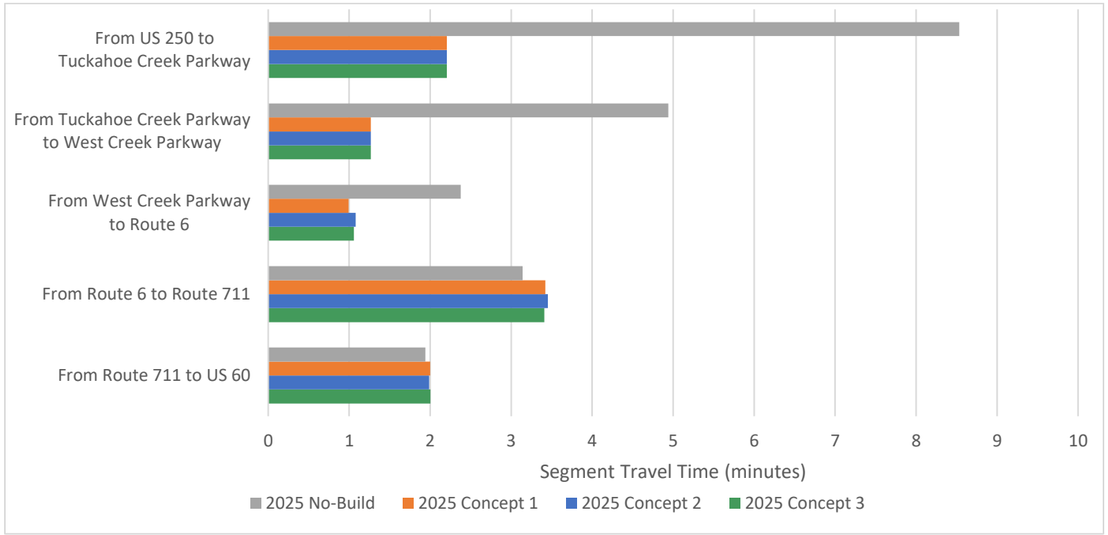


Figure 38: Southbound Route 288 PM Peak Hour 2040 VISSIM Travel Times

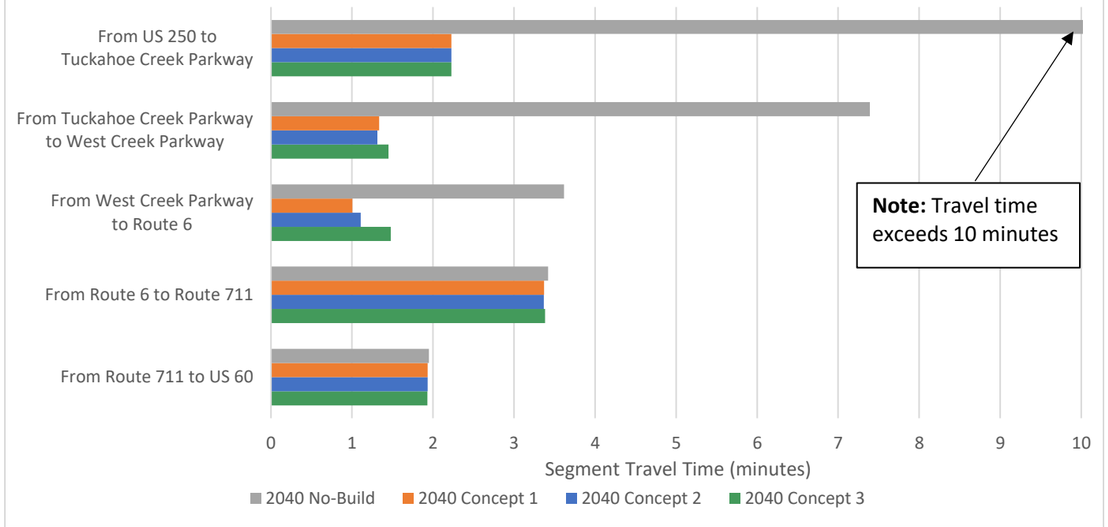


Figure 39: Preferred Southbound Route 288 Concept Diagram from West Creek Parkway to Route 711

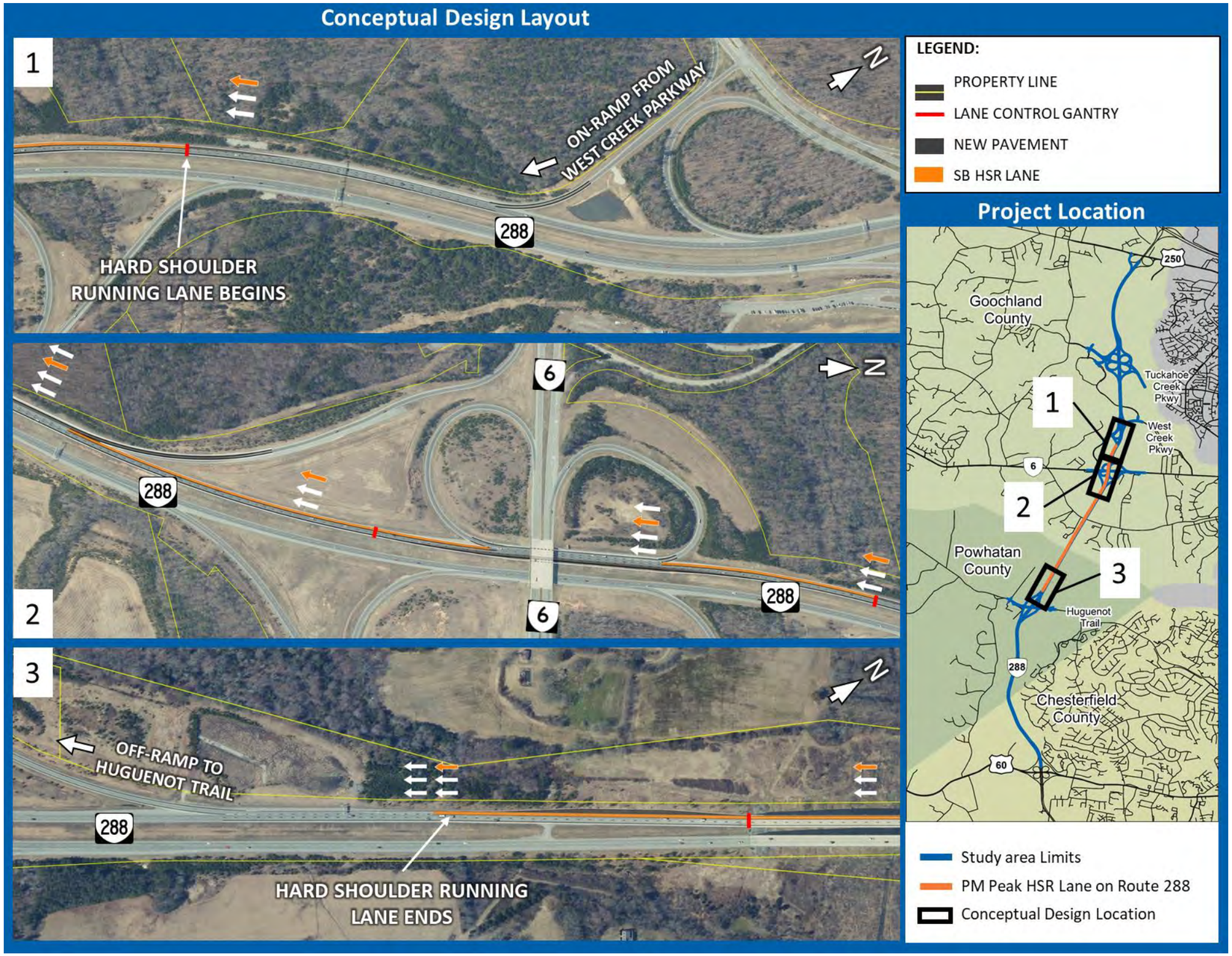
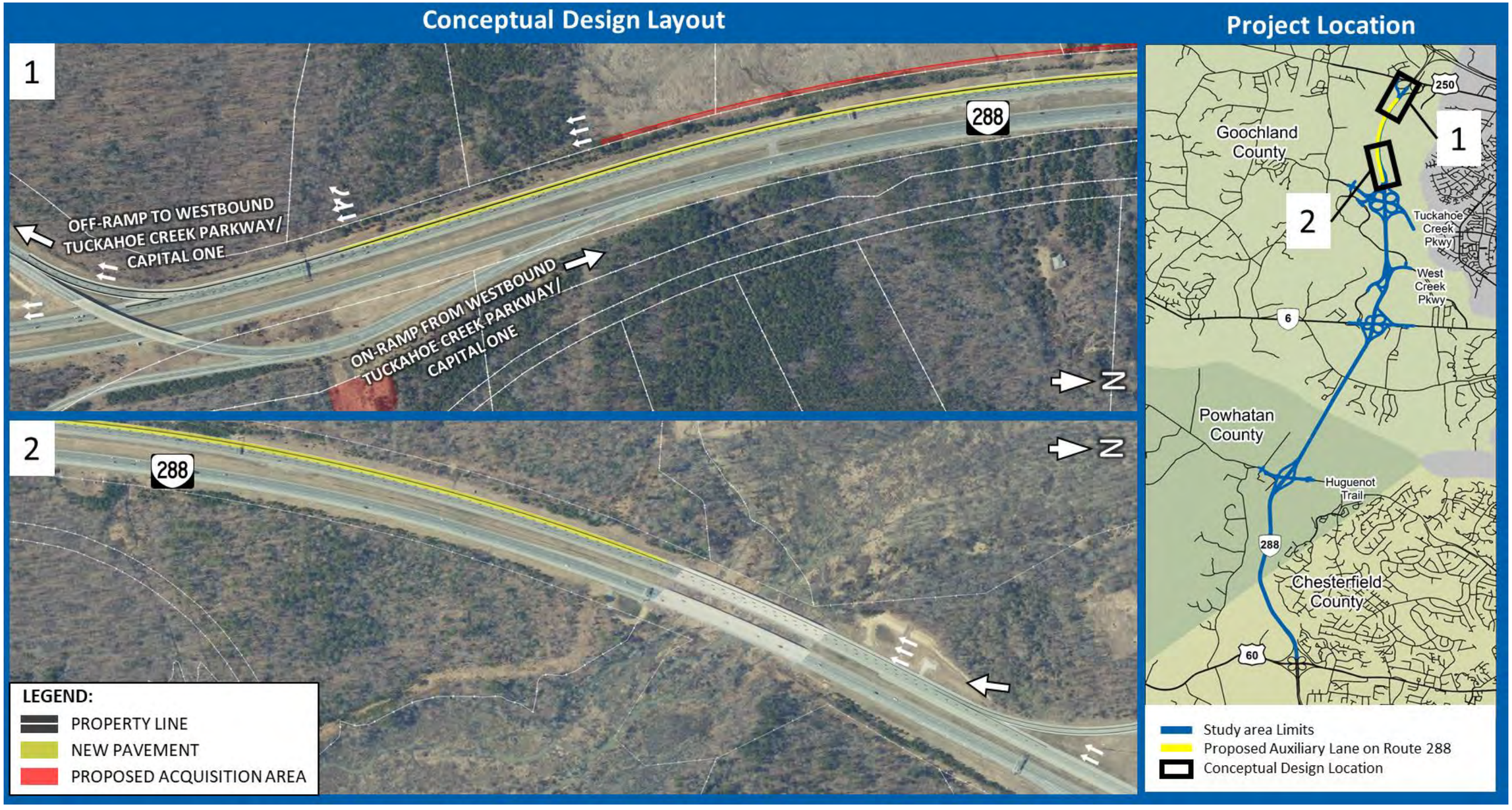


Figure 40: Auxiliary Lane from US 250 to Tuckahoe Creek Parkway Conceptual Diagram



7 Preferred Build Traffic Conditions (2025)

VISSIM models were developed to analyze freeway operations on Route 288 and intersections operations on Tuckahoe Creek Parkway, West Creek Parkway, Route 6, and Route 711 within the study area under Preferred Build (2025) AM and PM peak hour conditions.

7.1 Modeling Assumptions

The No-Build VISSIM models were used as a basis to develop the Preferred Build VISSIM models. The proposed improvements were coded into the calibrated No-Build AM and PM VISSIM models separately to maintain existing and No-Build calibration adjustments. A detailed summary of VISSIM modeling inputs and assumptions is provided in **Appendix B.**

The VDOT Sample Size Determination Tool was used to confirm that ten simulation runs would provide the acceptable 95 percent confidence level for both the AM and PM Preferred Build models. Therefore, 10 simulation runs were conducted for both the AM and PM models using different random seeds. The average of these runs was reported.

7.2 Freeway Analysis

Graphical representation of the freeway results is included in **Appendix G.** The schematics present the average density (veh/ln/mi) and average speed (mph) for each freeway link in the network.

7.2.1 AM Peak Hour

During the AM peak hour in the northbound direction under Preferred Build conditions, congestion improved on Route 288 upstream of the on-ramp from Route 711. Under No-Build conditions, segments between the on-ramp from US 60 and the off-ramp to Route 711 were projected to operate with average speeds below 20 mph and average link densities of 45 veh/ln/mi and above. Under Preferred Build conditions, all segments of Route 288 between the on-ramp from US 60 and the off-ramp to Route 711 were projected to operate with an average speed of 60 mph and above. Densities were projected to decrease to below 25 veh/ln/mi. Downstream of the on-ramp from Route 711, densities were projected to fall to 40 veh/ln/mi or below and average speeds were projected to stay consistent above 50 mph, similar to the No-Build conditions. The northbound Route 288 freeway schematic between US 60 and Route 711 is illustrated in **Figure 41**.

In the southbound direction during the AM peak hour, congestion was projected to improve on Route 288. Under No-Build conditions, congestion was projected on Route 288 from the US 250 on-ramp to Tuckahoe Creek Parkway, with densities of 35 veh/ln/mi and above and average speeds 50 mph and below. Under Preferred Build conditions, southbound Route 288 throughout the project limits was projected to operate with moderate-to-light densities and average speeds consistently 60 mph or above. The southbound Route 288 freeway schematic between US 250 and Tuckahoe Creek parkway is illustrated in **Figure 42**.

7.2.2 PM Peak Hour

In the northbound direction during the PM peak hour, the Preferred Build conditions were projected to be similar to the No-Build conditions. All segments of Route 288 northbound were projected to operate with densities less than 26 veh/ln/mi and average speeds of 60 mph and above.

In the southbound direction during the PM peak hour, the Preferred Build conditions were projected to improve compared to No-Build. Under No-Build Conditions, congestion was projected from US 250 to Route 6, with average speeds below 35 mph and densities greater than 45 veh/ln/mi. Under Preferred Build conditions, the projected average speed increased to 60 mph and above, and the projected average density decreased to below 35 veh/ln/mi from the on-ramp from US 250 to Route 6. The southbound Route 288 freeway schematics between US 250 and Route 6 are illustrated in **Figure 43** and **Figure 44**.

7.3 Intersection Analysis

The Preferred Build AM and PM VISSIM intersection delay results are presented in **Figure 45** and **Figure 46,** and the maximum queues are provided in **Table 9**. VISSIM results are summarized in **Appendix G**.

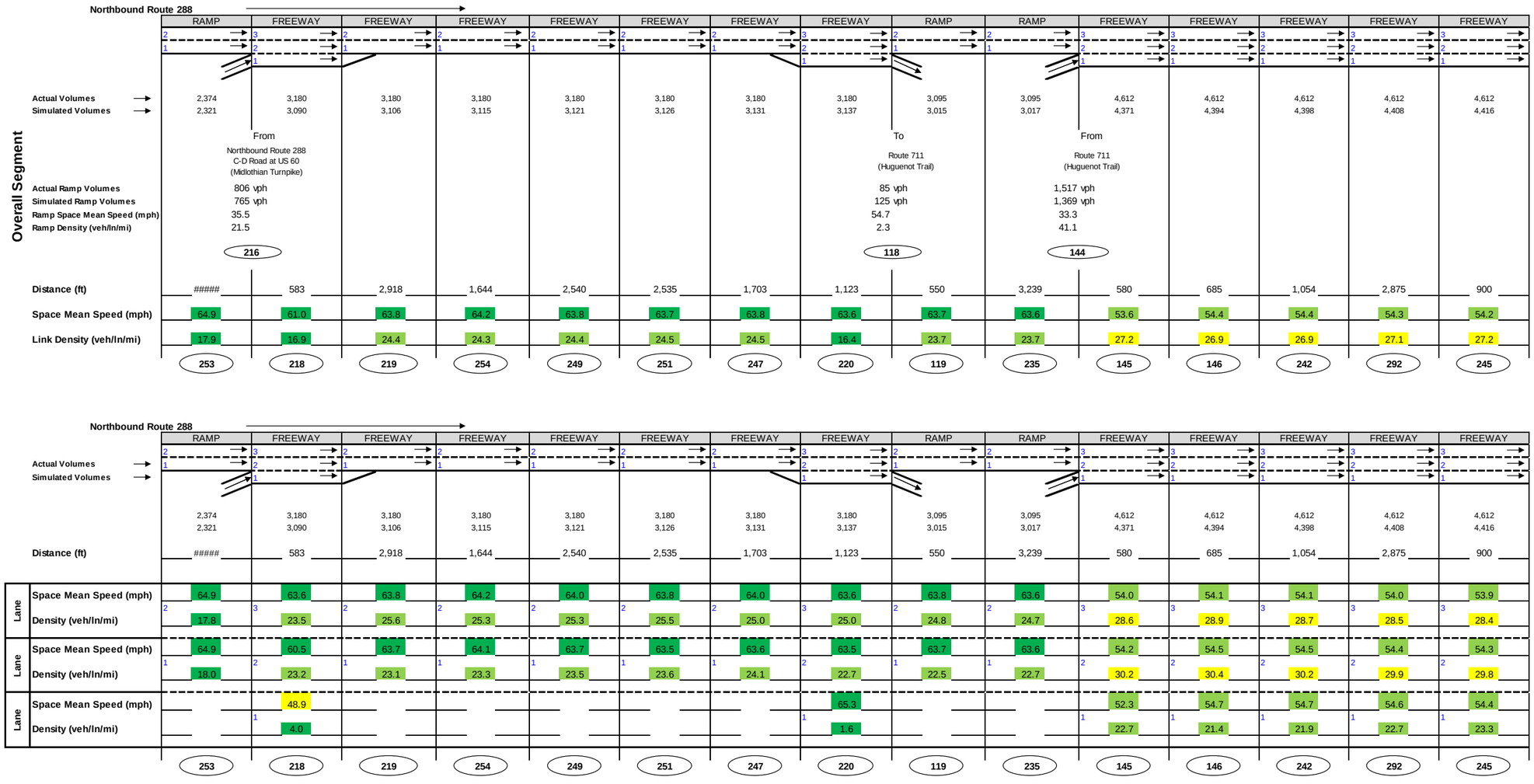
7.3.1 AM Peak Hour

Under the Preferred Build conditions during the AM peak hour, all intersections and all movements were projected to operate with acceptable delays. The overall intersection delay at Route 711 and the northbound Route 288 ramps was projected to decrease from a delay of 53.3 s/veh under No-Build conditions to 8.9 s/veh under Preferred Build conditions. The westbound right-turn queue at this intersection was eliminated under Preferred Build conditions. The maximum queue for the westbound right turn was projected to be over 4,000 feet under No-Build conditions. This queueing was a result of congestion on northbound Route 288 that caused the on-ramp to queue back through the intersection and onto westbound Route 711, which is alleviated with the proposed HSR.

7.3.2 PM Peak Hour

Under the Preferred Build conditions during the PM peak hour, all intersections were projected to operate with acceptable overall intersection delays. At the intersection of West Creek Parkway and Broad Branch Drive, the southbound approach was expected to experience excessive delays averaging 109.2 s/veh. The queue for the southbound approach remained similar to the queue under No Build conditions at 1,081 feet. At the Capital One Drive and Route 288 roundabout, the northbound through movement was projected to operate with excessive delays of 285.5 s/veh under build conditions. The SWG is aware of future issues at West Creek Parkway and Broad Branch Drive and at the Capital One Drive at Route 288 ramps and is and exploring ways to review intersections as part of separate studies.

Figure 41: Preferred Build (2025) AM VISSIM Schematic – Northbound Route 288 from US 60 to Route 711



NOTE: numbers in chart are provided for illustrative purposes only

LEGEND

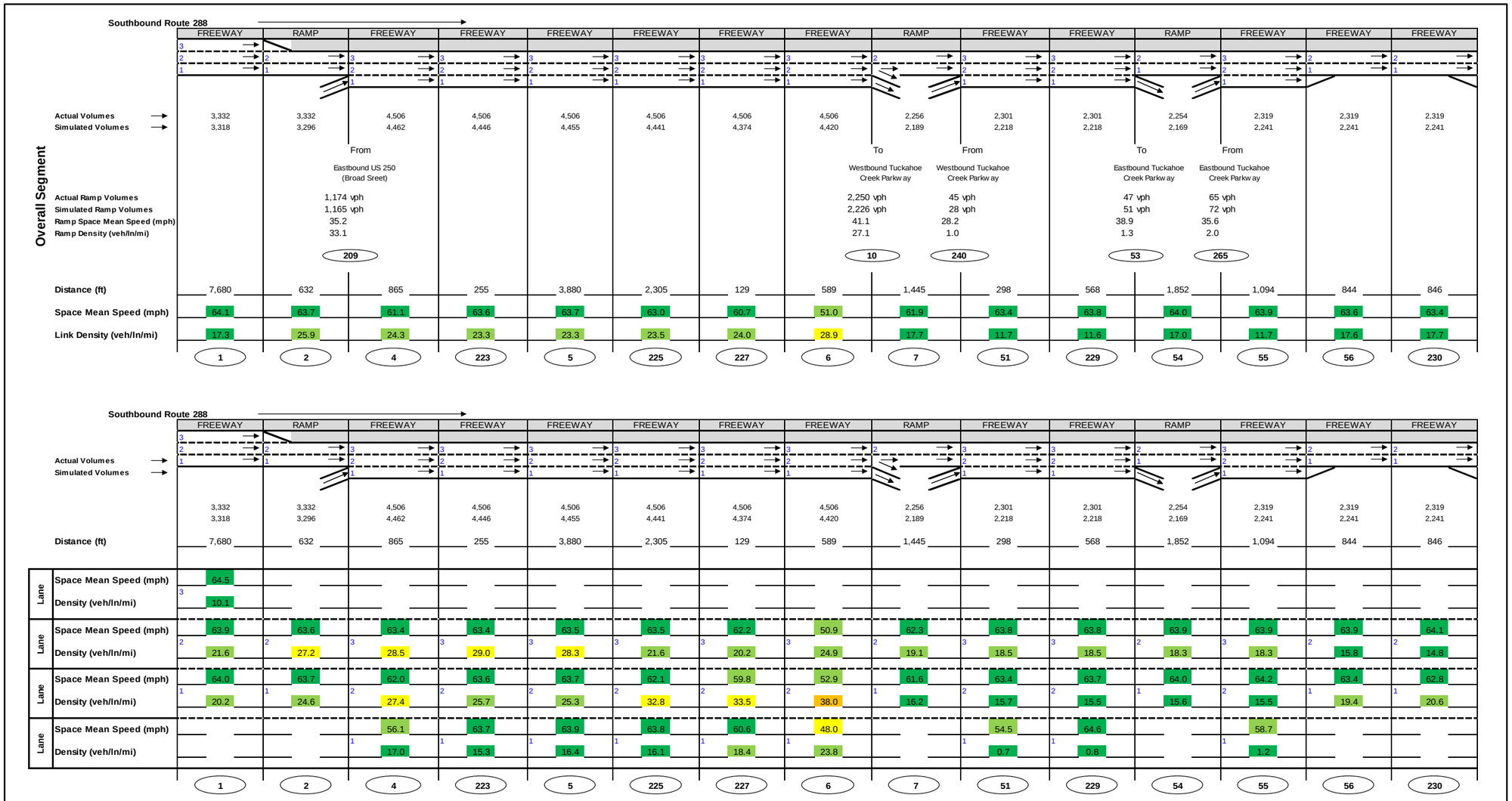
100 Link Number

Average Density (veh/ln/mi)
45 and above
35 to 45
26 to 35
18 to 26
0 to 18

Average Speed (mph)
0 to 20
20 to 35
35 to 50
50 to 60
60 and above

***The results shown are the average results across 10 microsimulation runs.**

Figure 42: Preferred Build (2025) AM VISSIM Schematic – Southbound Route 288 from US 250 to Tuckahoe Creek Parkway



NOTE: numbers in chart are provided for illustrative purposes only

LEGEND

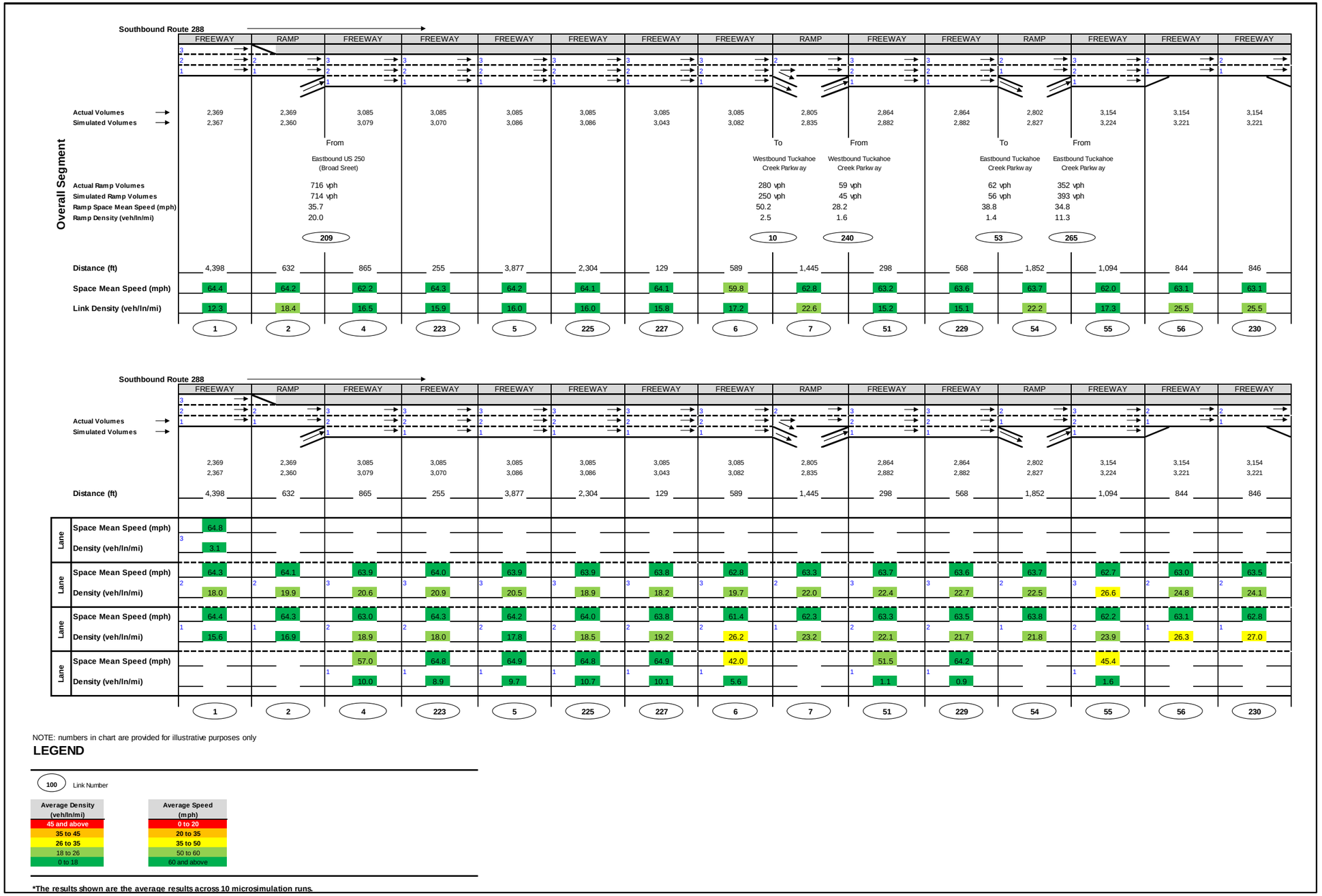
100 Link Number

Average Density (veh/ln/mi)
45 and above
35 to 45
26 to 35
18 to 26
0 to 18

Average Speed (mph)
0 to 20
20 to 35
35 to 50
50 to 60
60 and above

***The results shown are the average results across 10 microsimulation runs.**

Figure 43: Preferred Build (2025) PM VISSIM Schematic – Southbound Route 288 from US 250 to Tuckahoe Creek Parkway



NOTE: numbers in chart are provided for illustrative purposes only

LEGEND

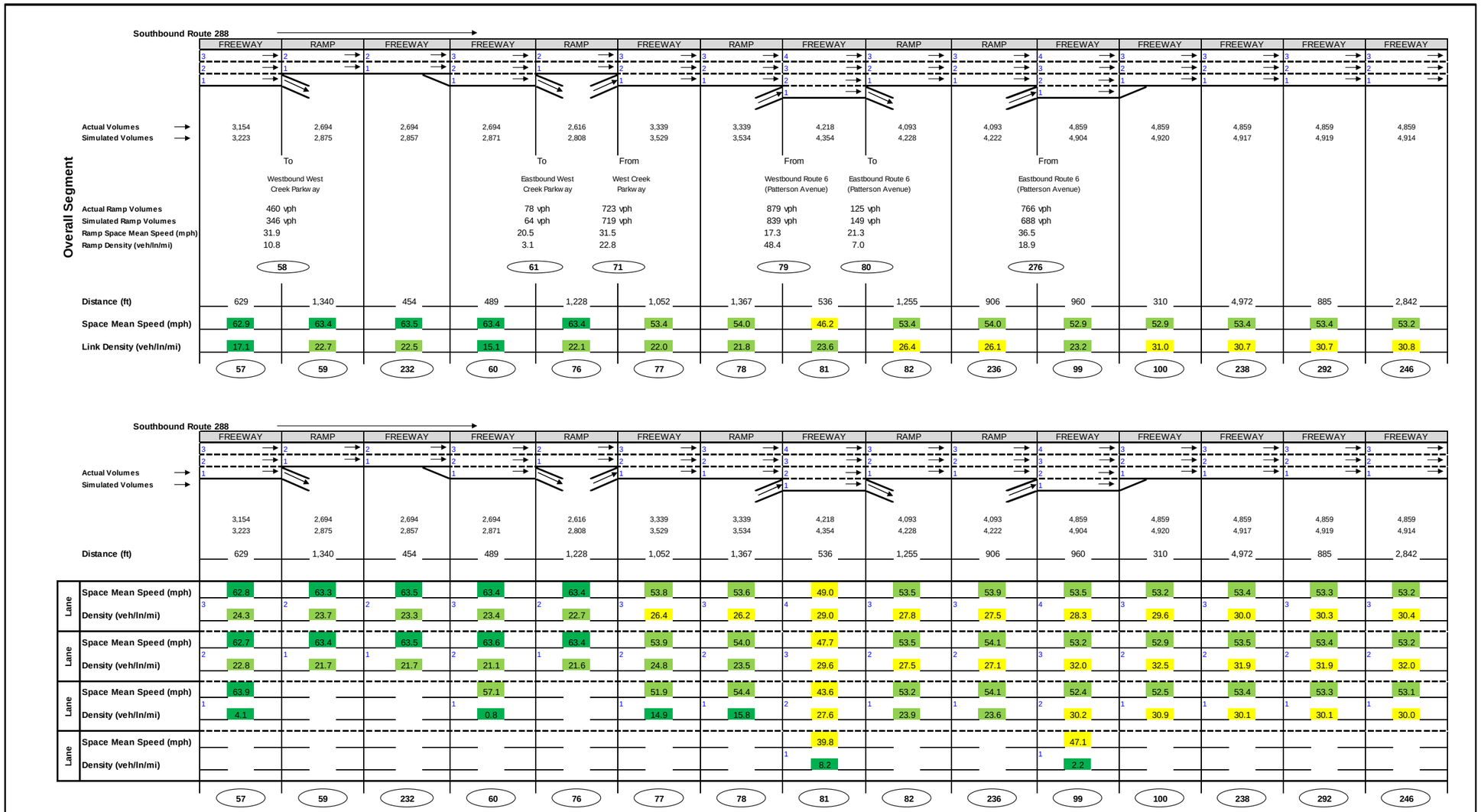
100 Link Number

Average Density (veh/ln/mi)
45 and above
35 to 45
26 to 35
18 to 26
0 to 18

Average Speed (mph)
0 to 20
20 to 35
35 to 50
50 to 60
60 and above

***The results shown are the average results across 10 microsimulation runs.**

Figure 44: Preferred Build (2025) PM VISSIM Schematic – Southbound Route 288 from West Creek Parkway to Route 6



NOTE: numbers in chart are provided for illustrative purposes only

LEGEND

100 Link Number

Average Density (veh/ln/mi)
45 and above
35 to 45
26 to 35
18 to 26
0 to 18

Average Speed (mph)
0 to 20
20 to 35
35 to 50
50 to 60
60 and above

***The results shown are the average results across 10 microsimulation runs.**

Figure 45: Preferred Build (2025) AM VISSIM Intersection Delays

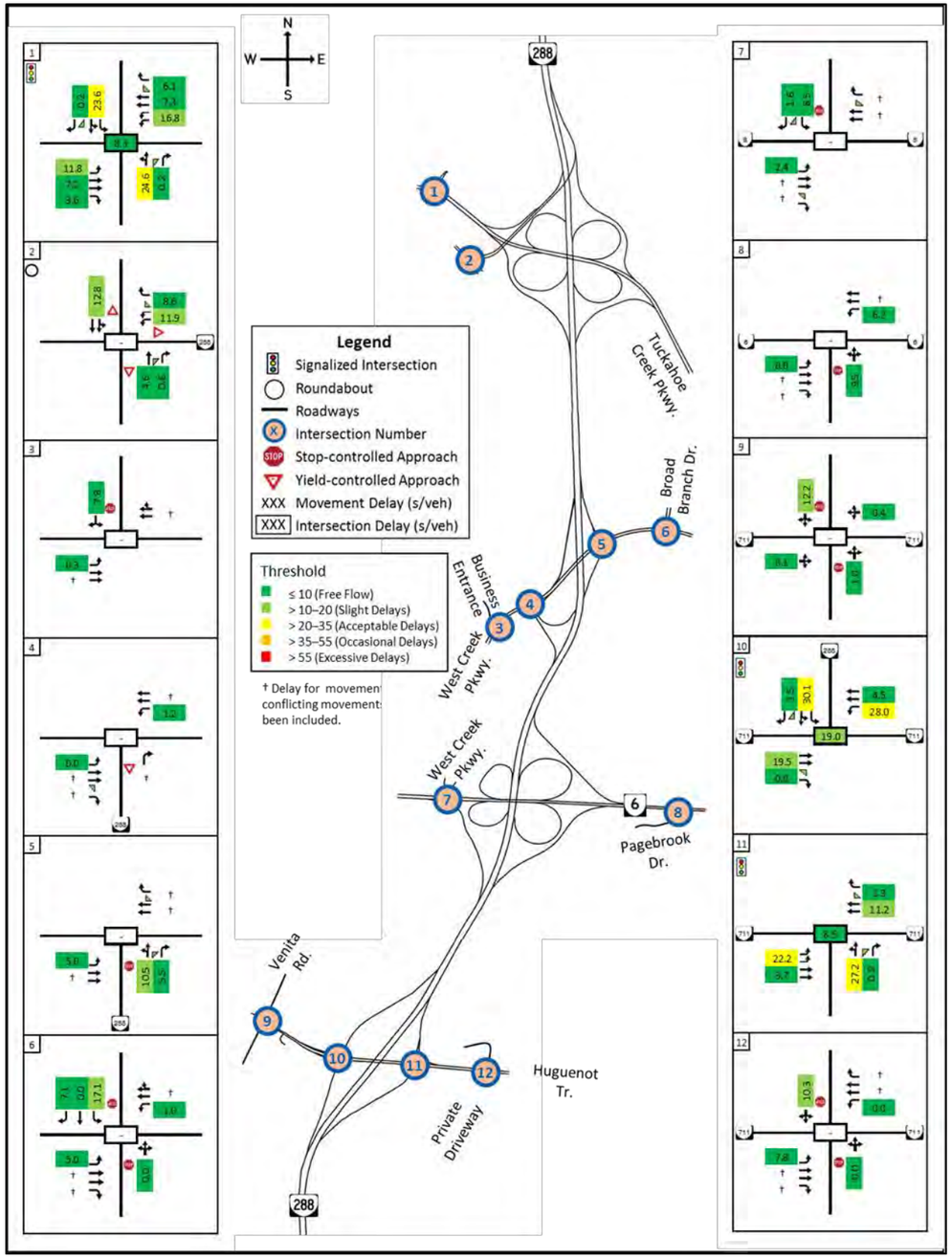


Figure 46: Preferred Build (2025) PM VISSIM Intersection Delays

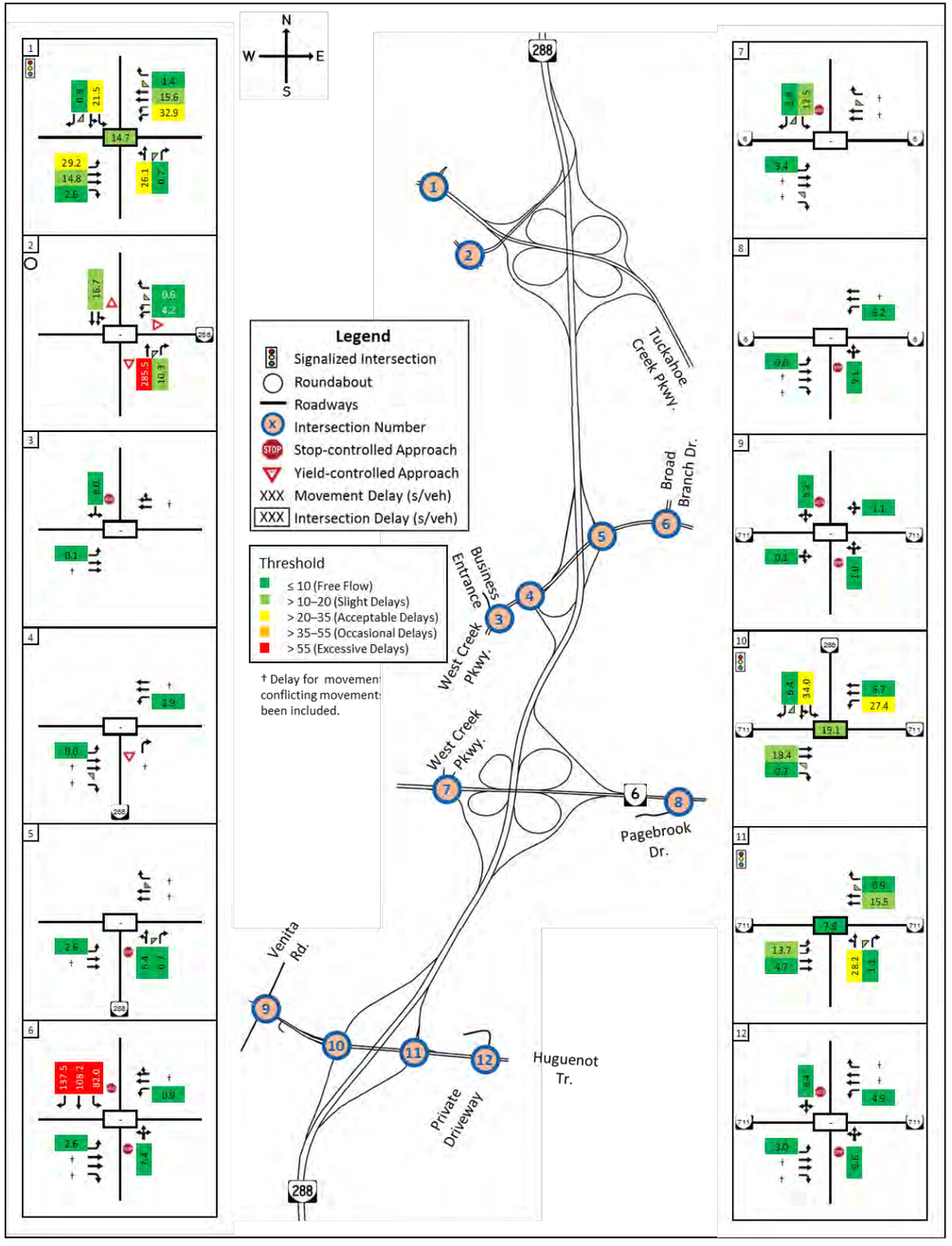


Table 9: Preferred Build AM and PM VISSIM Intersection Queues

Intersection		Type of Control	Lane Group	Northbound			Southbound			Eastbound			Westbound		
				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	Tuckahoe Creek Parkway and Capital One Drive	Signal		Capital One Drive			CarMax			Tuckahoe Creek Parkway			Tuckahoe Creek Parkway		
			Left	-	33	126	305	30	221	150	65	20	345	99	29
			Through							-	68	129	-	56	140
			Right	-	0	7	300	0	37	210	122	64	-	0	0
2	Route 288 and Capital One Drive	Roundabout		Capital One Drive			Capital One Drive			--			Route 288 Ramps		
			Left				-	70	385				-	110	2
			Through	-	30	635									
			Right	-	30	697							-	0	0
3	West Creek Parkway and Eastern Median Opening	One-Way Stop		--			Business Drive			West Creek Parkway			West Creek Parkway		
			Left				-	35	52	305	4	1			
			Through							-	†	†	-	†	†
			Right										-	†	†
4	West Creek Parkway and Route 288 SB On-Ramps	One-Way Stop		Route 288 SB On-Ramp			--			West Creek Parkway			West Creek Parkway		
			Left							255	0	0	225	23	150
			Through							-	†	†	-	†	†
			Right	-	†	†				-	†	†	-	-	-
5	West Creek Parkway and Route 288 NB Off/On-Ramps	One-Way Stop		Route 288 NB Off-Ramp			Route 288 NB On-Ramp			West Creek Parkway			West Creek Parkway		
			Left	430	58	43				235	35	68			
			Through							-	†	†	-	†	†
			Right	-	0	0				-	†	†	550	†	†
6	West Creek Parkway and Broad Branch Drive	Two-Way Stop		Sports Complex			Broad Branch Drive			West Creek Parkway			West Creek Parkway		
			Left	-	0	47	295	88	437	295	241	50	295	12	44
			Through				-	0	39	-	†	†	-	†	†
			Right				-	116	1,801	285	†	†	-	†	†
7	Route 6 (Patterson Avenue) and West Creek Parkway	One-Way Stop		--			West Creek Parkway			Route 6			Route 6		
			Left				-	54	155	215	55	32			
			Through							-	†	†	-	†	†
			Right				-	94	167	420	†	†	425	†	†
8	Route 6 (Patterson Avenue) and Pagebrook Drive	One-Way Stop		Pagebrook Drive			--			Route 6			Route 6		
			Left	-	61	63				285	0	0	300	38	46
			Through							-	†	†	-	†	†
			Right							-	†	†	-	-	-
9	Route 711 (Huguenot Trail) and Venita Road	Two-Way Stop		Venita Road			Venita Road			Route 711			Route 711		
			Left	-	1	1	-	27	35	-	18	15	-	0	0
			Through												
			Right												
10	Route 711 (Huguenot Trail) and Route 288 SB Ramps	Signal		--			Route 288 SB Off-Ramp			Route 711			Route 711		
			Left				275	246	290				515	153	200
			Through							-	336	132	-	60	142
			Right				280	0	0	630	0	0			
11	Route 711 (Huguenot Trail) and Route 288 NB Ramps	Signal		Route 288 NB Off-Ramp			--			Route 711			Route 711		
			Left	-	97	191				465	294	74			
			Through							-	196	274	-	80	142
			Right	370	0	0							645	0	0
12	Route 711 (Huguenot Trail) and Private Driveways	Two-Way Stop		Private Driveway			Private Driveway			Route 711			Route 711		
			Left	-	0	73	-	57	77	340	15	3	240	0	11
			Through							-	†	†	-	†	†
			Right							-	†	†	235	†	†

NOTE: Shared lane results are shown as one value that corresponds to all movements in the lane.

† Queues for movements with no conflicting movements have not been included.

Bold values indicate queues that exceed storage bay length

8 Design Considerations, Costs, and Schedules

Refined planning-level cost estimates and schedule estimates were developed for both the preferred northbound and southbound concepts and are summarized in the following sections. In addition, the SWG discussed design considerations for the HSR lanes throughout the study process which are also covered in the following sections. A one-page summary sheet for each concept is included in **Appendix H**. The summary sheets provide a brief project description, conceptual design layout, planning level cost estimate, project schedule, and project location map for each improvement project.

8.1 Planning-Level Cost Estimates

Refined planning-level cost estimates were developed for the two preferred concepts as two separate projects. The VDOT Project Cost Estimating System (PCES) was used as a resource for calculating the project preliminary engineering and construction costs. Quantities were determined based on the conceptual designs. A diagram of the preferred concepts is included in **Appendix F**. Right-of-way and utility relocation costs were estimated on a project-by-project basis based on the size and complexity of the project, as well as the existing right-of-way limits. In addition, the construction cost included an additional 25% of the base roadway construction cost for construction engineering and inspection (CEI). **Table 10** summarizes the preliminary engineering (PE), right-of-way and utility relocation (RW), construction (CN), and total planning level cost estimates for each improvement project. Costs are reported in fiscal year 2019 (FY19) dollars. A more detailed breakdown of the planning-level cost estimates is provided in **Appendix F**.

Table 10: Planning Level Cost Estimates

Concept	Cost Estimate (FY19 dollars)			
	Preliminary Engineering	Right of Way and Utilities	Construction	Total
Northbound HSR Concept	$ 2,500,000	$ 1,900,000	$ 13,100,000	**$ 17,500,000**
Southbound HSR Concept	$ 3,500,000	$ 1,900,000	$ 18,400,000	**$ 23,800,000**
Southbound Auxiliary Lane	$ 1,800,000	$ 1,500,000	$ 9,700,000	**$ 13,000,000**

8.2 HSR Design Considerations

HSR lanes are included in both the northbound and southbound preferred alternatives. HSR lanes utilize the existing shoulder as an additional travel lane during high congestion periods. Design of HSR lanes requires additional considerations compared to traditional widening. These additional design considerations are detailed in the following sections.

8.2.1 Existing Paved Shoulder

Construction plans for Route 288 in the study area, dated 2000 and 2001, were designed in metric units and show the outside paved shoulder as 3.0 meters wide (approximately 9.8 feet). Field measurements performed in 2018 confirmed the existing paved outside shoulder varies from 10.0 feet to 10.5 feet wide. Construction plans show that the paved shoulder was not proposed to be the same full-depth asphalt section as the adjacent lanes. According to the construction plan, the paved shoulder was proposed to be 2 inches of surface mix asphalt and 2.5 inches of intermediate mix asphalt on approximately 12.5 inches of aggregate base, whereas the adjacent travel lanes were proposed to be 2 inches of surface mix asphalt, 5.5 inches of intermediate mix asphalt, and 3 inches of base mix asphalt on 6 inches of aggregate base.

VDOT contracted with Schnabel Engineering in the March 2018 to perform pavement cores in the shoulder of the study area to determine the actual constructed pavement thickness of the outside shoulders. The report prepared by Schnabel, dated April 6, 2018 and included in **Appendix I**, confirms that the existing outside shoulder is composed of an average asphalt thickness of 4.5 inches on an average aggregate base thickness of 13 to 15 inches. This Schnabel report also details the presence of lime treated subgrade soils below the pavement within most of the cores performed in March 2018.The lime treatment strengthens the subgrade during construction and may extend the life of the existing shoulder under HSR operations.

The existing paved shoulder was not designed or constructed with the same section as the adjacent travel lanes since it was not intended to carry a regular traffic loading. Therefore, proposing to use the existing outside shoulder as an HSR lane would increase the equivalent single axel loads (ESALs) on the shoulder beyond what it was designed to accommodate. To determine the impact of adding the traffic load to the shoulder during peak period operations, VDOT performed preliminary pavement design calculations in March 2018 based on the existing pavement section. These pavement design calculations, included in **Appendix I**, show that the existing shoulder will be adequate to handle the additional ESALs for an 18-year surface life with only a 2-inch mill and overlay and no additional strengthening or overlays.

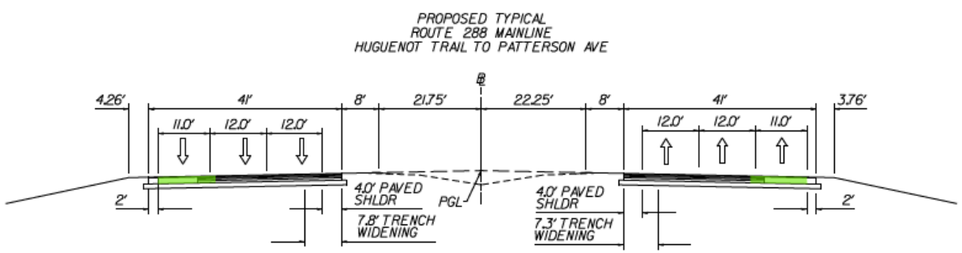
8.2.2 HSR Lane Width

The existing lane widths on Route 288 in the study corridor were designed to be metric equivalent of 12 feet. Existing travel lanes are 3.6 meters wide (11.8 feet). While the current VDOT and AASHTO standard lane width for a rural principal arterial/freeway (GS-1) is 12 feet, the existing lanes are 11.8feet wide and are assumed, with concurrence from VDOT and the SWG, to be adequate and do not require a design exception.

Several proposed typical sections were explored to provide adequate width to all lanes. Simply moving traffic to the left to utilize the pavement of the existing inside paved shoulder is not a viable alternative alone, as the inside shoulder is the same minimal-depth pavement section as the outside shoulder. While the existing outside shoulder pavement section is adequate during shoulder running operations, the inside shoulder would carry traffic 24 hours a day and would be inadequate for the proposed ESALs without additional strengthening. Therefore, without modifying the inside shoulder, the existing inside paved shoulder would remain four feet wide, the two travel lanes would be 11 feet wide, and the outside shoulder would be 12 feet wide (11 feet for the HSR lane and one foot for the outside paved shoulder). This option was undesirable due to the minimal width of the outside of the paved shoulder and travel lanes.

Ultimately the SWG selected an option that would provide a standard inside paved shoulder of four feet, two travel lanes that are 12 feet, and an outside shoulder that is 13 feet wide (11 feet for the HSR lane and 2 feet for the paved shoulder). In the locations where guardrail exists on the right side of traffic, the guardrail would be replaced at the edge of the outside paved shoulder, 2 feet from the shoulder lane. This typical section can only be achieved by widening to the inside and reconstructing the existing inside paved shoulder to be full-depth pavement. The total additional width of pavement added to the inside would be approximately 3 feet. The proposed typical section from Route 711 to Route 6 for Route 288 is included in **Figure 47**.

Figure 47: Proposed Typical Section Route 711 to Route 6



Because the proposed shoulder lanes are 11 feet wide, less than the FHWA-recommended 12 feet, several strategies were considered to further supplement the design plan for using the shoulder lane. Those recommended for implementation include:

- Advance Signing: Install MUTCD standard sign W5-1 (ROAD NARROWS) at the start of the HSR lanes, as shown in **Figure 48**
- Decrease spacing of raised pavement markers (RPMs): Place RPMs at intervals of 40 feet (half of the VDOT standard spacing of 80 feet) to increase visibility of lanes in low-light conditions
- Dynamic Speed Limit: Reduce the speed limit of all lanes from 65 mph to 55 mph when the HSR lane is in operation. See the ITS Section that follows for more discussion on the dynamic speed limit.
- Rumble Strips: Install a rumble strip (or rumble stripe) adjacent to the HSR lane to help reduce lane departures onto shoulder.
- Emergency Turnouts: See the **Section 8.2.4** (Emergency Turnouts)
- Increased frequency of guardrail object makers: Reduce the standard guardrail object marker spacing to help visibility of guardrail adjacent to shoulders in low-light conditions

Figure 48: MUTCD Standard Sign W5-1

Additional lane width mitigation strategies that were explored but ultimately not recommended include:

- Corridor lighting: Lighting the entire corridor would improve visibility but does not have a measurable crash-reduction benefit and would be costly to design and construct

8.2.3 Bridge

Implementing HSR lanes within the proposed project limits requires crossing the James River Bridge. The James River Bridge has two independent structures: one for northbound Route 288 travel lanes and one for southbound Route 288 travel lanes. The bridges have the same design and dimensions; therefore, this report considers them to be identical.

The existing bridge is 39.36 feet wide from the outside face of rail to the inside face of parapet (two 11.81-foot lanes with a 5.90-foot inside shoulder and 9.84-foot outside shoulder). To provide an additional travel lane during HSR operations over the bridge the lane widths must be adjusted. Based on input from VDOT Structure and Bridge, the preferred typical section consists of three 11-foot lanes (two general purpose travel lanes and one HSR lane), with a 4-foot inside shoulder and 2.36-foot outside shoulder. The inside shoulder is proposed to be wider since the left lane will be open to traffic 24 hours a day, whereas the outside lane is only open to traffic during the AM or PM peak period during HSR operations. The right shoulder on the bridge would be 13.36 feet outside of HSR operations.

It was also necessary to confirm that the bridge could handle the additional live load from the third travel lane and use of the existing bridge shoulder as a travel lane. VDOT Structure and Bridge performed a design analysis of the bridge in June 2018 and confirmed that the existing bridge is adequately designed to handle the additional loads. This analysis is included in **Appendix I**.

Because the lanes on the bridge are 11 feet wide, less than the VDOT standard 12 feet, several mitigation strategies were considered to further supplement the design plan for using the shoulder lane on the bridge. Those recommended for implementation include:

- Advance Signing: Use of MUTCD standard sign W5-2 (NARROW BRIDGE) in advance of each bridge approach, as shown in **Figure 49**
- Halve spacing of RPMs: Place RPMs at intervals of 40 feet (half of the VDOT standard spacing of 80 feet) to increase visibility of lanes in low-light conditions
- Increased frequency of parapet object makers: Reduce the standard parapet object marker spacing to help visibility of the adjacent parapet in low-light conditions

Figure 49: MUTCD Standard Sign W5-2

Additional bridge lane width mitigation strategies that were explored but ultimately not recommended include:

- Lighting: Lighting the roadway on the bridge would improve visibility but does not have a measurable crash-reduction benefit and would be very costly to design and construct
- Replacing the existing outside railing with a standard parapet: The existing bridge was constructed with a parapet wall on the inside but a railing on the outside. This railing is a crash-tested item and there is no expected safety benefit from performing the costly replacement of this railing with a solid parapet.

8.2.4 Emergency Turnouts

The FHWA *Guide for Planning, Evaluating, and Designing Part-Time Shoulder Use as a Traffic Management Strategy* (February 2016) recommends that providing emergency turnouts for disabled vehicles beyond the shoulder is highly desirable with part-time shoulder use. Further, it recommends that emergency turnouts be constructed desirably at half-mile intervals. The location of the 0.7-mile long James River Bridge in the middle of the study corridor prevents the addition of turnouts at precise half-mile intervals without cost-prohibitive bridge widening; therefore, emergency turnouts are proposed to be located just north and south of the bridge in both northbound and southbound directions.

The turnouts south of the bridge will be approximately 0.5 miles north of the Route 711 interchange, and the turnouts north of the bridge will be approximately 1 mile south of the Route 6 interchange. Turnouts are proposed to be 16 feet wide (as recommended by FHWA) and 300 feet long to enable a tow truck to park and load a broken-down vehicle. The FHWA guide does not provide a recommendation for the taper to and from the turnout, so the VDOT standard shoulder taper was utilized in this study (one-third of the width multiplied by the speed at 55mph, which equals 300 feet).

8.2.5 Intelligent Transportation System Components

Several Intelligent Transportation System (ITS) components will be added with the implementation of HSR lanes. Lane control signage will be used to communicate to drivers whether the HSR lane is open or closed. FHWA recommends lane control signage be placed no more than one-half mile apart and that as vehicles traverse the corridor the subsequent sign be visible from the previous. This report has considered that lane control signs be placed at one-quarter mile increments for visibility consistency, similar to other lane control gantry spacing throughout the Commonwealth.

Because the existing James River bridge is 0.7 miles long, the one-quarter mile sign spacing would require two to three lane control signs to be placed on the bridge. Since adding the lane control signs to the existing bridge structure is complex and costly, it was assumed that only two lane-control signs will be added to the bridge. The adjacent signs off the bridge will be spaced accordingly. The VDOT Structure and Bridge Division analysis of the existing bridge structure and its load capacity, included in **Appendix I**, concluded that the existing bridge structure can adequately support the addition of these lane control signs.

The lane control signs are proposed to show either a red "X" if the HSR lane is closed or a green arrow if the HSR lane is open. An example of the lane control gantry and sign is included in **Figure 50**. Additionally, it is recommended to include variable speed limit signs on every other lane control sign gantry. This project does not propose to implement congestion-based dynamic speed limits, but rather have the speed limit change statically based on whether the HSR lane is open or closed. These signs will display either a 65-mph speed limit when the HSR lane is closed or a 55-mph speed limit when the HSR lane is open. The speed limit would apply to all lanes of traffic.

Figure 50: Example of Lane Control Gantry

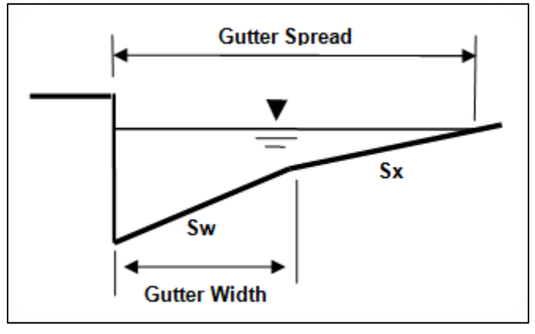
The HSR lane will be more prone to flooding during heavy rainfall events than the general travel lanes when guardrail is present. Additional details about flooding of the HSR lane are provided in **Section 8.2.6** (Spread) It is recommended that the HSR lane be closed during heavy rainfall events so that vehicles are not in the lane during intense rain events. The details of this system have yet to be determined, but at a minimum it would require video cameras to be installed on the corridor so that conditions could be monitored from a remote traffic operations center (TOC). The TOC should also have up to date weather information to be aware of heavy rainfall events in the area. A TOC operator can remotely close the HSR lane when necessary.

There are additional ITS components proposed to be added in the Route 288 corridor with this project. The *I-95 South Smart Technology Corridor Planning Study* (VDOT 2014) recommended that various components of ITS infrastructure be added to Route 288 that includes fiber communication lines, CCTV cameras, and DMS (dynamic message signs), many of which are located within the Route 288 study area. Since this project will require the installation of the communications infrastructure (fiber communication lines) along the project corridor to enable the use of the HSR lane control and dynamic speed limit signs, it would be cost effective to install the additional ITS components recommended by VDOT with this project. The overlapping components include four CCTV cameras and the fiber communication lines. One DMS in each direction is included as part of the respective preferred HSR concept. Other DMS that were not within the HSR project limits were not included in the preferred concepts. This report is attached in **Appendix I**.

8.2.6 Spread

Spread is defined as the distance ponded water extends out from the curb onto the roadway surface. A diagram of spread is shown in **Figure 51**. Spread is only a design concern when stormwater runoff from the roadway cannot flow freely off the shoulder down the ditch foreslope, as is the case on the James River Bridge and in the locations where there is adjacent guardrail with curb beneath. Spread becomes a concern in these areas while the HSR lane is in operation, since the shoulder is often designed to flood during heavy rainfall events.

Figure 51: Illustration of Gutter Spread



The existing spread was calculated using the current VDOT Drainage Manual criteria based on the following conditions:

- Design storm intensity: 10-year intensity
- Maximum allowable spread (for general travel lanes): shoulder width
- Inlet spacing: 945 feet (actual)
- Longitudinal roadway slope: actual minimum (0.5% south of the James River Bridge in Powhatan County)
- Time of concentration: 5 minutes

Based on the design criteria above, a 6.62 in/hr storm intensity yields a maximum spread of 14.1 feet. The width of the shoulder adjacent to guardrail was designed as 3.3 meters (10.8 feet), therefore the actual spread in this existing condition floods the entire shoulder. This is an issue when running traffic on the shoulder during HSR lane operations. Spread north of the bridge is not as wide as the longitudinal grade is steeper than 0.5%.

The spread on the James River Bridge is not as severe as it is just south of the bridge. There are existing curb drains on the bridge spaced approximately every 33 feet. Based on the frequency of these curb drains and utilizing the slightly higher Goochland County intensity of 6.77 in/hr in the 10-year, 5-minute duration storm, the existing spread on the bridge is only 4.1 feet.

VDOT practice is to design new shoulder-lane facilities for a maximum spread of 3 feet using the actual 10-year intensity. VDOT does not currently require spread to be addressed on projects planning to repurpose an existing shoulder (such as this project). Retrofitting the existing drainage system on Route 288 to reduce the spread to 3 feet would be costly and require new inlets to be installed as frequent as every 25 feet. Therefore, it is not recommended to alter the storm drainage system for this project.

However, given the spread issue at locations where guardrail is present, it is recommended that Route 288 HSR lanes be closed to traffic in heavy rainfall events. See **Section 8.2.5** (Intelligent Transportation System Components) for more information on design considerations for how to close the HSR lane during heavy rainfall events.

8.2.7 Stormwater Management

Stormwater management requirements must be considered for any project that is considered a land disturbing activity. VDOT IIM-LD-195.9 states that removal and replacement of an existing pavement structure within the same footprint that does not expose the subgrade (i.e., soil) is not considered a land disturbing activity. Therefore, in the context of this project, the addition of emergency turnouts (constructed by widening Route 288) and the 3 feet of inside widening to achieve the desired typical section are considered land disturbance and must comply with stormwater management requirements for both water quality and water quantity.

Water quality can be most cost-effectively achieved through the purchase of nutrient credits. The inside widening of about 3 feet on both sides of Route 288 will require about 4 pounds of credits, the emergency pullouts will require about 0.8 pounds of credits each, and the potential widening of Route 288 under the Route 6 bridge over Route 288 will require about 1.2 pounds of credits. Therefore, both northbound and southbound projects combined likely won't require more than 8.5 pounds of nutrient credits to satisfy water quality requirements. Per VDOT IIM-LD-251.4, if the post-construction phosphorus water quality reduction requirement for the project is less than 10 pounds, then the purchase of nutrient credits is an acceptable treatment method.

Water quantity requirements can largely be met by outfalling directly to the James River. The contributing drainage area for this project would be considerably less than 1% of the total drainage area to the James River at this location. However, there are several existing Best Management Practices (BMPs) in the project area that were included with the initial construction of Route 288. Changes in the impervious area draining to any BMPs would require each to be analyzed and potentially re-designed.

9 Project Advancement

This Study should be used as a planning tool to achieve the next steps of planning, programming, designing, and constructing the identified safety and operational improvements in the study corridor. To build upon the efforts of this Study, the Study Work Group and other stakeholders should continue to coordinate as further developments are made along the Route 288 corridor and reevaluate the proposed projects from this Study as necessary. To advance these projects beyond the planning stage, members of the SWG should take the following steps:

9.1 Prepare Projects for Advancement

Outreach meetings should be conducted for further vetting of the proposed projects, as needed. These outreach meetings should include additional stakeholders that were not in the SWG. Other stakeholders may include business owners on the corridor and area residents.

Improvement projects should be prioritized on a local and regional level. Prior to submitting funding applications, applicant must have one of the following:

1. Inclusion or proven consistency with the Constrained Long-Range Transportation Plan (CLRP)
2. Resolution of support from governing body

9.2 Study Recommendations

The identified safety and operation improvement projects recommended for advancement by this study include:

- Northbound Route 288 hard shoulder running lane from Route 711 to Route 6
- Southbound Route 288 hard shoulder running lane from West Creek Parkway to Route 711
- Southbound Route 288 full-width auxiliary lane from US 250 to Tuckahoe Creek Parkway

9.3 Potential Additional Improvements

Additional traffic operations issues were identified in the study but were not addressed by the recommended projects. The following intersections and segments should be explored in more detail by future studies:

- Capital One Drive at Route 288 ramps (Roundabout)
- West Creek Parkway at Broad Branch Road
- Route 6 at West Creek Parkway
- Southbound Route 288 mainline south of Route 711

9.4 Apply for Funding

The following funding sources should be considered for improvement projects identified in this Study.

9.4.1 SMART SCALE

SMART SCALE allocates funding from the construction District Grants Program (DGP) and High-Priority Projects Program (HPPP) to transportation projects based on a scoring prioritization process. The scoring process evaluates, scores, and ranks projects based on congestion mitigation, economic development, accessibility, safety, environmental quality, and land use factors. For projects in the Richmond District, the scoring factors with the highest weight are accessibility (25%), followed by economic development (20%), safety (20%), and congestion mitigation (15%). All three recommendations from this study were submitted as FY20 SMART SCALE applications:

- Northbound Route 288 hard shoulder running lane from Route 711 to Route 6
- Southbound Route 288 hard shoulder running lane from West Creek Parkway to Route 711

9.4.2 Revenue Sharing

Revenue sharing is a program that provides a dollar for dollar state match to local funds for transportation projects. Projects eligible for Revenue Sharing funds include construction, reconstruction, improvement, and maintenance projects. The proposed Route 288 improvement projects are candidate projects for Revenue Sharing.

9.4.3 Congestion Mitigation and Air Quality

Congestion Mitigation and Air Quality (CMAQ) allocates funding to surface transportation projects that improve air quality by reducing congestion. The proposed Route 288 improvement projects are candidate projects for CMAQ funding.

9.4.4 Highway Safety Improvement Program

The Highway Safety Improvement Program (HSIP) provides funding improvements that improve safety on a section of roadway or intersection with a high incidence of crashes. The proposed Route 288 improvement projects are candidate projects for HSIP funding.