DRAFT

ROUTE 11 (VALLEY PIKE/VALLEY AVENUE) CORRIDOR STUDY FINAL DRAFT REPORT

From Battle Park Drive to Renaissance Drive

STARS VDOT

Route 11 (Valley Pike / Valley Avenue) Corridor Study

From Battle Park Drive to Renaissance Drive

Existing Conditions and Future Volumes Report

August 6, 2018 | Final Draft

Prepared for

VDOT Virginia Department of Transportation

Prepared by

WSP USA
277 Bendix Road, Suite 300
Virginia Beach, VA 23452

Table of Contents

Figures

Tables

1 INTRODUCTION

1.1 Background

The Virginia Department of Transportation Staunton District Office (VDOT), VDOT Transportation Mobility and Planning Division (TMPD), Frederick County, City of Winchester, and WinFred Metropolitan Planning Organization (MPO) identified the need to evaluate existing and future conditions for the Route 11 (Valley Pike / Valley Avenue) corridor. This STARS corridor study focuses on evaluating the Route 11 corridor from Battle Park Drive to Renaissance Drive in terms of both congestion and safety, assessing measures to reduce congestion, and recommending potential improvements to address the identified congestion and safety issues.

Route 11 is a north- south primary state highway in Virginia that extends from Salem, VA and continues north to Harrisburg, PA as Pennsylvania Route 11. It parallels Interstate 81 and can serve as an alternate route to the interstate. Route 11 (Valley Pike) in Frederick County varies from a three to seven lane road and Route 11 (Valley Avenue) in the City of Winchester varies from a four to five lane road. Both serve as a critical road segments for the region's economic development growth, and are commuter routes that serve a number of businesses and local traffic in Frederick County and the City of Winchester.

The section in the study area is considered mostly developed and caters to numerous retail businesses, professional centers, residential complexes, auto retail and service centers, restaurants and industrial developments. The current (year 2017) daily traffic volume along this corridor is 14,300 vehicles per day north of Creekside Station and 9,800 vehicles per day south of Renaissance Drive. AADT data posted on VDOT's website shows a daily volume of 17,000 vpd between Route 37 and Winchester City limits in 2016.

1.2 Purpose of Study

The primary goal of this study is to determine and assess measures to reduce congestion and improve safety, recommend possible adjustments to signal phasing, roadway geometry, and/or spot improvements to alleviate congestion and address safety as well as access management issues.

The ***operational*** issues intended to be addressed by this study include existing and future projected congestion within the corridor. This corridor experiences a significant amount of truck traffic due to the industrial type land uses along the corridor. Reduction in intersection delays would mitigate congestion, improve mobility and reduce travel time.

This study also intends to address existing and future ***safety*** concerns within the study corridor.

Route 11 (Valley Pike / Valley Avenue) serves a mix of industrial, commercial, retail and residential uses. This study also intends to address ***access*** deficiencies within the limits of the study corridor by identifying and documenting driveway locations and their spacing, with the objective of recommending access management improvements in the context of the current *VDOT Access Management Standards for Entrances and Intersections.*

1.3 Study Work Group

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

- VDOT Staunton District Office and TMPD
- WinFred MPO
- Frederick County
- City of Winchester
- WSP Team

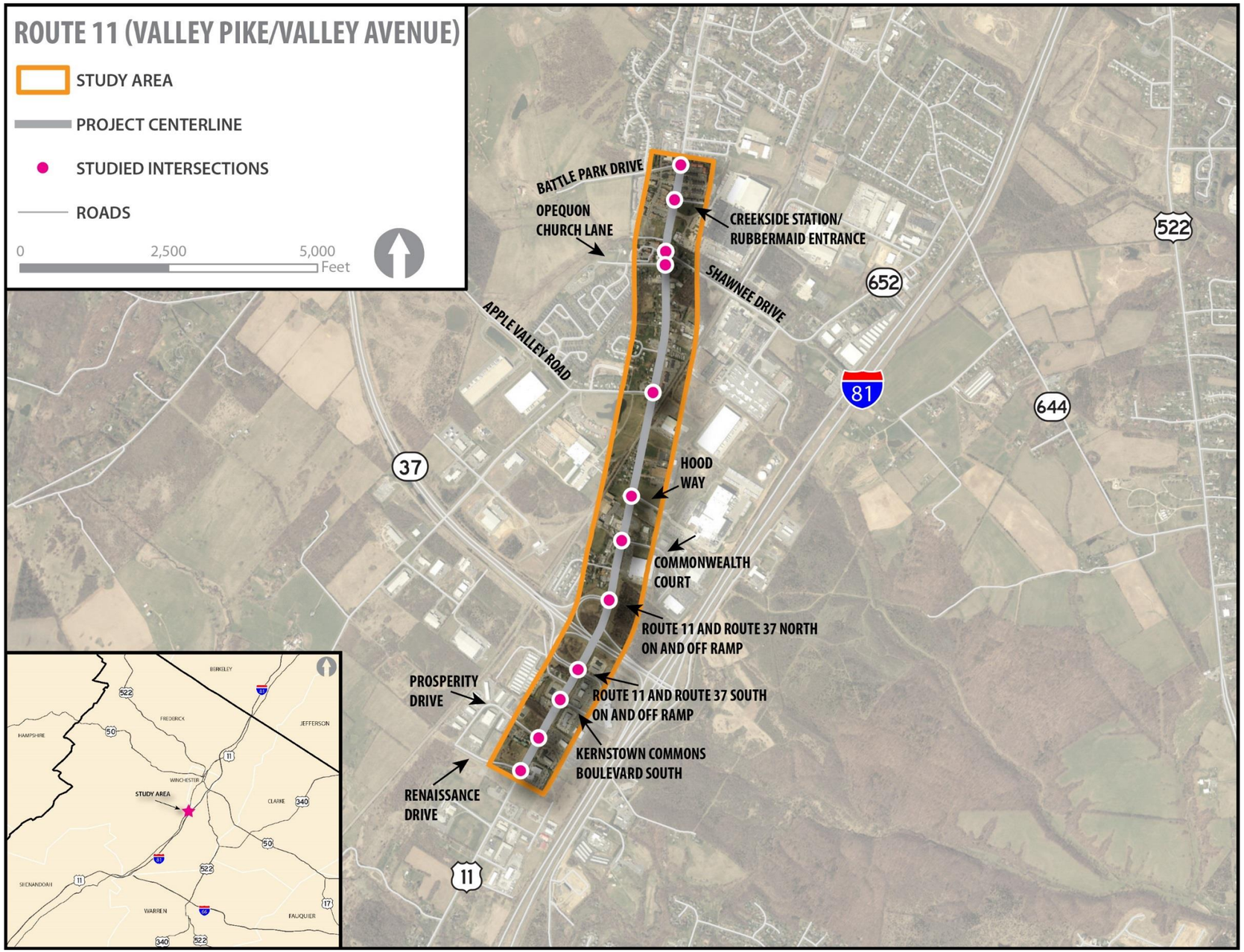
1.4 Study Area

Route 11 (Valley Pike / Valley Avenue) is in the City of Winchester within Frederick County, Virginia. The study area is approximately 1.9 miles in length and includes twelve (12) study intersections. These study intersections are listed below and shown in **Figure 1**.

Study Area Intersections

1. Route 11 and Battle Park Drive
2. Route 11 and Rubbermaid Entrance / Creekside Station
3. Route 11 and Shawnee Drive / Creekside Lane
4. Route 11 and Opequon Church Lane
5. Route 11 and Apple Valley Road
6. Route 11 and Hood Way
7. Route 11 and Commonwealth Court
8. Route 11 and 37 N (WB) On and Off Ramp
9. Route 11 and Route 37 S (EB) On and Off Ramp / Kernstown Commons Boulevard
10. Route 11 and Kernstown Commons Boulevard South
11. Route 11 and Prosperity Drive
12. Route 11 and Renaissance Drive

Figure 1. Study Area Map



2 EXISTING CONDITIONS

2.1 Existing Land Use

Land use in the immediate vicinity of the study corridor between Battle Park Drive to Renaissance Drive consists primarily of commercial properties, retail stores, industrial uses, office/business/commerce centers, and residential properties. These parcels generate a mixture of passenger vehicles, heavy machinery, and tractor trailers.

2.2 Existing Roadway Network

An inventory of the existing roadway condition was prepared along Route 11 based on field reviews. Traffic, crash and Geographic Information System (GIS) data was used to document existing conditions. During the field review, following data was collected and documented:

Digital photographs, videos, and observation to capture:

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

The study corridor includes seven (7) signalized and five (5) unsignalized intersections as discussed in **Sections 2.2.1** through **2.2.13** below:

2.2.1 Route 11 (Valley Pike / Valley Avenue Corridor

Route 11 between Battle Park Drive to Renaissance Drive is classified as Other Principal Arterial per *VDOT Functional Classification* and a Minor Arterial south of Route 37. To the north of Route 37 N (northwestbound) ramps, Route 11 (Valley Pike) has a single thru lane in each direction along with a middle two-way left turn lane. After entering the City and to the south of Route 37, Route 11 consists of two thru lanes. Generally, exclusive turn lanes are present along both directions of Route 11 intersections. Route 11 (Valley Pike) crosses CSX railway tracks approximately 500 feet to the south of Apple Valley Road. Vehicular traffic on Route 11 is controlled by the Grade Crossing signs, pavement markings and automatic gates when railroad tracks are in use. The following posted speed limits are noted within the study corridor:

- Approx. 200 feet to the south of CSX railway tracks to north of project limit: 35 miles per hour
- Approx. 200 feet to the south of CSX railway tracks to south project limit: 45 miles per hour

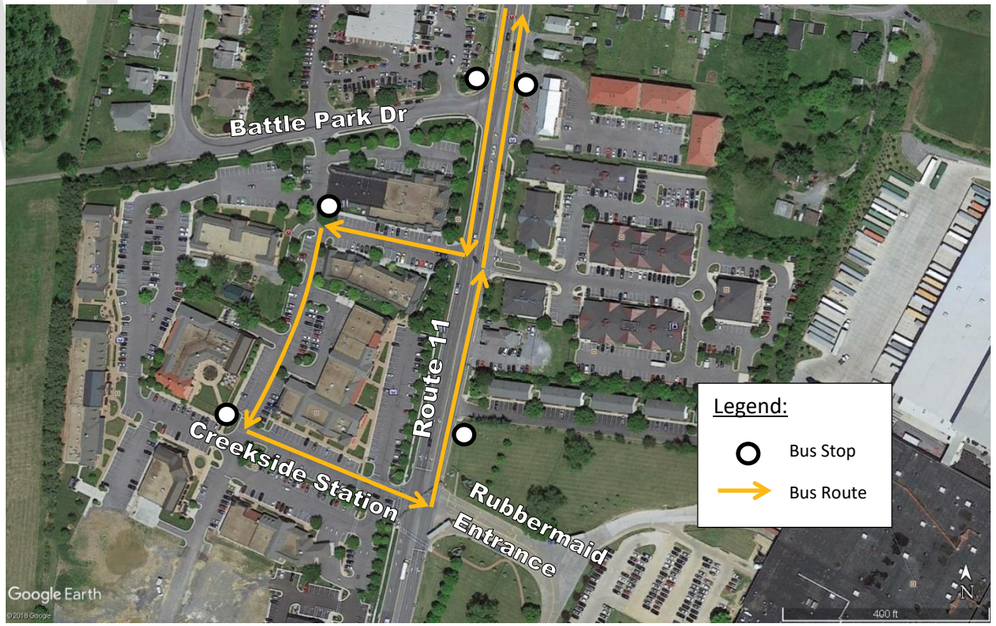
There is a high percentage of truck traffic along the corridor, with AM peak Route 11 through truck percentages around 6 – 15 % and PM peak Route 11 through truck percentages around 3 – 4 %. There are heavy truck movements to and from the Rubbermaid factory, Apple Valley Road, Hood Way, and Route 37.

Pedestrian facilities such as sidewalks, multi-use paths, crosswalks, pedestrian crossing signals with ADA ramps and pedestrian push buttons are intermittent and disjointed along the study corridor. Sidewalks or multi-use paths are located outside of the Creekside Station development, as well as the retail development near Apple Valley Road, near Kernstown Commons Shopping Center, and near Renaissance Dr. There is no connectivity between the sidewalks or multi-use paths. The only east-west crosswalk across Route 11 in the study area is located at the Creekside Station / Rubbermaid Entrance.

Although there is no designated bike lane, there are segments of the roadway that are striped approximately two feet from the gutter pan or from the edge of pavement in which bicycles could potentially ride. However, there are sections of roadway that do not include this striped additional pavement. There are intermittent “Share the Road” signs along the corridor in locations that do not have additional pavement for bicyclists.

The Winchester Public Transit System (WinTran) ‘Valley Avenue’ route operates along Valley Avenue in the study area. The Valley Avenue Route begins north of the study area in Old Town Winchester and ends within Creekside Station, with intermediate stops within the study area at Battle Park Drive. The route and stops that are located within the study area are shown in **Figure 2**. The ‘Valley Avenue’ transit route, schedule, and passenger data are included in the **Appendix.** WinTran does not have immediate plans to extend the bus service south of the Rubbermaid Entrance into Frederick County.

Figure 2. Winchester Transit 'Valley Avenue' Route and Bus Stop Locations



2.2.2 Intersection 1: Route 11 at Battle Park Drive

The intersection of Route 11 at Battle Park Drive is a 3-leg unsignalized intersection. The northbound and southbound approaches of the mainline are free-flow. There are no posted speed limit signs along Battle Park Drive. The northbound approach of Route 11 has one left-turn lane, two through lanes. The southbound approach has one through lane and one shared thru-right lane. The eastbound approach of Battle Park Drive has one shared left-right lane. There is a small apartment complex on the east side of the intersection with entrances just to the north and south of the Battle Park Drive intersection. Limited pedestrian facilities, which include concrete sidewalks on the west side of Route 11 and the south side of Battle Park Drive. There are two WinTran bus stops for the 'Valley Avenue' transit route at this intersection. **Figure 3** shows an aerial of the intersection.

Figure 3: Route 11 at Battle Park Drive

Source: Google Imagery

2.2.3 Intersection 2: Route 11 at Rubbermaid Entrance / Creekside Station

The intersection of Route 11 at Rubbermaid Entrance / Creekside Station is a 4-leg signalized intersection. The northbound approach of Route 11 has one left turn bay, one through lane and one thru-right lane. The southbound approach has one left-turn lane, one through lane, and one thru-right lane. The eastbound approach of Creekside Station has one left-turn lane and one right-turn lane. The westbound approach of Rubbermaid Entrance has one shared left-thru lane and one right-turn lane. The signal operations include protected/permitted left turns for both approaches on Route 11. Pedestrian facilities (crosswalks, pedestrian signals, sidewalks) are provided along the west side of the roadway and across the south and west approaches. **Figure 4** shows an aerial of the intersection.

Figure 4: Route 11 at Rubbermaid Entrance Creekside Station

Source: Google Imagery

2.2.4 Intersection 3: Route 11 at Shawnee Drive / Creekside Lane

The intersection of Route 11 at Shawnee Drive / Creekside Lane is a 4-leg signalized intersection. Shawnee Drive is classified as Major Collector per *VDOT Functional Classification.* The posted speed along Shawnee Drive is 35 miles per hour. The northbound approach of Route 11 has one left-turn lane, one through lane, and one right-turn lane. The southbound approach has one left-turn lane, one through lane, and one right-turn lane. The eastbound approach of Creekside Lane has one left-turn lane and one shared thru-right lane. The westbound approach of Shawnee Drive has one left-turn lane and one shared thru-right lane. The signal operations include protected left turns for northbound and southbound lefts and split phasing operation on eastbound and westbound approaches. No pedestrian facilities (crosswalks, pedestrian signals, sidewalks) are currently present at this intersection. **Figure 5** shows an aerial of the intersection.

Figure 5: Route 11 at Shawnee Drive / Creekside Lane

Source: Google Imagery

2.2.5 Intersection 4: Route 11 at Opequon Church Lane

The intersection of Route 11 at Opequon Church Lane is currently a 3-leg unsignalized T-intersection just south of Shawnee Drive. Northbound and southbound Route 11 are free flow. There are no posted speed limit signs along Opequon Church Lane. The northbound approach of Route 11 has one two way left turn median and two through lanes (the outside through lane transitions to a right turn lane at Shawnee Dr). The southbound approach has one through lane and one shared thru-right lane. The eastbound approach of Opequon Church Lane has one left-turn lane and one right-turn lane. No pedestrian facilities (crosswalks, pedestrian signals, sidewalks) are currently present at this intersection. **Figure 6** shows an aerial of the intersection.

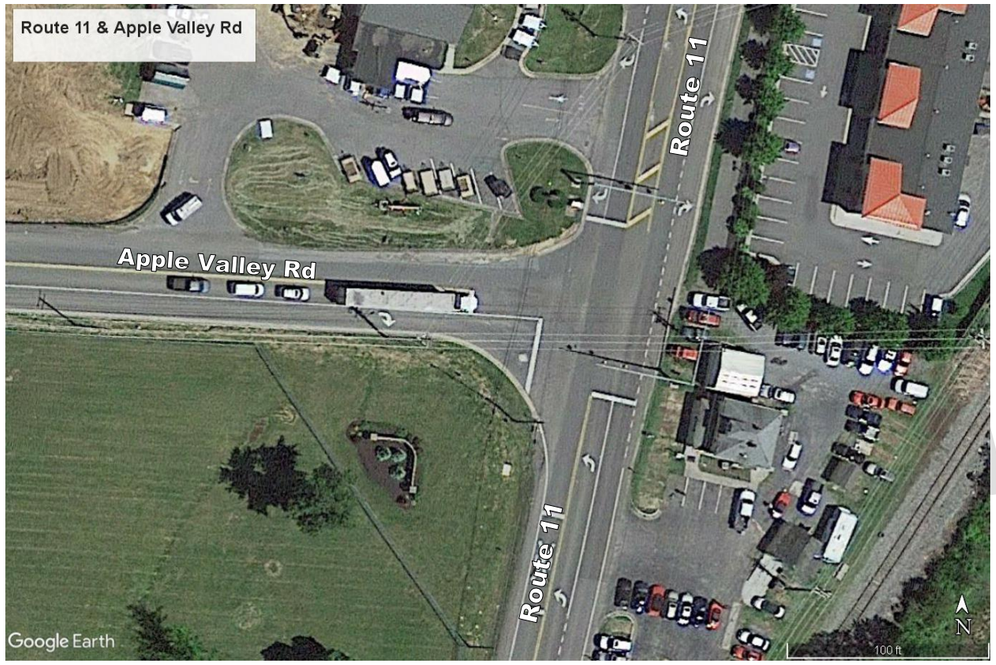
Figure 6: Route 11 at Opequon Church Lane

Source: Google Imagery

2.2.6 Intersection 5: Route 11 at Apple Valley Road

The intersection of Route 11 at Apple Valley Road is currently a 3-leg signalized T-intersection. Apple Valley Road is classified as Major Collector per *VDOT Functional Classification.* The posted speed limit for Apple Valley Road is 35 miles per hour. The northbound approach of Route 11 has one left-turn lane and one thru lane. The southbound approach has one through lane and one right-turn lane. The eastbound approach of Apple Valley Road has one left-turn lane and one right-turn lane. The signal operations include protected/permitted lefts for the northbound approach. Pedestrian facilities (crosswalks, pedestrian signals, sidewalks) are currently not provided at this intersection. **Figure 7** shows an aerial of the intersection.

Figure 7: Route 11 at Apple Valley Road

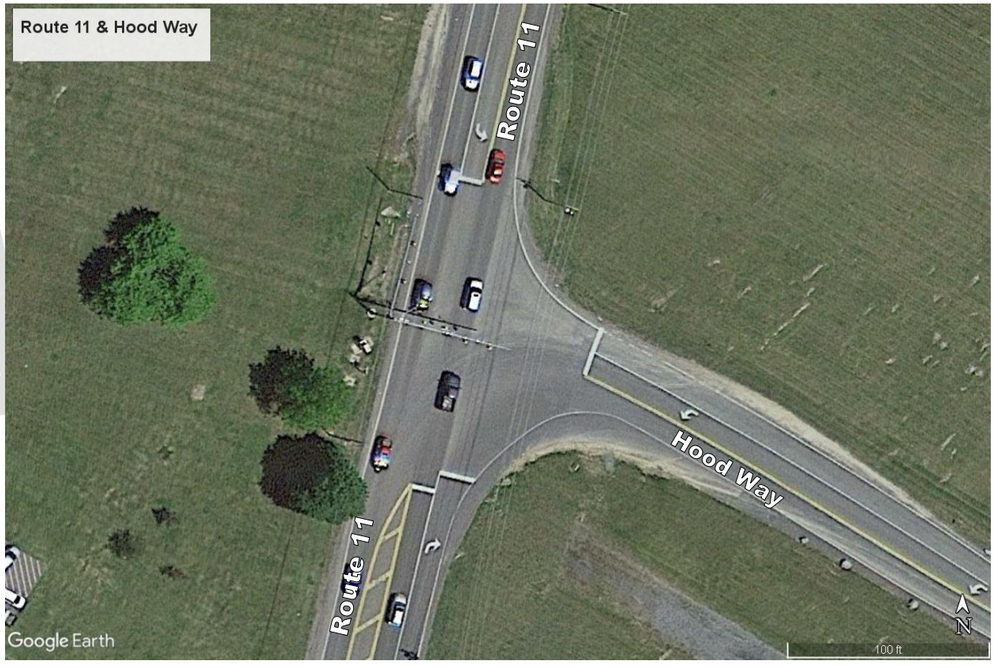


Source: Google Imagery

2.2.7 Intersection 6: Route 11 at Hood Way

The intersection of Route 11 at Hood Way is currently a 3-leg signalized T-intersection. There are no posted speed limit signs along Hood Way. The northbound approach of Route 11 has one through lane and one right-turn lane. The southbound approach has one left-turn lane and one through lane. The westbound approach has one left-turn lane and one right-turn lane. The signal operations include protected/permitted lefts for the southbound approach. Pedestrian facilities (crosswalks, pedestrian signals, sidewalks) not currently provided for this intersection. **Figure 8** shows an aerial of the intersection.

Figure 8: Route 11 at Hood Way



Source: Google Imagery

2.2.8 Intersection 7: Route 11 at Commonwealth Court

The intersection of Route 11 at Commonwealth Court is currently a 4-leg signalized intersection. The posted speed limit for Commonwealth Court is 25 miles per hour. The northbound approach of Route 11 has one left-turn lane, one through lane, and one right-turn lane. The southbound approach has one left-turn lane and one shared thru-right lane. The eastbound approach of the gas station entrance has one shared left-thru-right lane. The westbound approach of Commonwealth Court has one left-turn lane and one shared thru-right lane. The signal operations include protected/permitted lefts for the northbound and southbound lefts and split phasing operation on eastbound and westbound approaches. Pedestrian facilities (crosswalks, pedestrian signals, sidewalks) are currently not provided at this intersection. However, ADA ramps are present in the northeast and southeast corners of the intersection. **Figure 9** shows an aerial of the intersection.

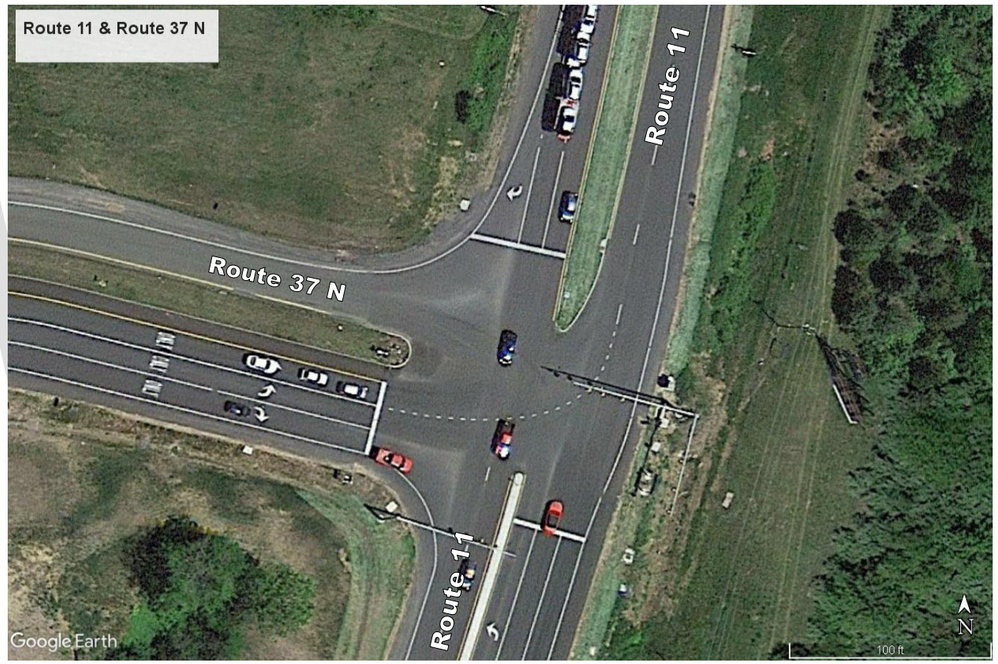
Figure 9: Route 11 at Commonwealth Court

Source: Google Imagery

2.2.9 Intersection 8: Route 11 at Route 37 N (WB) On and Off Ramp

Route 37 N On and Off Ramp is classified as Other Freeway or Expressway per *VDOT Functional Classification.* The intersection of Route 11 at Route 37 N (WB) On and Off Ramp is currently a 3-leg signalized intersection. The posted speed limit for Route 27 N On Ramp is 35 miles per hour and for the Off Ramp is 30 miles per hour. The northbound approach of Route 11 has one left-turn lane and two through lanes. The southbound approach has two through lanes and one right-turn lane. The eastbound approach of Route 37 N On and Off Ramp has two left-turn lanes and one right-turn lane. No pedestrian facilities (crosswalks, pedestrian signals, sidewalks) are currently provided at this intersection. **Figure 10** shows an aerial of the intersection.

Figure 10: Route 11 at Route 37 N (WB) On and Off Ramp

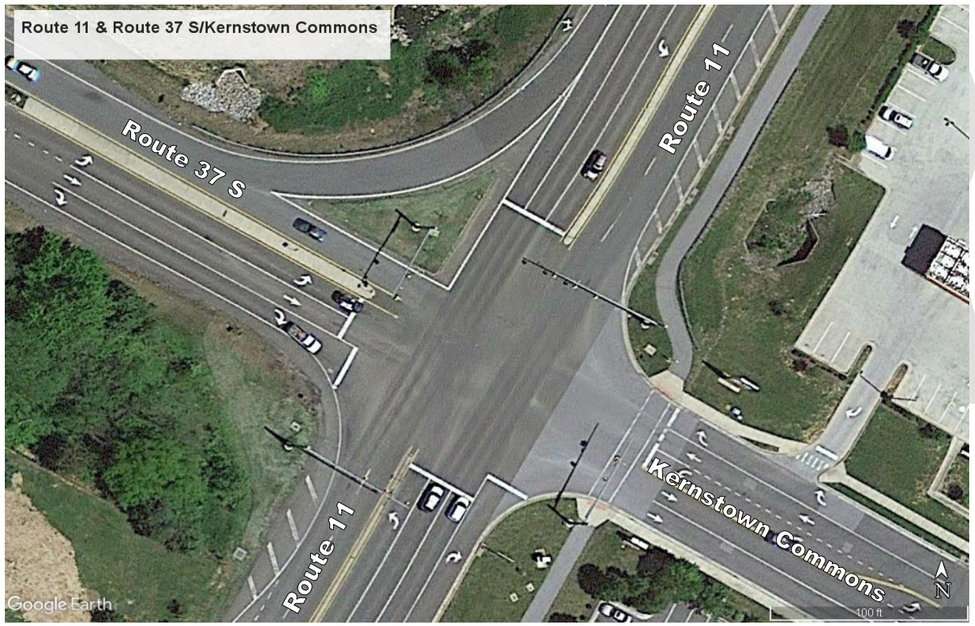


Source: Google Imagery

2.2.10 Intersection 9: Route 11 at Route 37 S (EB) On and Off Ramp / Kernstown Commons Blvd

Route 37 S On and Off Ramp is classified as Other Freeway or Expressway per *VDOT Functional Classification.* The intersection of Route 11 at Route 37 S (EB) On and Off Ramp is currently a 4-leg signalized intersection. The posted speed limit for Route 37 S Off Ramp is 35 miles per hour. The northbound approach of Route 11 has one left-turn lane, two through lanes, and one right-turn lane. The southbound approach has one left-turn lane, two through lanes, and a channelized right-turn lane. The eastbound approach of Route 37 S On and Off Ramp has one left-turn lane, one through lane, and one right-turn lane. The westbound approach has one left-turn lane, one through lane, and one right-turn lane. The signal operations include protected left turn phasing for the northbound and southbound lefts and protected/permitted left turn phasing for the eastbound and westbound lefts. Pedestrian facilities (crosswalks, pedestrian signals, sidewalks) are present on the east leg of the intersection. **Figure 11** shows an aerial of the intersection.

Figure 11: Route 11 at Route 37 S (EB) On and Off Ramp / Kernstown Commons Blvd

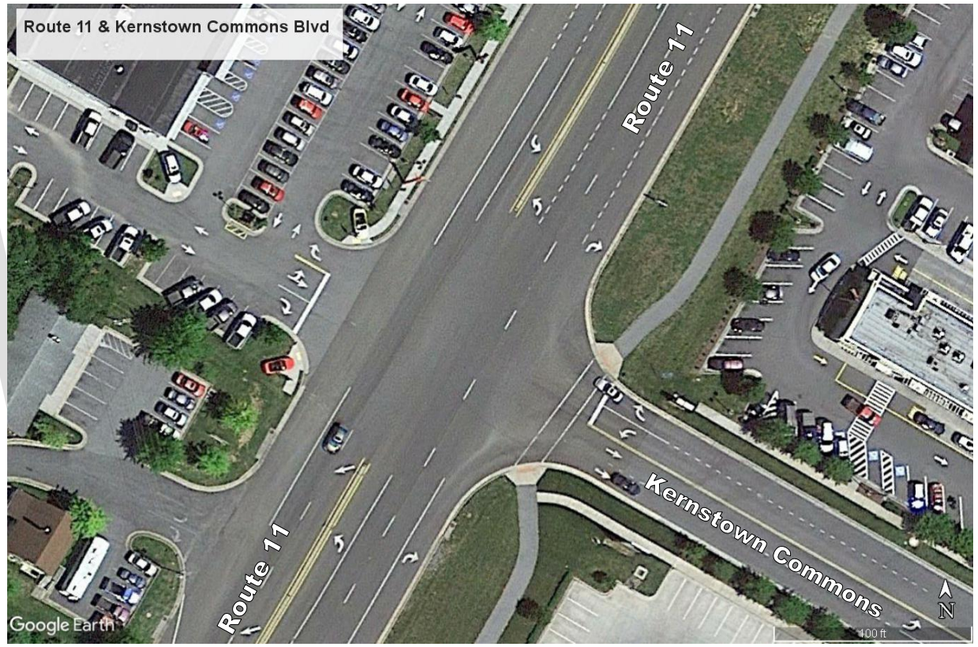


Source: Google Imagery

2.2.11 Intersection 10: Route 11 at Kernstown Commons Blvd South

The intersection of Route 11 at Kernstown Commons Blvd South is currently a 4-leg unsignalized intersection. The northbound and southbound movements are free flow. There are no posted speed limit signs along Kernstown Commons Boulevard South. The northbound approach of Route 11 has one left-turn lane, two through lanes, and one right-turn lane. The southbound approach has one left-turn lane, one through lane, and one shared through-right-turn lane. The eastbound approach has one shared left-thru lane and one right-turn lane. The westbound approach of Kernstown Commons Blvd South has one left-turn lane one right-turn lane. Pedestrian facilities (crosswalk and ADA ramps) are currently present on the east leg of this intersection. An asphalt multiuse path is present on the east side on Route 11 (Valley Pike) and a concrete sidewalk is present on the northwest side on Route 11. **Figure 12** shows an aerial of the intersection.

Figure 12: Route 11 at Kernstown Commons Blvd South



Source: Google Imagery

2.2.12 Intersection 11: Route 11 at Prosperity Drive

The intersection of Route 11 at Prosperity Drive is currently a 4-leg unsignalized intersection. The northbound and southbound approach are free flow. There are no posted speed limit signs along Prosperity Drive. The northbound approach of Route 11 has one left-turn lane, one through lane, and one right-turn lane. The southbound approach has one left-turn lane, one through lane, and one right-turn lane. The eastbound approach of Prosperity Drive has one shared left-thru-right lane. The westbound approach has one shared left-thru lane and one right-turn lane. No pedestrian facilities (crosswalks, pedestrian signals, sidewalks) are currently provided at this intersection. **Figure 13** shows an aerial of the intersection.

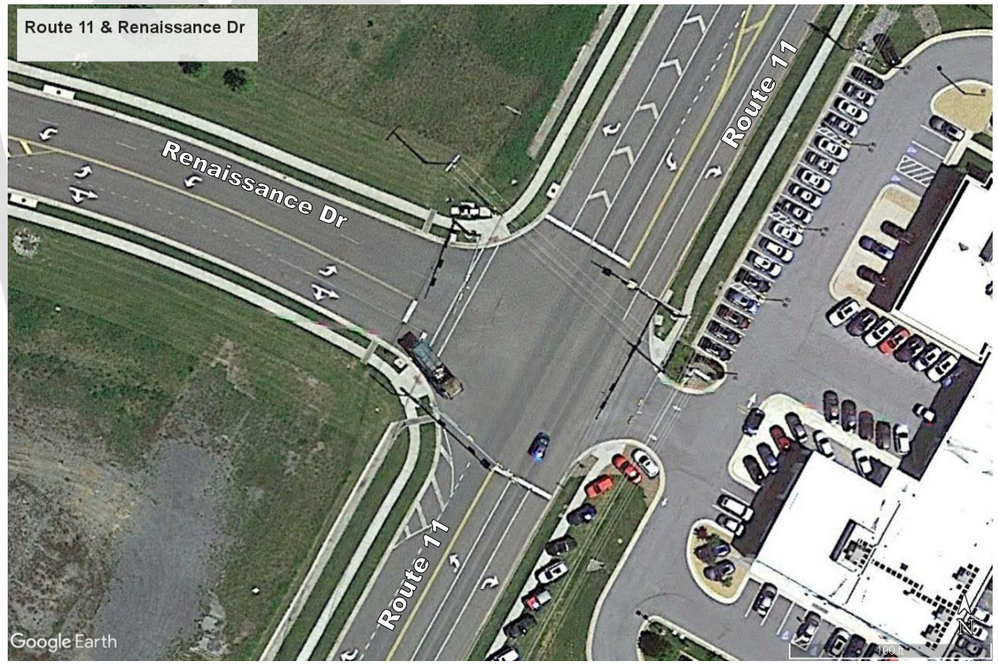
Figure 13: Route 11 at Prosperity Drive

Source: Google Imagery

2.2.13 Intersection 12: Route 11 at Renaissance Drive

The intersection of Route 11 at Renaissance Drive is currently a 4-leg unsignalized intersection, with the entrance to an auto dealership as the fourth leg. The posted speed limit for Renaissance Drive is 25 miles per hour. Based upon aerial photography, a signal is currently being installed at the intersection but at the time the data was collected, the intersection was unsignalized. The northbound approach of Route 11 has one left-turn lane, one through lane, and one right-turn lane. The southbound approach has one left-turn lane, one through lane, and one right-turn lane. The eastbound approach of Renaissance Drive has one left-turn lane and one shared thru-right lane. The westbound approach of the auto dealership has one shared left-thru-right lane. Pedestrian facilities (crosswalks and ADA ramps) are currently present on the east and west legs of this intersection, with sidewalks on both sides of Route 11. The intersection is anticipated to be signalized with pedestrian push buttons and pedestrian signals on the west leg of the intersection. **Figure 14** shows an aerial of the intersection. As indicated on the County's 2035 Comprehensive Plan, Renaissance Drive will be extended to Shady Elm Road to provide east west connection south of Route 37.

Figure 14: Route 11 at Renaissance Drive



Source: Google Imagery

2.3 Traffic Data

2.3.1 2017 Existing Traffic Volumes

Existing traffic volume data along the study corridor was collected in September, 2017 while school was in session:

- 24-hour classification counts were collected on September 12, 2017 at the following locations:
  - Route 11, north of Brookfield Drive / Creekside Station / Rubbermaid Factory Entrance
  - Route 11, south of Renaissance Drive

- AM and PM peak period turning movement counts were collected on September 12th, 2017 from 7:00 am – 9:00 am and 4:30 – 6:30 pm at the following intersections:
  - Route 11 / Battle Park Drive (collected January 10, 2018)
  - Route 11 / Rubbermaid Factory / Creekside Station
  - Route 11 / Opequon/Shawnee Drive
  - Route 11 / Apple Valley Road
  - Route 11 / Hood Way
  - Route 11 / Commonwealth Court
  - Route 11 / Route 37 N (WB) On and Off Ramp
  - Route 11 / Route 37 S (EB) On and Off Ramp / Kernstown Commons Blvd
  - Route 11 / Kernstown Commons Blvd South
  - Route 11 / Prosperity Drive
  - Route 11 / Renaissance Drive
  - Route 11 / Commonwealth Court and Route 37 N (WB) On and Off Ramp (Updated count): After receiving initial comments from VDOT, additional PM peak period turning movement counts were collected at the intersections of Route 11 / Commonwealth Court (February 13, 2018) and Route 11 / Route 37 N (WB) On and Off Ramp (February 15, 2018). Commonwealth Court provides the access to the Sports Complex which is busier during the winter months compared to the month of September. To address the concern, data was collected during PM peak hours from 4:00 pm – 7:00 pm at both locations.

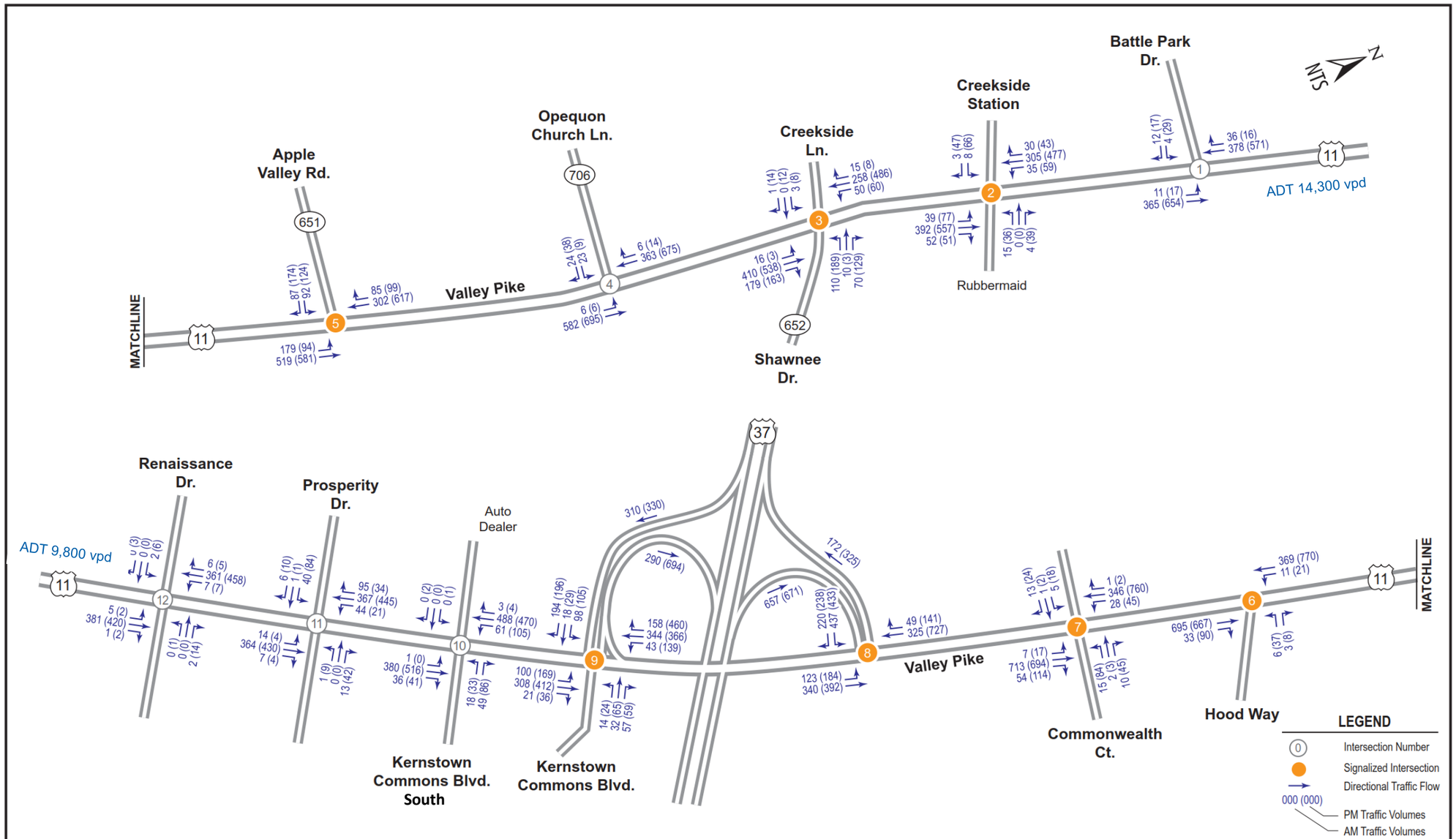
The field counts are enclosed with this report in the **Appendix**. Traffic volumes on Route 11 were updated and rebalanced to include traffic data collected in February 2018. The existing (2017) peak hour volumes and Average Daily Traffic (ADT) volumes are summarized in **Figure 15**.

2.3.2 Additional Data

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

- Travel time runs, to be used in the calibration of the existing network, in the event Simtraffic is used in the analysis rather than Synchro.
- Crash Data from the last five years to perform the crash analysis.
- Signal timing data from Frederick County for input into the Synchro analysis model

Figure 15. Existing (2017) Peak Hour Volumes and Average Daily Traffic



STARS VDOT Virginia Department of Transportation

US ROUTE 11 (WINCHESTER CORRIDOR), City of Winchester, VA

US ROUTE 11 2017 EXISTING PEAK HOUR VOLUMES

FIGURE 15

2.3.3 Existing Access Management

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

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

Highway Functional Classification	Minimum Centerline to Centerline Spacing (Feet)			
	Spacing between Signalized Intersections	Spacing between Unsignalized Intersections and Full/Directional Median Crossovers and Other Intersections or Median Crossovers	Spacing between Full Access Entrances and Other Full Access Entrances, Intersections, or Median Crossovers	Spacing between Partial Access Entrances (one or two-way) and Other Entrances, Intersections, or Median Crossovers
Principal Arterial	1,320	1,050	565	305
Minor Arterial	1,050	660	470	250

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

A total of 87 access points are located within the study corridor of Route 11 corridor from Battle Park Drive to Renaissance Drive. Most of these access points are closely spaced and serve industrial, commercial and retail parcels, with a small percentage serving residential parcels. The access points are spread in clusters throughout the corridor with several private and commercial driveways in close proximity to each other. These access points are shown graphically in **the Appendix** and identified as **AP1** through **AP87**. The spacing of these points was analyzed to assess their compliance with the VDOT minimum spacing standards shown in **Table 1**. **Table 2** below identifies the access points that do not meet the minimum spacing standard; as well as those that are compliant with the spacing standard.

Table 2. Access Point Design Compliance Analysis

Roadway	Number of Access Points	Per VDOT Spacing Guidelines	
		Compliant	Non-Compliant
Route 11	87	0 Total:	87 Total: AP1 through AP87

Note: Refer to the Appendix for graphical presentation of access points.

Along Route 11, the spacing standards are not satisfied for any of the 87 access point locations involving full/partial access driveways, entrances, median crossovers and intersections. The area serves suburban land uses, with significant closely-spaced access points along both sides of the roadway. Application of access management practices would benefit corridor operations by reducing conflict points along the corridor.

3 Traffic Operational Analysis

3.1 Analysis Peak Periods

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

- AM Peak: 7:45 AM – 8:45 AM
- PM Peak: 4:30 PM – 5:30 PM

3.2 Analysis Tools

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

3.3 Measures of Effectiveness

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

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

Level of service (LOS) describes traffic conditions in terms of the amount of traffic congestion at an intersection or on a roadway. LOS ranges from A to F, where LOS A indicates a condition of little or no congestion and LOS F indicates a condition with severe congestion, unstable traffic flow, and stop-and-go conditions. For Frederick County, LOS A through LOS C is considered acceptable, while LOS D through LOS F are considered unacceptable conditions. The Frederick County 2035 Comprehensive Plan identifies a goal to achieve a level of service C or better on area roadways.

As indicated in the *2010 Highway Capacity Manual (HCM)*, LOS at an intersection is based on the average amount of delay (seconds/vehicle) experienced by vehicles approaching the intersection. LOS thresholds for signalized and unsignalized intersections are shown in **Table 3**.

Table 3: HCM Intersection LOS Criteria Based on Average Delay

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

Source: Highway Capacity Manual 2010

3.4 Base Model Development

The Synchro model was developed utilizing the following information:

- The geometry and speed limits of the roadways and intersections as existed in the field during the data collection period, using aerial photography, streetview photography, and field observations
- Balanced peak hour traffic volumes, including truck percentages and overall intersection Peak Hour Factors as identified in the traffic count data
- Signal timing and phasing as provided by Frederick County

3.5 Intersection Operations: 2017 Existing Conditions

Traffic operations analyses were conducted using Synchro to evaluate overall performance of the study intersections within the Route 11 corridor. Operational analyses were performed at each of the study intersections for the Existing 2017 Conditions scenario.

Delay is reported from Synchro using HCM 2010 methodology for all the signalized intersections, while HCM 2000 methodology results were reported for all unsignalized intersections. **Table 4** provides a detailed summary of the average AM and PM peak hour delay and corresponding level of service for each movement for the study intersections along the corridor. **Figure 16** provides a graphical representation of the LOS for each movement as well as overall intersection LOS.

The results show that all intersections are operating at acceptable overall levels of service for both AM and PM peak periods. A few movements operate at LOS E or F through the corridor, notably the NB and SB lefts at the intersection of Route 37 S (EB), as well as the stop-controlled approaches at Kernstown Commons Boulevard South and Prosperity Drive. Moderate delays at LOS D are shown for all left turn movements at the intersection of Route 11 and Shawnee Drive / Creekside Ln, as well as cross-street movements at Apple Valley Rd, Hood Way, and Commonwealth Ct.

Queue length, or the distance to which stopped vehicles accumulate in a lane at an intersection, is another performance measure of intersection operations. Lengthy queues may be indicative of intersection capacity or operational issues, such as absence of or insufficient dedicated turn lanes, inefficient signal timings or phasing. **Table 5** provides a summary of the 95th percentile queue lengths during the AM and PM peak hours as compared to the available storage bay lengths. Based upon the results, the existing storage bay lengths are sufficient length to manage the turning vehicle queues. Synchro output is included in the **Appendix**. The results indicate that some through queues block the left turn bays, notably southbound at Shawnee Dr/Creekside Ln, Apple Valley Rd, Hood Way, and Commonwealth Ct. Additionally, through queues block the left turn bay northbound at Commonwealth Ct.

During field observations, extensive queues were observed on Route 11 between Apple Valley Road and Route 37 N (Westbound) On and Off ramps during both peak hours. Route 11 carries a considerable number of heavy vehicles. The combination of the number of private driveways and slow accelerating heavy vehicles result in frequent stops, queuing, and slower speeds on Route 11. Synchro software does not account for friction caused by an extensive amount of driveways or conflict points. It takes into account the higher percentages of truck traffic for intersection movements, but not the friction created with multiple driveways. Due to Synchro software's limitations, output did not reveal the conflict points and slower speeds, which could result in longer queuing observed in the field. Field observed queuing will be taken into account when developing alternatives for improvement.

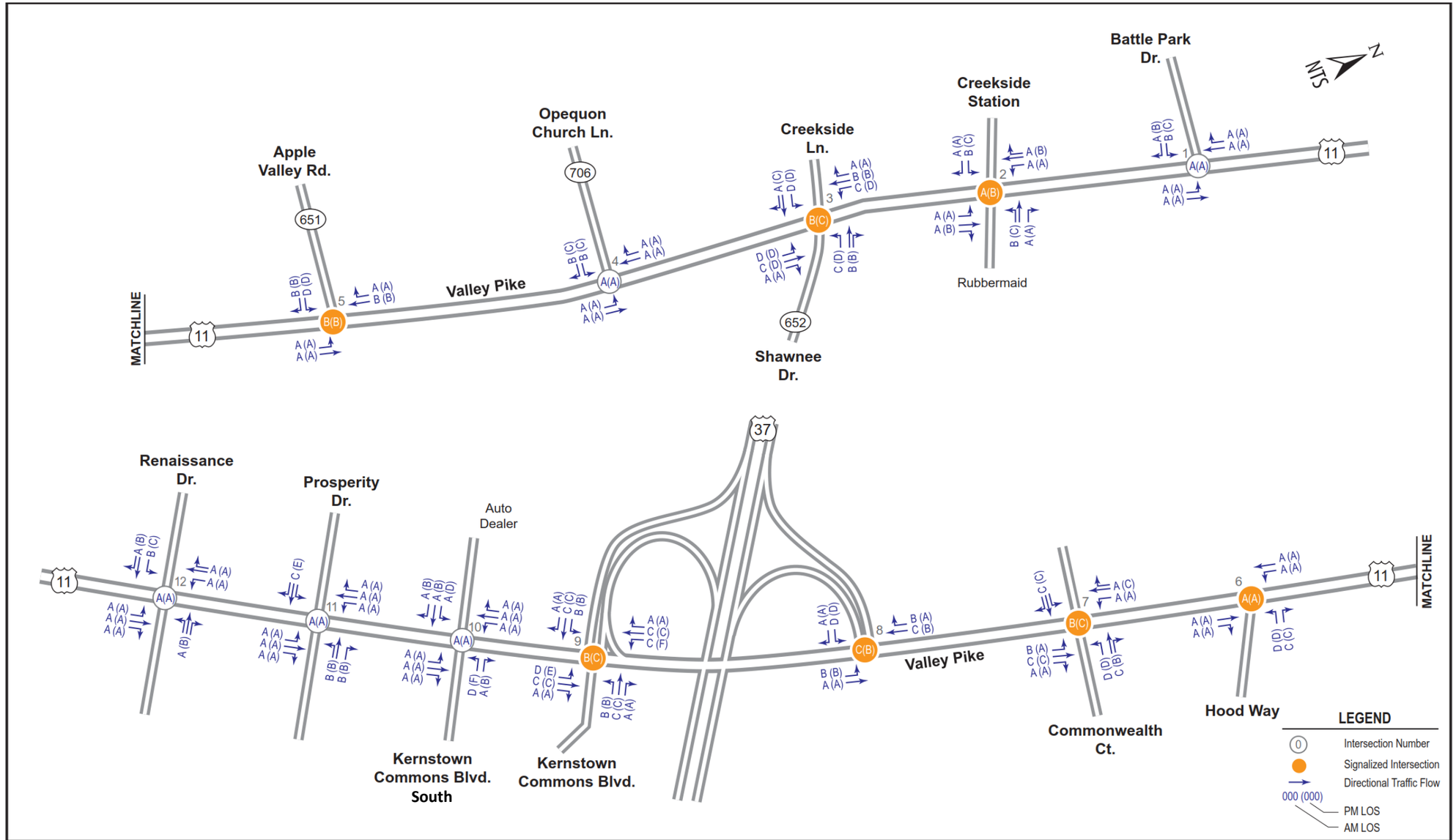
Table 4. Existing (2017) AM and PM Hour Delay and Level of Service (LOS)

Intersection Number and Description	Type of Control	Lane Group	Eastbound				Westbound				Northbound				Southbound				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
1 Route 11 and Battle Park Dr			Battle Park Dr								Route 11				Route 11					
	Two-Way Stop	Left	14.5	B	21.0	C	--	--	--	--	8.3	A	8.9	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	0.3	0.7
		Right	9.9	A	10.5	B	--	--	--	--	--	--	--	--					LOS	LOS
		Approach	11.1	B	17.2	C	--	--	--	--	0.3	A	0.2	A	0.0	A	0.0	A	A	A
2 Route 11 and Rubbermaid Ent/ Creekside Station			Creekside Station				Rubbermaid Entrance				Route 11				Route 11					
	Signal	Left	15.2	B	25.6	C	16.0	B	22.4	C	3.2	A	6.2	A	3.3	A	6.4	A	Delay	Delay
		Through	--	--	--	--					6.4	A	13.0	B	6.3	A	14.5	B	6.3	13.0
		Right	0.0	A	1.2	A	0.0	A	0.7	A									LOS	LOS
		Approach	11.4	B	15.4	B	12.4	B	11.2	B	6.1	A	12.3	B	6.1	A	13.7	B	A	B
3 Route 11 and Shawnee Dr/ Creekside Lane			Creekside Lane				Shawnee Dr				Route 11				Route 11					
	Signal	Left	38.0	D	45.9	D	32.8	C	48.3	D	36.6	D	46.7	D	34.6	C	46.4	D	Delay	Delay
		Through	0.0	A	30.9	C	12.4	B	10.3	B	21.3	C	36.4	D	11.7	B	18.3	B	17.4	27.1
		Right									4.0	A	4.1	A	0.1	A	0.0	A	LOS	LOS
		Approach	28.5	C	34.5	C	24.2	C	32.7	C	16.6	B	29.0	C	14.7	B	21.0	C	B	C
4 Route 11 and Opequon Church Lane			Opequon Church Lane								Route 11				Route 11					
	Two-Way Stop	Left	11.5	B	16.0	C	--	--	--	--	8.5	A	9.7	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	0.6	0.6
		Right	11.5	B	16.0	C	--	--	--	--	--	--	--	--	0.0	A	0.0	A	LOS	LOS
		Approach	11.5	B	16.0	C	--	--	--	--	0.1	A	0.1	A	0.0	A	0.0	A	A	A
5 Route 11 and Apple Valley Rd			Apple Valley Rd								Route 11				Route 11					
	Signal	Left	49.4	D	52.3	D	--	--	--	--	6.3	A	4.5	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	8.2	A	4.9	A	13.3	B	17.4	B	12.1	13.5
		Right	13.0	B	11.5	B	--	--	--	--	--	--	--	--	2.9	A	2.9	A	LOS	LOS
		Approach	31.7	C	28.5	C	--	--	--	--	7.7	A	4.8	A	11.0	B	15.4	B	B	B
6 Route 11 and Hood Way							Hood Way				Route 11				Route 11					
	Signal	Left	--	--	--	--	43.8	D	40.6	D	--	--	--	--	3.3	A	1.6	A	Delay	Delay
		Through	--	--	--	--	--	--	--	--	3.9	A	7.1	A	4.3	A	2.1	A	4.2	5.1
		Right	--	--	--	--	27.7	C	20.4	C	0.0	A	0.6	A	--	--	--	--	LOS	LOS
		Approach	--	--	--	--	38.0	D	37.0	D	3.7	A	6.3	A	4.3	A	2.1	A	A	A
7 Route 11 and Commonwealth Ct			Gas Station				Commonwealth Ct				Route 11				Route 11					
	Signal	Left	30.6	C	30.7	C	46.3	D	45.6	D	10.1	B	7.3	A	3.7	A	8.1	A	Delay	Delay
		Through					26.0	C	14.3	B	26.9	C	23.6	C	6.2	A	20.2	C	19.4	21.1
		Right									1.3	A	0.9	A					LOS	LOS
		Approach	30.6	C	30.7	C	37.1	D	34.2	C	25.0	C	20.1	C	6.0	A	19.5	B	B	C

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

Intersection Number and Description	Type of Control	Lane Group	Eastbound				Westbound				Northbound				Southbound				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
8 Route 11 and Route 37 N (WB) on and off ramp			Route 37 N (WB) on & off ramp								Route 11				Route 11					
	Signal	Left	42.2	D	41.3	D	--	--	--	--	10.2	B	12.1	B	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	9.2	A	8.0	A	26.9	C	12.6	B	22.7	16.3
		Right	6.9	A	7.6	A	--	--	--	--	--	--	--	--	18.2	B	2.3	A	LOS	LOS
		Approach	30.4	C	29.4	C	--	--	--	--	9.4	A	9.3	A	25.7	C	10.9	B	C	B
9 Route 11 and Route 37 S (EB) on and off ramp / Kernstown Commons Blvd			Route 37 S (EB) on & off ramp				Kernstown Commons Blvd				Route 11				Route 11					
	Signal	Left	17.9	B	19.9	B	15.9	B	17.5	B	35.6	D	68.9	E	33.1	C	80.9	F	Delay	Delay
		Through	21.3	C	25.9	C	27.7	C	31.1	C	20.4	C	25.2	C	22.6	C	24.6	C	16.6	23.7
		Right	3.5	A	4.6	A	0.5	A	0.6	A	0.0	A	0.2	A	0.2	A	0.6	A	LOS	LOS
		Approach	9.1	A	11.3	B	11.0	B	16.8	B	23.0	C	35.7	D	16.9	B	21.3	C	B	C
10 Route 11 and Kernstown Commons Blvd South			Auto Dealership				Kernstown Commons Blvd S				Route 11				Route 11					
	Two-Way Stop	Left	0.0	A	32.3	D	28.2	D	54.8	F	8.4	A	0.0	A	8.4	A	9.1	A	Delay	Delay
		Through					--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	1.5	3.0
		Right	0.0	A	11.4	B	9.8	A	10.7	B	0.0	A	0.0	A	0.0	A	0.0	A	LOS	LOS
		Approach	0.0	A	18.4	C	14.7	B	22.9	C	0.0	A	0.0	A	0.9	A	1.7	A	A	A
11 Route 11 and Prosperity Dr			Prosperity Dr				Prosperity Dr				Route 11				Route 11					
	Two-Way Stop	Left	21.3	C	38.9	E	11.0	B	13.6	B	8.3	A	8.7	A	8.2	A	8.4	A	Delay	Delay
		Through									0.0	A	0.0	A	0.0	A	0.0	A	1.7	4.2
		Right					11.0	B	13.6	B	0.0	A	0.0	A	0.0	A	0.0	A	LOS	LOS
		Approach	21.3	C	38.9	E	11.0	B	13.6	B	0.3	A	0.1	A	0.0	A	0.4	A	A	A
12 Route 11 and Renaissance Dr							Renaissance Dr				Route 11				Route 11					
	Two-Way Stop	Left	14.7	B	18.6	C	9.7	A	10.5	B	8.1	A	9.6	A	8.3	A	8.2	A	Delay	Delay
		Through	0.0	A	11.9	B					0.0	A	0.0	A	0.0	A	0.0	A	0.2	0.4
		Right												A	0.0	A	0.0	A	LOS	LOS
		Approach	16.4	C	16.4	C	9.7	A	10.5	B	0.1	A	0.0	A	0.2	A	0.1	A	A	A

Figure 16. Existing (2017) AM (PM) Peak Level of Service



STARS VDOT Virginia Department of Transportation

US ROUTE 11 (WINCHESTER CORRIDOR), City of Winchester, VA

US ROUTE 11 2017 EXISTING PEAK HOUR LEVEL OF SERVICE (LOS)

FIGURE 16

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

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
1 Route 11 and Battle Park Dr			Battle Park Dr						Route 11			Route 11		
	Two-Way Stop	Left	--	1	11	--	--	--	130	1	2	--	--	--
		Through	--	--	--	--	--	--	--	0	0	--	0	0
		Right	--	1	2	--	--	--	--	--	--			
2 Route 11 and Rubbermaid Entrance / Creekside Station			Rubbermaid Entrance			Creekside Station			Route 11			Route 11		
	Signal	Left	--	12	58	--	18	36	170	14	27	150	13	22
		Through	--	--	--				--	94	150	--	72	128
		Right	--	0	2	--	0	0						
3 Route 11 and Shawnee Dr/ and Creekside Lane			Creekside Lane			Shawnee Dr			Route 11			Route 11		
	Signal	Left	--	12	22	--	131	#240	--	34	12	225	73	85
		Through	--	0	37	--	49	55	--	356	#578	--	195	407
		Right							--	43	39	100	0	0
4 Route 11 and Opequon Church Lane			Opequon Church Lane						Route 11			Route 11		
	Two-Way Stop	Left	--	4	10	--	--	--	200	1	1	--	--	--
		Through	--	--	--	--	--	--	--	0	0	--	0	0
		Right	340	4	10	--	--	--	--	--	--	--	0	0
5 Route 11 and Apple Valley Rd			Apple Valley Rd						Route 11			Route 11		
	Signal	Left	--	108	#151	--	--	--	250	23	6	--	--	--
		Through	--	--	--	--	--	--	--	57	98	--	189	358
		Right	500	38	49	--	--	--	--	--	--	150	21	22
6 Route 11 and Hood Way						Hood Way			Route 11			Route 11		
	Signal	Left	--	--	--	--	17	52	--	--	--	170	m11	m2
		Through	--	--	--	--	--	--	--	56	121	--	273	77
		Right	--	--	--	230	10	14	400	m0	m0	--	--	--
7 Route 11 and Commonwealth Ct			Gas Station			Commonwealth Ct			Route 11			Route 11		
	Signal	Left	--	26	45	--	31	94	350	m8	m5	130	2	m18
		Through				--	20	32	--	#685	#736	--	18	#796
		Right							350	6	m0			
8 Route 11 and Route 37 N (WB) on and off ramp			Route 37 N (WB) on and off ramp						Route 11			Route 11		
	Signal	Left	--	184	180	--	--	--	400	69	77	--	--	--
		Through	--	--	--	--	--	--	--	83	74	--	177	156
		Right	--	47	61	--	--	--	--	--	--	80	51	m8
9 Route 11 and Route 37 S (EB) on and off ramp/ Kernstown Commons Blvd			Route 37 S (EB) on and off ramp			Kernstown Commons Blvd N			Route 11			Route 11		
	Signal	Left	--	63	73	115	15	24	--	#103	#211	340	49	#187
		Through	--	24	36	--	36	66	--	97	130	--	107	116
		Right	--	31	36	--	0	0	--	0	0	--	0	0
10 Route 11 and Kernstown Commons Blvd South						Kernstown Commons Blvd S			Route 11			Route 11		
	Two-Way Stop	Left	--	0	1	--	9	32	160	0	0	--	5	10
		Through				--	--	--	--	0	0	--	0	0
		Right	--	0	0	--	5	11	300	0	0	240	0	0
11 Route 11 and Prosperity Dr			Prosperity Dr			Prosperity Dr			Route 11			Route 11		
	Two-Way Stop	Left	--	16	63	--	1	6	225	1	0	175	3	2
		Through							--	0	0	--	0	0
		Right				85	1	6	--	0	0	215	0	0
12 Route 11 and Renaissance Dr						Renaissance Dr			Route 11			Route 11		
	Two-Way Stop	Left	190	0	2	--	0	2	230	0	0	105	1	1
		Through	--	0	0				--	0	0	--	0	0
		Right										265	0	0

NOTES: # Synchro results indicates that 95th % queue may be longer
m Synchro results indicates that volume (and therefore the queue) is metered by upstream signal

3.6 Future Traffic Volumes

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

The annual growth rate was determined using Average Annual Daily Traffic (AADT) volumes from a continuous count station data recorded from 1997 through 2016 by VDOT on Route 11 between the SR-37 N ramp and the south city limits, as shown in **Table 6**.

Table 6. VDOT Historic Traffic Volumes

Year	Roadway Segment/AADT Volume	
	AADT	Type of Count
1997	**15110**	Average of Selected Continuous Count Data
1998	**15673**	Average of Complete Continuous Data
1999	**15735**	Factored Short Term Traffic Count Data
2000	**15801**	Average of Selected Continuous Count Data
2001	**15139**	Average of Complete Continuous Data
2002	**15854**	Average of Complete Continuous Data
2003	**16501**	Average of Complete Continuous Data
2004	**17399**	Average of Selected Continuous Count Data
2005	**17445**	Average of Complete Continuous Data
2006	**17304**	Average of Selected Continuous Count Data
2007	**17219**	Average of Selected Continuous Count Data
2008	**16305**	Average of Complete Continuous Data
2009	**15959**	Average of Complete Continuous Data
2010	**16593**	Average of Complete Continuous Data
2011	**16615**	Average of Complete Continuous Data
2012	**16772**	Average of Complete Continuous Data
2013	**16788**	Average of Complete Continuous Data
2014	**16432**	Average of Complete Continuous Data
2015	**16577**	Average of Complete Continuous Data
2016	**16707**	Average of Complete Continuous Data

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

Linear growth rates were calculated for these segments three time periods:

- Post-recession to present 2010-2016 (0.1% linear growth)
- Recession low point to present 2009-2016 (0.7% linear growth)
- Full dataset 1997-2016 (0.5% linear growth)

The calculated linear historic growth rates show primarily low growth in the study area. Based upon the evaluation, the project team has identified and agreed upon an annual growth rate of 0.5% for this study.

The suggested growth rate of 0.5% per year was applied to the Existing 2017 traffic volumes to generate projected 2030 AM and PM peak hour traffic volumes. These volumes are presented in **Figure 17**.

3.7 Future No Build Background Improvements

Following background development are proposed by the City of Winchester and the Frederick County:

- Convert Left-turn phasing on Route 11 to Dallas protected-permitted phasing,
- Co-ordinate signals at Route 11 and Shawnee Drive/Creekside Lane, and Route 11 and Route 37 S (EB)/Kernstown Commons Boulevard with the adjacent signals,
- Install a GPS Clock at Route 11 and Shawnee Drive/Creekside Lane,
- Restripe northbound lanes to provide two travel lanes on Route 11 between Route 37 N(WB) On/Off Ramp and Fay Street, and
- Construct sidewalk on the east side of Route 11 within the City of Winchester limits (Exhibit is shown in the **Appendix**).

The above improvements are included for the Future 2030 No-Build Condition analysis.

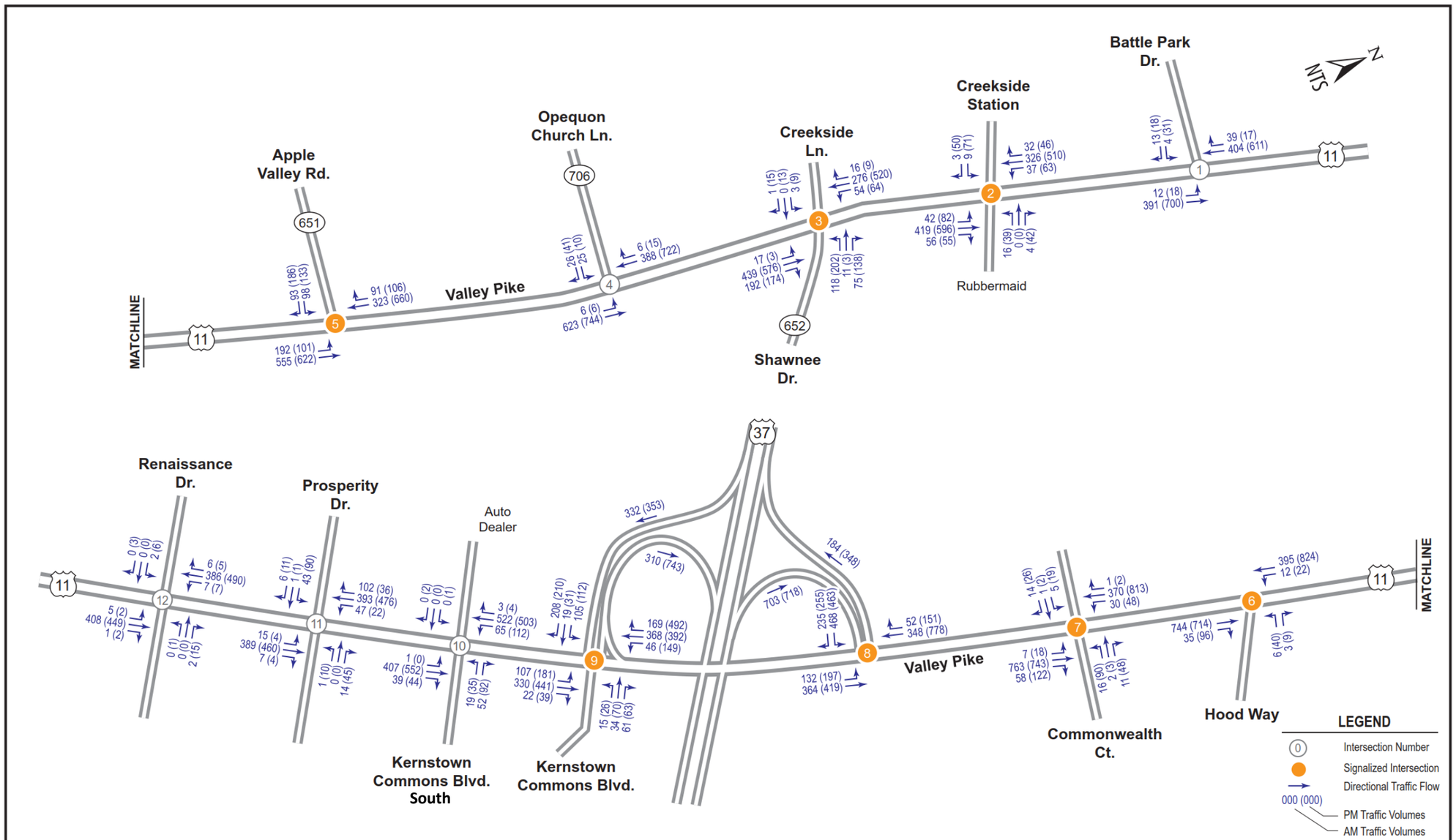
3.8 Intersection Operations: Future 2030 No-Build Conditions

Operational analysis was performed at each of the study intersections for the Future 2030 No-Build Conditions scenario. **Table 7** summarizes the average AM and PM peak hour delay and the level of service for each movement of the study intersections along the Route 11 corridor. **Figure 18** summarizes the overall intersection delay graphically. Synchro outputs are provided in the **Appendix**.

The results in **Table 7** suggest that, under Future 2030 No Build Conditions, all intersections are operating at acceptable overall levels of service for both AM and PM peak periods, and are mostly consistent with the Existing 2017 Conditions. The LOS improves for the northbound approach of Route 11 and Route 37 S (EB)/Kernstown Commons Boulevard after coordinating the signal with the adjacent intersection. A few movements operate at LOS E or F through the corridor, notably the stop-controlled approaches at Kernstown Commons Boulevard South and Prosperity Drive, and the cross-street approaches at signalized intersections at Apple Valley Road, and Shawnee Drive/Creekside Lane. Moderate delays at LOS D are shown for cross-street movements at Shawnee Drive/Creekside Lane, Rubbermaid Entrance, Apple Valley Rd, Hood Way, Commonwealth Ct, and Route 37 North (WB) as well as South (EB) On and Off Ramps.

Queuing analysis was completed for the study intersections during the AM and PM peak hours for 2030 No Build Conditions. *95th percentile* Queue Lengths in feet were reported for each lane. **Table 8** provides a summary of the 95th percentile queue lengths during the AM and PM peak hours as compared to the available storage bay lengths. Based upon the results, the existing storage bay lengths are sufficient to manage the turning vehicle queues. Future 2030 No Build Conditions are consistent with the Existing 2017 Conditions, with the exception of the northbound queues at Commonwealth Court which are reduced significantly due to restriping of Route 11 to provide two northbound lanes. Synchro output is included in the **Appendix**. The results indicate that some through queues block the left turn bays, notably southbound at Shawnee Drive/Creekside Lane, Apple Valley Rd, Hood Way, and Commonwealth Court.

Figure 17. Future (2030) AM (PM) Peak Hour Traffic Volumes



STARS VDOT Virginia Department of Transportation

US ROUTE 11 (WINCHESTER CORRIDOR), City of Winchester, VA

US ROUTE 11 2030 NO BUILD PEAK HOUR VOLUMES

FIGURE 17

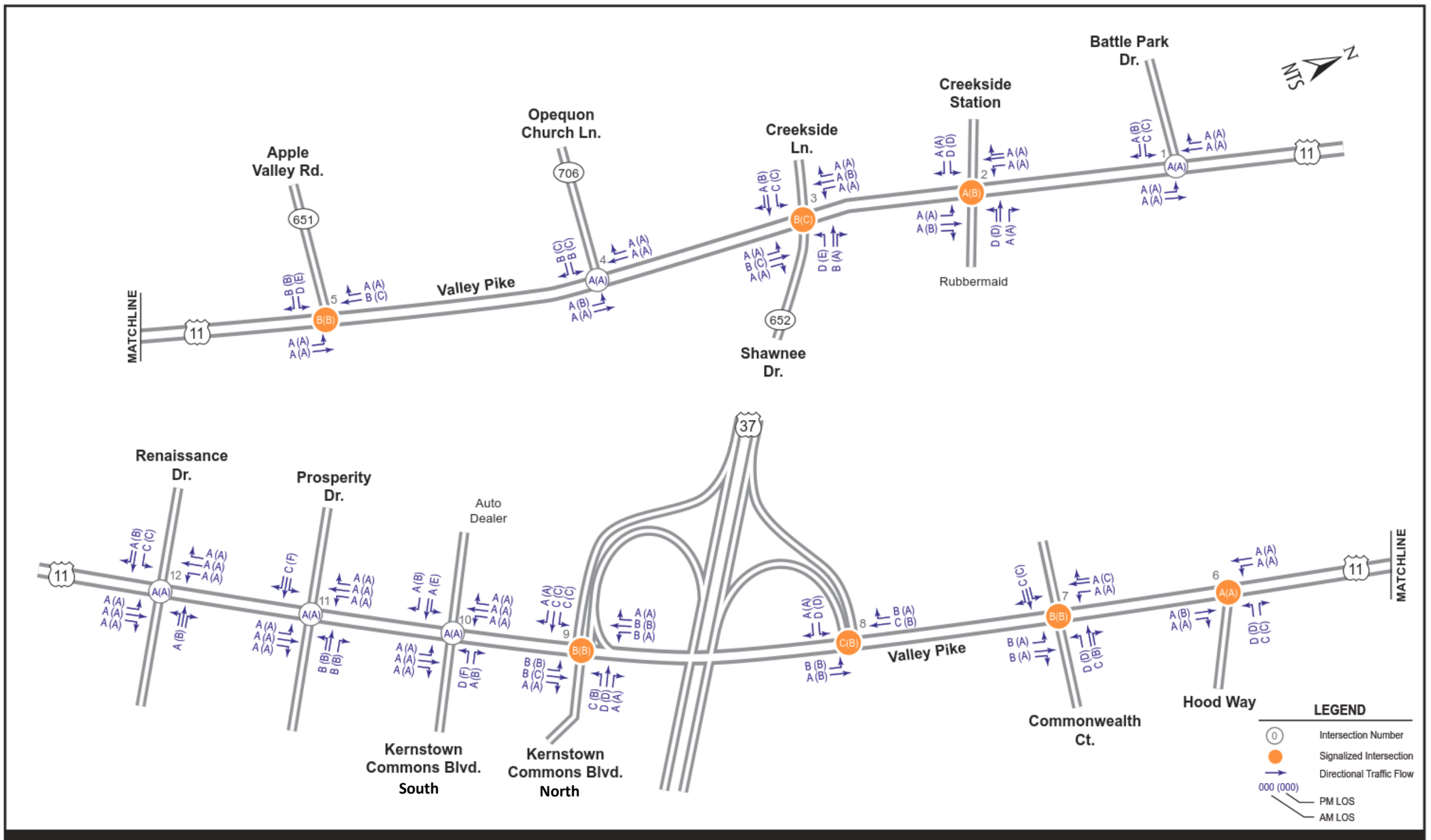
Table 7. Future (2030 No-Build) AM and PM Hour Delay and Level of Service (LOS)

Intersection Number and Description	Type of Control	Lane Group	Eastbound				Westbound				Northbound				Southbound				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
1 Route 11 and Battle Park Dr			Battle Park Dr								Route 11				Route 11					
	Two-Way Stop	Left	15.2	C	24.0	C	--	--	--	--	8.4	A	9.1	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	0.3	0.8
		Right	10.0	A	10.8	B	--	--	--	--	--	--	--	--					LOS	LOS
		Approach	11.3	B	19.0	C	--	--	--	--	0.2	A	0.2	A	0.0	A	0.0	A	A	A
2 Route 11 and Rubbermaid Ent/ Creekside Station			Creekside Station				Rubbermaid Entrance				Route 11				Route 11					
	Signal	Left	42.9	D	46.5	D	48.9	D	37.3	D	3.8	A	7.3	A	2.4	A	5.0	A	Delay	Delay
		Through	--	--	--	--					6.9	A	18.8	B	4.4	A	10.0	A	6.6	15.1
		Right	0.2	A	1.3	A	0.2	A	1.1	A									LOS	LOS
		Approach	30.7	C	27.8	C	38.3	D	18.4	B	6.6	A	17.5	B	4.2	A	9.5	A	A	B
3 Route 11 and Shawnee Dr/ Creekside Lane			Creekside Lane				Shawnee Dr				Route 11				Route 11					
	Signal	Left	32.0	C	29.4	C	54.4	D	60.7	E	5.5	A	9.2	A	3.9	A	6.2	A	Delay	Delay
		Through	0.0	A	18.7	B	12.4	B	8.3	A	11.5	B	20.8	C	7.0	A	14.5	B	12.9	20.3
		Right									3.2	A	4.6	A	1.3	A	0.0	A	LOS	LOS
		Approach	25.6	C	21.3	C	36.7	D	39.1	D	8.9	A	17.0	B	6.2	A	13.4	B	B	C
4 Route 11 and Opequon Church Lane			Opequon Church Lane								Route 11				Route 11					
	Two-Way Stop	Left	11.7	B	16.8	C	--	--	--	--	8.6	A	10.1	B	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	0.6	0.6
		Right	11.7	B	16.8	C	--	--	--	--	--	--	--	--	0.0	A	0.0	A	LOS	LOS
		Approach	11.7	B	16.8	C	--	--	--	--	0.1	A	0.1	A	0.0	A	0.0	A	A	A
5 Route 11 and Apple Valley Rd			Apple Valley Rd								Route 11				Route 11					
	Signal	Left	49.6	D	56.1	E	--	--	--	--	4.2	A	8.7	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	5.4	A	4.7	A	15.7	B	25.8	C	11.5	17.3
		Right	12.7	B	11.8	B	--	--	--	--	--	--	--	--	6.3	A	7.9	A	LOS	LOS
		Approach	31.6	C	30.2	C	--	--	--	--	5.1	A	5.2	A	13.6	B	23.3	C	B	B
6 Route 11 and Hood Way							Hood Way				Route 11				Route 11					
	Signal	Left	--	--	--	--	44.1	D	40.9	D	--	--	--	--	2.1	A	2.1	A	Delay	Delay
		Through	--	--	--	--	--	--	--	--	9.7	A	10.2	B	3.5	A	2.3	A	7.5	6.5
		Right	--	--	--	--	27.7	C	20.2	C	0.1	A	0.2	A	--	--	--	--	LOS	LOS
		Approach	--	--	--	--	38.7	D	37.4	D	9.2	A	9.0	A	3.5	A	2.3	A	A	A
7 Route 11 and Commonwealth Ct			Gas Station				Commonwealth Ct				Route 11				Route 11					
	Signal	Left	30.2	C	31.6	C	46.5	D	46.1	D	12.4	B	5.6	A	1.9	A	8.3	A	Delay	Delay
		Through					25.9	C	14.3	B	20.0	B	7.9	A	1.9	A	24.9	C	14.9	16.2
		Right																	LOS	LOS
		Approach	30.3	C	31.6	C	37.8	D	34.4	C	20.0	B	7.8	A	1.9	A	23.9	C	B	B

Table 7 Contd. Future (2030 No-Build) AM and PM Hour Delay and Level of Service

Intersection Number and Description	Type of Control	Lane Group	Eastbound				Westbound				Northbound				Southbound				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
8 Route 11 and Route 37 N on and off ramp			Route 37 N on & off ramp								Route 11				Route 11					
	Signal	Left	41.9	D	43.4	D	--	--	--	--	12.0	B	18.5	B	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	9.1	A	10.2	B	25.4	C	12.0	B	22.2	17.5
		Right	6.6	A	7.6	A	--	--	--	--	--	--	--	--	13.9	B	2.3	A	LOS	LOS
		Approach	30.0	C	30.7	C	--	--	--	--	9.8	A	12.9	B	23.9	C	10.5	B	C	B
9 Route 11 and Route 37 S on and off ramp / Kernstown Commons Blvd North			Route 37 S on & off ramp				Kernstown Commons Blvd N				Route 11				Route 11					
	Signal	Left	30.4	C	24.6	C	23.5	C	19.5	B	12.9	B	16.7	B	12.6	B	9.7	A	Delay	Delay
		Through	32.5	C	28.6	C	44.0	D	40.6	D	18.9	B	25.7	C	15.1	B	13.4	B	14.2	13.6
		Right	7.3	A	5.4	A	1.1	A	0.9	A	0.0	A	0.2	A	0.2	A	1.6	A	LOS	LOS
		Approach	16.0	B	13.6	B	17.5	B	21.2	C	16.6	B	21.8	C	10.6	B	7.3	A	B	B
10 Route 11 and Kernstown Commons Blvd South			Auto Dealership				Kernstown Commons Blvd S				Route 11				Route 11					
	Two-Way Stop	Left	0.0	A	37.4	E	32.4	D	73.0	F	8.6	A	0.0	A	8.5	A	9.3	A	Delay	Delay
		Through					--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	1.5	3.5
		Right	0.0	A	11.8	B	9.9	A	10.9	B	0.0	A	0.0	A	0.0	A	0.0	A	LOS	LOS
		Approach	0.0	A	20.4	C	15.9	C	28.3	D	0.0	A	0.0	A	0.9	A	1.7	A	A	A
11 Route 11 and Prosperity Dr			Prosperity Dr				Prosperity Dr				Route 11				Route 11					
	Two-Way Stop	Left	23.7	C	51.6	F	11.3	B	14.2	B	8.4	A	8.8	A	8.3	A	8.5	A	Delay	Delay
		Through									0.0	A	0.0	A	0.0	A	0.0	A	1.8	5.4
		Right					11.3	B	14.2	B	0.0	A	0.0	A	0.0	A	0.0	A	LOS	LOS
		Approach	23.7	C	51.6	F	11.3	B	14.2	B	0.3	A	0.1	A	0.7	A	0.4	A	A	A
12 Route 11 and Renaissance Dr							Renaissance Dr				Route 11				Route 11					
	Two-Way Stop	Left	15.5	C	20.0	C	9.8	A	10.7	B	8.2	A	9.7	A	8.4	A	8.3	A	Delay	Delay
		Through	0.0	A	12.2	B					0.0	A	0.0	A	0.0	A	0.0	A	0.2	0.4
		Right												A	0.0	A	0.0	A	LOS	LOS
		Approach	15.5	C	17.7	C	9.8	A	10.7	B	0.1	A	0.0	A	0.2	A	0.1	A	A	A

Figure 18. Future (2030 No-Build) AM (PM) Peak Level of Service



STARS VDOT Virginia Department of Transportation

US ROUTE 11 (WINCHESTER CORRIDOR), City of Winchester, VA

US ROUTE 11 2030 NO BUILD PEAK HOUR LEVEL OF SERVICE (LOS)

FIGURE 18

Table 8. Future (2030 No-Build) Conditions: Summary of Intersection Queues (95th Percentile Queue, feet)

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
1 Route 11 and Battle Park Dr			Battle Park Dr						Route 11			Route 11		
	Two-Way Stop	Left	--	1	14	--	--	--	130	1	2	--	--	--
		Through	--	--	--	--	--	--	--	0	0	--	0	0
		Right	--	2	3	--	--	--	--	--	--			
2 Route 11 and Rubbermaid Entrance / Creekside Station / Brookfield Dr			Rubbermaid Entrance			Creekside Station			Route 11			Route 11		
	Signal	Left	--	21	81	--	32	50	170	24	m46	150	12	24
		Through	--	--	--				--	139	274	--	70	140
		Right	--	0	0	--	0	0	235'					
3 Route 11 and Shawnee Dr/ and Creekside Lane			Creekside Lane			Shawnee Dr			Route 11			Route 11		
	Signal	Left	--	11	18	--	131	#251	--	m8	m2	225	5	5
		Through	--	0	30	--	46	51	--	213	310	--	189	419
		Right							--	21	m40	100	2	m0
4 Route 11 and Opequon Church Lane			Opequon Church Lane						Route 11			Route 11		
	Two-Way Stop	Left	--	4	12	--	--	--	200	1	1	--	--	--
		Through	--	--	--	--	--	--	--	0	0	--	0	0
		Right	340	4	12	--	--	--	--	--	--	--	0	0
5 Route 11 and Apple Valley Rd			Apple Valley Rd						Route 11			Route 11		
	Signal	Left	--	112	#166	--	--	--	250	14	20	--	--	--
		Through	--	--	--	--	--	--	--	35	92	--	225	553
		Right	500	39	49	--	--	--	--	--	--	150	45	m48
6 Route 11 and Hood Way						Hood Way			Route 11			Route 11		
	Signal	Left	--	--	--	--	18	55	--	--	--	170	m7	m2
		Through	--	--	--	--	--	--	--	274	221	--	250	81
		Right	--	--	--	230	10	14	400	0	0	--	--	--
7 Route 11 and Commonwealth Ct			Gas Station			Commonwealth Ct			Route 11			Route 11		
	Signal	Left	--	27	48	--	33	100	350	m10	m3	130	3	m19
		Through				--	19	35	--	300	224	--	25	#875
		Right							350					
8 Route 11 and Route 37 N on and off ramp			Route 37 N on and off ramp						Route 11			Route 11		
	Signal	Left	--	194	194	--	--	--	400	81	145	--	--	--
		Through	--	--	--	--	--	--	--	87	141	--	159	m167
		Right	--	47	63	--	--	--	--	--	--	80	42	m7
9 Route 11 and Route 37 S on and off ramp/ Kernstown Commons Blvd			Route 37 S on and off ramp			Kernstown Commons Blvd N			Route 11			Route 11		
	Signal	Left	--	86	81	115	20	26	--	67	109	340	29	27
		Through	--	30	40	--	50	78	--	121	156	--	76	142
		Right	--	54	44	--	0	0	--	0	0	--	0	40

Table 8. Cont. Future (2030 No-Build) Conditions: Summary of Intersection Queues (95th Percentile Queue, feet)

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
10 Route 11 and Kernstown Commons Blvd South						Kernstown Commons Blvd S			Route 11			Route 11		
	Two-Way Stop	Left	--	0	1	--	11	44	160	0	0	--	5	11
		Through				--	--	--	--	0	0	--	0	0
		Right	--	0	0	--	6	12	300	0	0	240	0	0
11 Route 11 and Prosperity Dr				Prosperity Dr			Prosperity Dr			Route 11			Route 11	
	Two-Way Stop	Left	--	20	85	--	2	7	225	1	0	175	3	2
		Through							--	0	0	--	0	0
		Right				85	2	7	--	0	0	215	0	0
12 Route 11 and Renaissance Dr						Renaissance Dr			Route 11			Route 11		
	Two-Way Stop	Left	190	0	2	--	0	2	230	0	0	105	1	1
		Through	--	0	0				--	0	0	--	0	0
		Right										265	0	0

NOTES: # Synchro results indicates that 95th % queue may be longer
m Synchro results indicates that volume (and therefore the queue) is metered by upstream signal

4 Safety Analysis

The Virginia Department of Transportation (VDOT) requested an Operational Analysis to include a safety analysis of Route 11 from Battle Park Drive to Renaissance Drive, in Frederick County/City of Winchester. The safety analysis, which included a review of crash data and existing field conditions, was conducted to evaluate the potential safety deficiencies that occur along the roadway segment, determine the likely factors contributing to crashes, and propose potential mitigation activities.

4.1 Procedure

Crash data for the most recent five (5) years (August 30, 2012 through August 30, 2017) were obtained from VDOT's *Crashtools* database. The crash data were evaluated to identify crash locations and patterns, severity of crashes, and likely causes for crashes. The crash data was examined to identify crash locations on which to focus during field reviews. Field reviews were conducted, with particular focus on the crash patterns, to evaluate conditions in the field that could be influencing the crash locations based on historical crash data. The crash data were used to identify an AM Peak period (6AM–9AM), a Midday Peak period (12PM-3PM) and a PM Peak period (3PM–6PM), during which the highest number of crashes occurred. Field reviews were conducted during both the AM and PM peak periods in order to examine factors such as traffic conditions, human-vehicle interaction, geometric layout, and the presence and condition of signing, pavement markings, and delineation.

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

The findings for the project area are separated by Crash Data Analysis findings and Field Review findings. The Crash Data Analysis findings describe trends in the data regarding the year, time of day, type of crash, and roadway condition. The Field Review findings describe the field observations and discuss how those observations may relate to trends identified in the crash data. The findings and recommendations are provided in the following sections.

4.2 Crash Data Analysis

4.2.1 Crashes by Year

A total of 242 crashes occurred from Battle Park Drive to Renaissance Drive between August 30, 2012 and August 30, 2017, as shown in **Figure 19**. Note that the 2012 and 2017 bars are striped since the data does not include a full calendar year. The AADT values were used to associate the traffic volume with crashes per year, as shown in **Figure 19** (orange line). The AADT values were constant from 2012 to 2016, with the exception of the decrease in 2014. The total number of crashes slightly fluctuated between 2013 and 2015 and then peaked in 2016.

Additionally, **Figure 20** shows that 1 fatal injury (0.4%), 11 non-visible injuries (4.5%), 9 ambulatory injuries (3.7%) and 59 visible injuries (24.4%) occurred in the study area within the five-year period. The majority of crashes that occurred were property damage, which accounted for 67% of all crashes. **Figure 21** provides a crash density map of the overall corridor.

Figure 19. Number of crashes per year for the project study area.

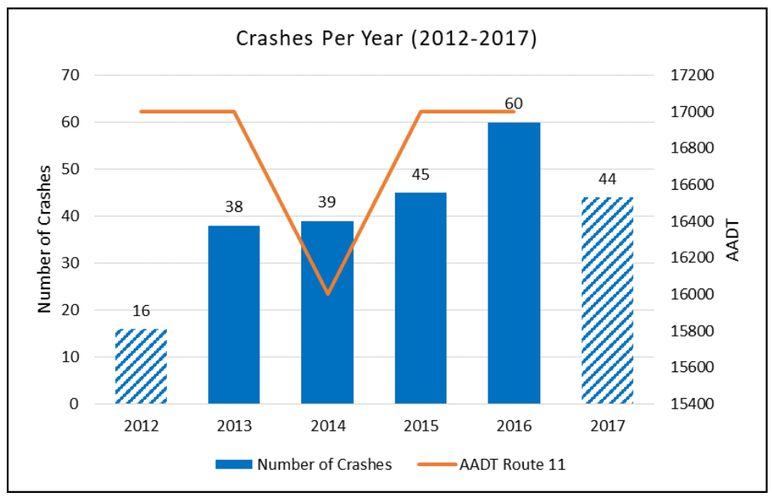


Figure 20. Severity of crashes for the project study area.

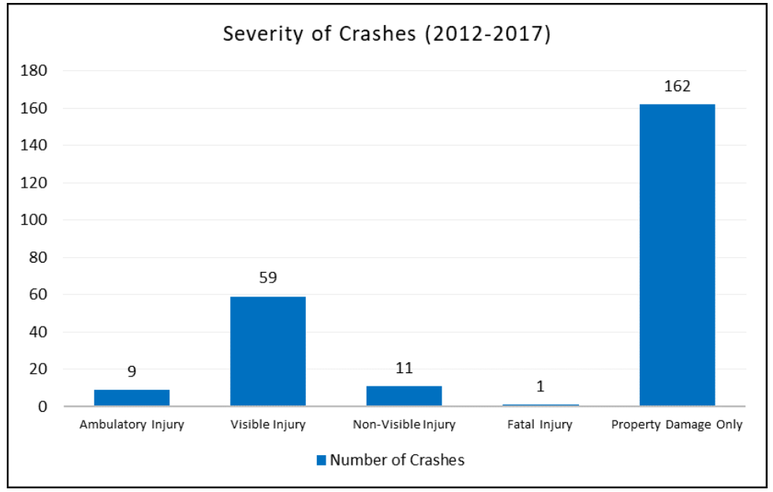
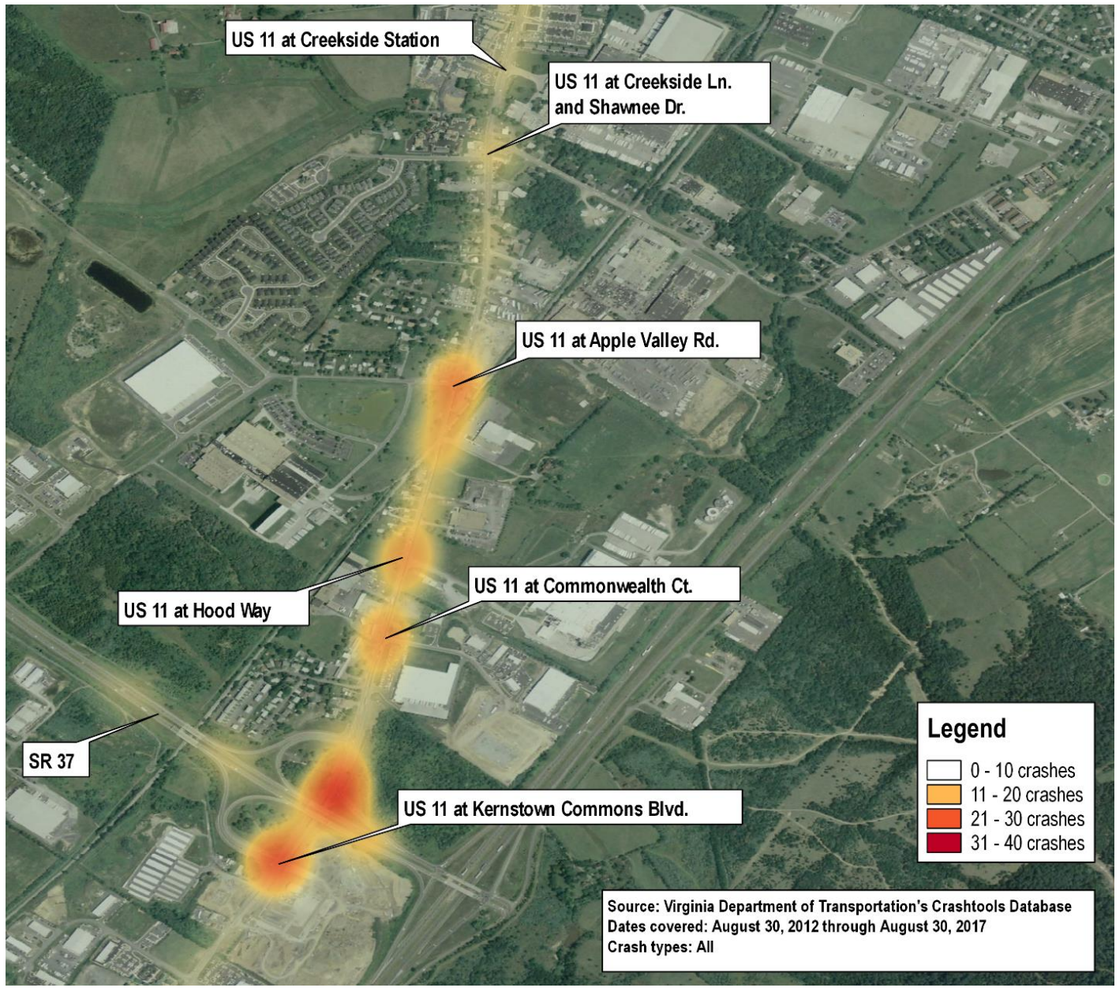


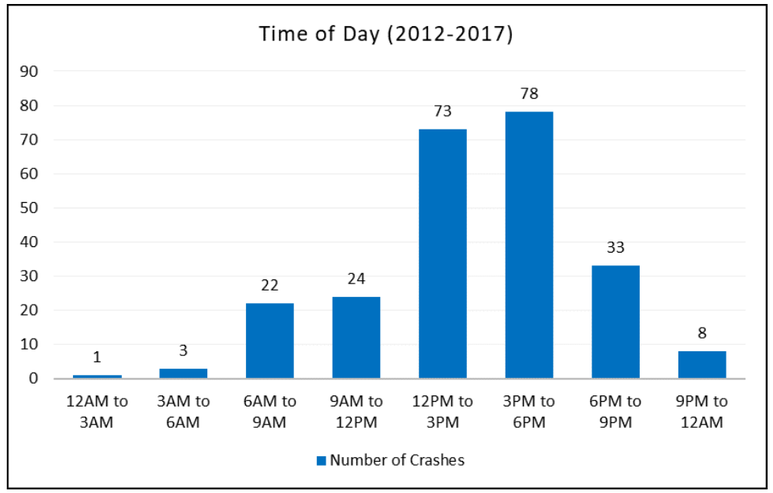
Figure 21. Crash heat map for Route 11/Valley Pike (2012-2017).



4.2.2 Crashes by Time of Day

Figure 22 displays the number of crashes that occurred by time of day, presented in 3-hour increments. The highest frequency of crashes occurred from 3PM–6PM (32%), from 12PM–3PM (30%), from 6PM–9PM (14%), and from 9AM–12PM (10%). Nine (9%) of the total crashes occurred during AM peak hour from 6AM to 9AM.

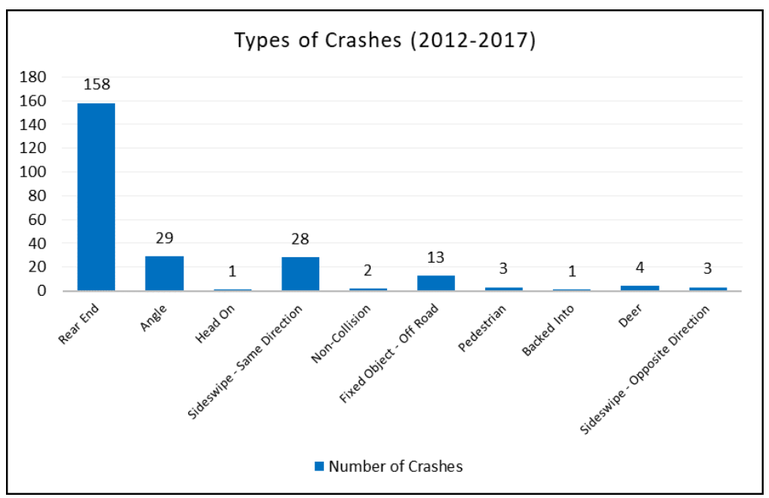
Figure 22. Number of crashes by time of day for the project study area.



4.2.3 Crashes by Type

As shown in **Figure 23**, the majority of crashes that occurred were rear-end crashes (65%), followed by angle crashes (12%), sideswipe same-direction crashes (12%), and fixed object off-road crashes (5%); the remaining crash types each accounted for less than 6% of the overall crashes. Three (3) pedestrian related crashes occurred between five year period. It should be noted that 16 crashes were incorrectly categorized within the *Crashtools* database; these crash classifications were corrected and updated to ensure the accuracy of the crash type analysis.

Figure 23. Number of crashes by type of crash for the project study area.



Based on the *historical crash data* that were reviewed, **Table 9** includes the most prominent crash types along the route. Note that for the purposes of analyzing the most frequent crashes, not all crashes are included in the crash pattern analysis.

Table 9. Crash patterns along the project study area.

Location (Intersection, Segment)	Intersection Approach/Leg/Ramp	Most Prominent Crash Type(s)	Vulnerable Road User Crashes	Year(s)	Total Crashes (Highest Crash Type %)
Route 11 at Kernstown Common Boulevard/SB Route 37 off-ramp	NB approach	Angle, side-swipe	N/A	2012-2013; 2015-2016	13 total (38% angle)
Route 11 at Commonwealth Court	SB approach	Rear-end	N/A	2013	3 total (100% rear-end)
	SB approach/SB receiving lanes of the south leg	Rear-end	N/A	2017	6 total (100% rear-end)
	NB approach/NB receiving lanes of the north leg	Rear-end	N/A	2017	4 total (100% rear-end)
Route 11 at Hood Way	SB approach	Rear-end	N/A	2013; 2015-2017	17 total (100% rear-end)
Route 11 at Budweiser Plant Driveway	NB and SB approaches	Rear-end	N/A	2012; 2014-2016	12 total (92% rear-end)
Route 11 at Apple Valley Way	NB approach	Rear-end	N/A	2013	4 total (100% rear-end)

4.2.4 Crashes by Roadway and Weather Conditions

Figure 24 indicates the number of crashes by roadway surface condition. The majority (90%) of crashes occurred during dry roadway conditions. Wet conditions accounted for 7% of crashes. Remaining 3% of the crashes occurred on snowy or icy or slushy roadway conditions. Additionally, **Figure 25** shows that most of the collisions occurred under clear/cloudy weather conditions (90%), followed by rainy weather conditions (5%). Snowy weather conditions accounted for less than 2% of the total accidents.

Figure 24. Number of crashes by roadway surface condition for the project study area.

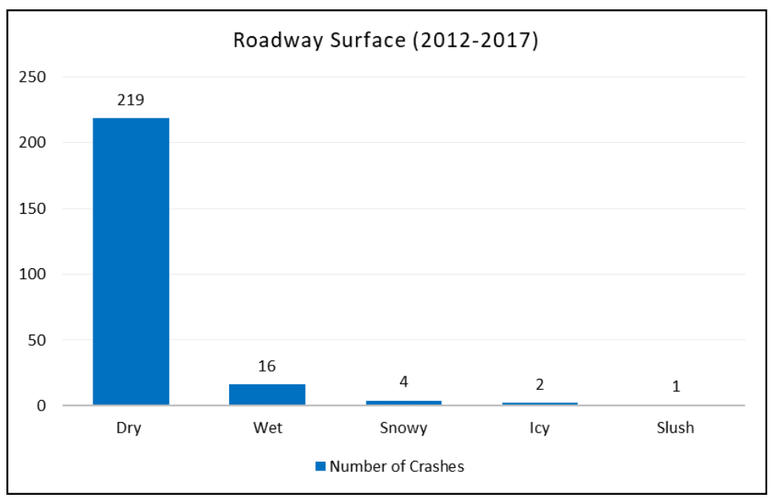
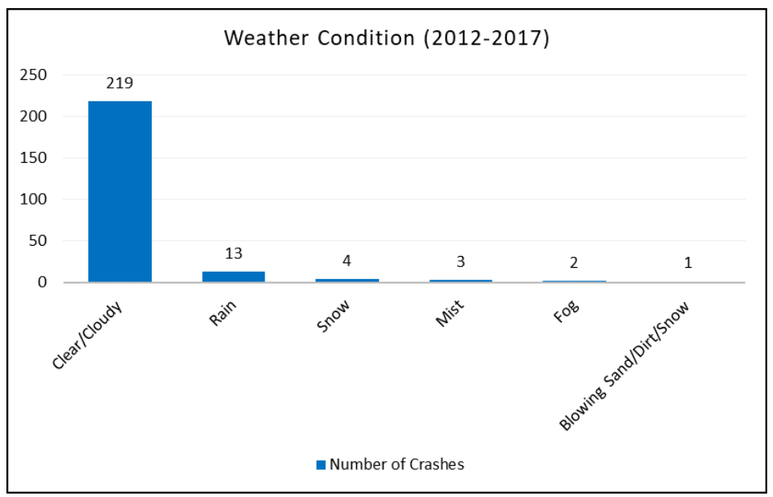


Figure 25. Number of crashes by weather condition for the project study area.



4.2.5 Crash Density by ¼-mile

Crash density histograms were developed in ¼-mile increments to provide a visual representation of crashes along the corridor based on crash type, crash severity, time-of-day, and roadway conditions. Crash hot spots were identified along the corridor as locations with the highest crash density. As shown in **Figure 26,** two (2) crash hotspots were identified along Route 11: 1) Kernstown Common Boulevard and 2) between Hood Way and Apple Valley Road. A discussion of the crash hotspots is provided below.

4.2.5.1 Route 11 Northbound/Southbound

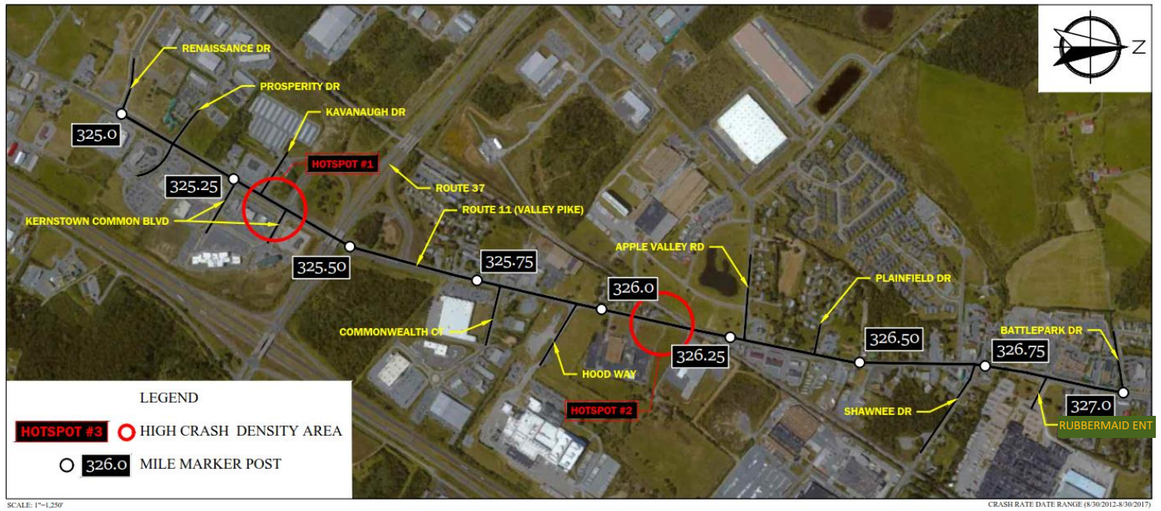
HOTSPOT 1: KERNSTOWN COMMON BOULEVARD INTERSECTION (MILEPOST 325.25 – 325.50)

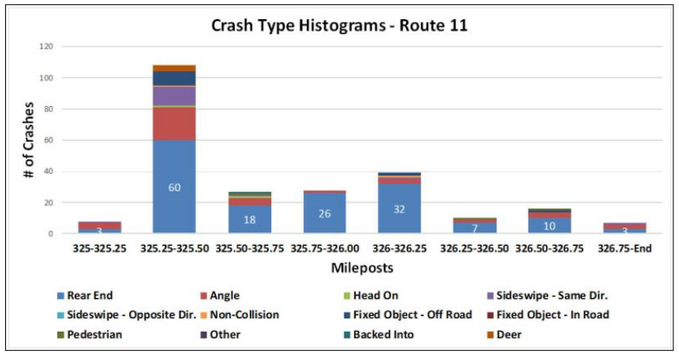
A total of 108 crashes occurred at this hotspot. The majority of crashes were rear-end (56%) and angle (19%) crashes, with most crashes resulting in property damage and visible injuries. In addition, the crashes predominately occurred from 3:00-6:00PM (31%) and 12:00PM-3:00PM (29%) and primarily under dry pavement conditions.

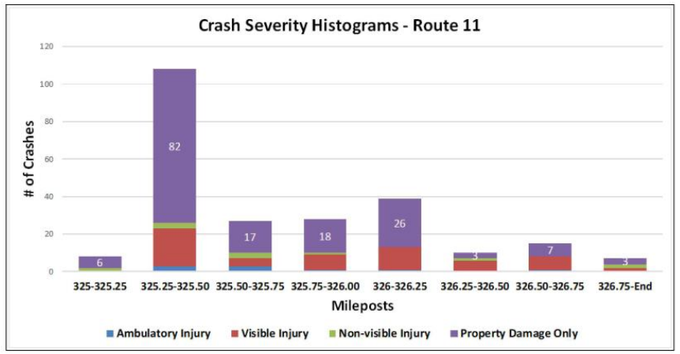
HOTSPOT 2: BETWEEN HOOD WAY AND APPLE VALLEY ROAD (MILEPOST 326.0 – 326.25)

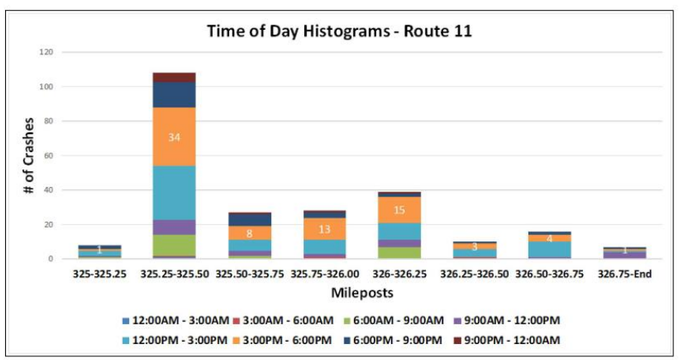
A total of 39 crashes occurred at this hotspot. The majority of crashes were rear-end (82%), with almost all crashes resulting in property damage and visible injuries. In addition, the crashes predominately occurred from 3:00-6:00PM (38%) and 12:00PM-3:00PM (26%) and primarily under dry pavement conditions.

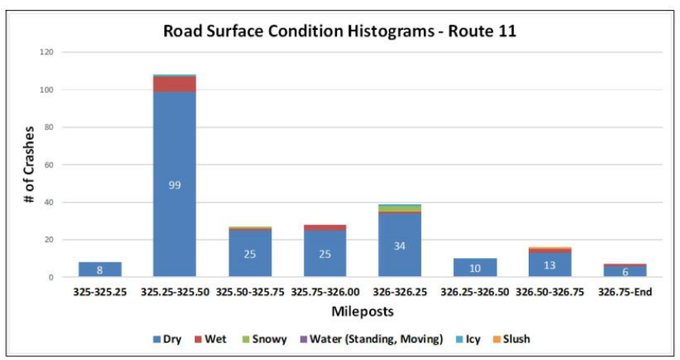
Figure 26. Crash density histograms per ¼-mile (Route 11).











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

The crash rates were calculated utilizing the rate calculations described in the *Highway Safety Manual*. For our project areas, crash rates were calculated by using the road segment equation and intersection equation. The intersections and roadway segments were broken up on Route 11 to better identify and target high crash rate areas. These areas are provided in **Table 10** and **Table 11**. Road segments that exceed the statewide average for the same type of facility are shaded in red in **Table 11**. Five of the eight segments exceed the statewide average rate for total crashes as well as injury crashes.

Table 10. Crash rates (intersections).

Intersection	Total Crash Rate (Per MEV)	Fatal Crash Rate (Per MEV)	Injury Crash Rate (Per MEV)	PDO Crash Rate (Per MEV)
Creekside Station	0.12	0.04	0.00	0.08
Creekside Ln.	0.14	0.00	0.11	0.04
Apple Valley Rd.	0.48	0.00	0.18	0.29
Hood Way	0.60	0.00	0.12	0.48
Commonwealth Ct.	0.40	0.00	0.11	0.29
WB US 37 ramp	0.18	0.00	0.06	0.12
EB US 37 ramp	0.70	0.00	0.15	0.55

4.2.7 Crash Data Summary

The following observations were made for crashes that occurred during the five (5) year period from Battle Park Drive to Renaissance Drive:

- One (1) fatal pedestrian crash occurred in 2016 during the 12PM to 3PM time period. The collision occurred under dry roadway conditions and in clear weather. The pedestrian was waiting on the sidewalk on the west side of Valley Avenue at Creekside Station / Rubbermaid Entrance and entered the crosswalk to cross Valley Avenue from west to east. The vehicle had a green signal and collided with the pedestrian.
- 33 percent (33%) of crashes resulted in non-fatal injuries (e.g., ambulatory, visible, and non-visible injuries) (79 crashes).
- 90 percent (90%) of crashes occurred under dry pavement conditions (219 crashes).
- 7 percent (7%) of crashes occurred under wet pavement conditions (16 crashes).
- 65 percent (65%) of crashes that occurred over the five (5) year period were rear-end crashes (158 crashes).
- 12 percent (12%) of crashes that occurred over the five (5) year period were angle crashes (29 crashes) and another 12 percent (12%) of crashes were side-swipe – same direction crashes (28 crashes).
- 5 percent (5%) of crashes occurred during dark lighting conditions, which includes the following time periods: 9PM–12AM, 12AM–3AM, and 3AM–6AM (12 crashes).
- 9 percent (9%) of crashes (22 crashes) occurred during the AM peak period (6AM–9AM). 32 percent (32%) of crashes (78 crashes) occurred during the PM peak period (3PM–6PM).

Table 11. Crash rates (segments).

Segment	Total CR (Per 100 MVM)		Statewide Average (2015)	Fatal CR (Per 100 MVM)		Statewide Average (2015)	Injury CR (Per 100 MVM)		Statewide Average (2015)	PDO CR (Per 100 MVM)		Statewide Average (2015)
Battle Park Dr. to Creekside Station	256.99	≥	151.62	0.00	≤	0.86	128.50	≥	51.77	128.50	≥	98.99
Creekside Station to Creekside Ln.	96.47	≤	151.62	0.00	≤	0.86	32.16	≤	51.77	64.31	≤	98.99
Creekside Ln. to Apple Valley Rd.	215.65	≥	151.62	0.00	≤	0.86	140.18	≥	51.77	75.48	≤	98.99
Apple Valley Rd. to Hood Way	399.96	≥	151.62	0.00	≤	0.86	141.92	≥	51.77	258.04	≥	98.99
Hood Way to Commonwealth Ct.	162.41	≥	151.62	0.00	≤	0.86	54.14	≥	51.77	108.27	≥	98.99
Commonwealth Ct. to WB US 37 ramp	151.50	≤	151.62	0.00	≤	0.86	94.69	≥	51.77	56.81	≤	98.99
WB US 37 ramp to EB US 37 ramp	585.36	≥	151.62	0.00	≤	0.86	117.07	≥	51.77	468.29	≥	98.99
EB US 37 ramp to Renaissance	100.94	≤	151.62	0.00	≤	0.86	28.84	≤	51.77	72.10	≤	98.99

Exceeds the state average crash rate

4.3 Field Review

Field observations were conducted at the project study area on Wednesday, January 10, 2018 and Thursday, January 11, 2018 during the AM and PM peak periods to assess traffic operations, roadway geometrics, safety, queuing, vehicle interaction conflicts, and existing signage. In order to evaluate these conditions within the field, various engineering manuals (e.g., Manual on Uniform Traffic Control Devices (MUTCD), Virginia Supplement to MUTCD, 2010 ADA Standards for Accessible Design (ADA)) were used to guide the recommendations. It should be noted, that while *historical crash data* were utilized to determine crash patterns and areas of focus within the field, other recommendations and/or observations were noted that may not be directly related to crash patterns.

Table 12 lists common observations/recommendations from the field and the respective standards. Note that existing standards will be cited within the Field Review and Recommendations sections for any unique observations/recommendations that are not listed within **Table 12**.

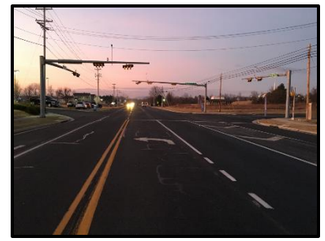
Table 12. Common Field Observations/Recommendations and the Associated Standards

Observation/Recommendation	Associated Standard
Tactile domes do not comply with standards and should be updated	VDOT RBS; ADA Section 705.1
Pedestrian crossing pavement markings are faded and should be refurbished	MUTCD Section 3B.18
Stop bar/yield lines are faded and should be refurbished	MUTCD Section 3B.16
Pavement marking arrows	MUTCD Section 3B.24
Pavement and Curb markings	MUTCD Section 3B
Pavement marking line extensions through intersections	MUTCD Section 3B.08
Stop sign is not present and should be installed	MUTCD Section 2B.10
Pedestrian facilities are not provided and should be installed	MUTCD Section 3B.18 and MUTCD Chapter 4E
Distance buffer between the stop bar and crosswalk at an intersection approach	MUTCD Section 3B.16
Street name sign letter height appears smaller than recommended	MUTCD Section 2D.43

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

4.3.1 Route 11 (Valley Pike) at Renaissance Drive

Figure 27



- This intersection is currently functioning as an unsignalized intersection controlled by stop signs. At the time of field observations, signal heads were bagged and the signal heads were not yet in operation (**Figure 27**). All signal heads have backplates; however, the backplates do not have yellow retroreflective borders installed. *(See Recommendation A1)*
- The pavement markings along the northbound and southbound approaches are faded. Additionally, the westbound approach does not provide a stop bar. *(See Recommendation A2)*

4.3.2 Route 11 (Valley Pike) from Renaissance Drive to Prosperity Drive

- The pavement markings along the northbound and southbound lanes are faded. *(See Recommendation A3)*

4.3.3 Route 11 (Valley Pike) at Prosperity Drive (unsignalized intersection)

Figure 28

- The pavement markings for all approaches and legs of the intersection are faded. *(See Recommendation A4)*
- Currently, a blank or faded street name sign is provided on top of the existing "Stop" sign panel (R1-1) post located on the northeast corner (**Figure 28**). *(See Recommendation A5)*
- Currently, a street name sign post is provided on the southwest corner of the intersection approximately 10 feet from the intersection; however, it is difficult to read for southbound approaching vehicles. *(See Recommendation A6)*
- Currently, the northbound right turn lane is a right turn only condition; however, no signage is provided for northbound vehicles that right lane vehicles must turn right. *(See Recommendation A7)*

4.3.4 Route 11 (Valley Pike) from Prosperity Drive to Kernstown Commons Boulevard

- Currently, pavement markings and striping along all the northbound and southbound lanes are faded. *(See Recommendation A8)*

4.3.5 Route 11 (Valley Pike) at Kernstown Commons Boulevard/Route 37 Southbound (EB) On/Off Ramp

- Currently, the signal heads for all approaches of the intersection have backplates; however, the signal heads do not have yellow retroreflective borders. Based on *historical crash data*, rear-end crashes were prominent from 2012 through 2017, and poor visibility of the signal heads could be attributing to these crash statistics. *(See Recommendation A9)*
- Currently, all approaches and legs of the intersection, except for the eastbound approach, have faded pavement markings and pavement striping. *(See Recommendation A10)*

Figure 30

- The Route 37 southbound off-ramp (eastbound approach), has a skewed approach due to the orientation of the clover-leaf layout of the Route 37 interchange. Vehicles exiting along this southbound ramp are provided approximately 400 feet of stopping distance (i.e., reaction time distance and breaking distance) as full view of the intersection and signals are in sight. In order to prepare for the approach, vehicles are provided two advanced warning signal sign panels (W3-3), approximately 550 feet west (along the off-ramp) of the intersection (**Figure 30**). While this is helpful for eastbound vehicles to anticipate the signalized intersection, the warning signs at night and early in the morning may be less effective due to limited overhead lighting and the positioning of the sun rise in relation to the signal heads, respectively (**Figure 29**). Additionally, the advisory warning speed for exiting vehicles along this ramp is set to 35 mph. During the field observations, vehicles were observed traveling in excess of the advisory speed limit along the ramp and approaching the intersection as well as running red lights. Based on the *historical crash data*, angle crashes and rear-end crashes were prominent from 2013 through 2017 and could be due to combinations of vehicle speeds, red-light running violations, and insufficient signage for the approaching intersection. *(See Recommendation A11)*

Figure 29

4.3.6 Route 11 (Valley Pike) at Route 37 Northbound (WB)On/Off-Ramp

- The design of the northbound Route 37 off-ramp, until recently, provided access for vehicles to exit Route 37 to northbound Route 11 prior to the overpass. Due to substantial crash statistics at this former intersection, a new design eliminated this off ramp and was merged and redesigned into the existing northbound round-about off ramp. Vehicles are now directed over the Route 11 overpass and exit Route 37 northbound where they can turn onto Route 11 northbound or southbound at a signalized intersection.

Figure 31

- Currently, the eastbound approach provides 2 left turn lanes for vehicles proceeding to northbound Route 11, and 1 right turn lane for vehicles proceeding to southbound Route 11. Upon proceeding through the eastbound left turn movement, the right-most left turn lane along the north leg of the intersection merges (**Figure 32**), and no indication is provided of these merging conditions. Drivers familiar with the intersection were observed utilizing the left most turn lane along the ramp. During AM peak hours, vehicles were observed queuing back along the ramp due to vehicles primarily utilizing the left-most turn lane (**Figure 31**). *(See Recommendation A12)*

Figure 32

4.3.7 Route 11 (Valley Pike) from Route 37 Northbound Off-Ramp to Commonwealth Court

- Pavement markings along the northbound and southbound lanes are faded. *(See Recommendation A13)*
- Currently, no merging signs or pavement markings are provided for northbound vehicles to indicate the right lane is ending and vehicles are merging left, south of the intersection of Route 11 at Fay Street. *(See Recommendation A14)*
- Pavement markings along the eastbound and westbound approaches are missing and/or faded at the intersection of Route 11 at Fay Street. *(See Recommendation A15)*
- During the AM and PM peak hours, extensive vehicle queues were observed extending along the northbound and southbound lanes due to vehicle backups from the intersections of Route 11 at Hood Way, Route 11 at Commonwealth Court, and Route 11 at the Route 37 Northbound On/Off ramp intersections, which blocked side streets and private driveways along this stretch of corridor. During the PM peak, vehicles were observed making eastbound and westbound turning movements with inadequate gaps due to the congestion along the northbound and southbound lanes (**Figure 33**). Based on the historical crash data, angle crashes at the intersection of Route 11 at Fay Street, occurred in 2014 through 2015 and 2017 and could be due to vehicles attempting turning movements with inadequate gaps in the northbound and southbound vehicular traffic. Additionally, along this stretch of corridor, rear-end crashes were prominent from 2015 through 2017 and these prevalent queuing issues may be contributing to these crash statistics along the corridor.

Figure 33

4.3.8 Route 11 (Valley Pike) at Commonwealth Court

- Currently, the signal heads for all approaches of the intersection have backplates; however, the signal heads do not have yellow retroreflective borders. Based on historical crash data, rear-end crashes were prominent in 2013 and 2015 through 2017, and poor visibility of the signal heads could be attributing to these crash statistics. *(See Recommendation A16)*
- Pavement striping along the north and south legs of the intersection are faded. *(See Recommendation A17)*
- During the AM and PM peak hours, extensive vehicle queues were observed extending along the northbound and southbound lanes due to vehicle backups from the intersections of Route 11 at Apple Valley Way to the Route 11 at the Route 37 Northbound On/Off ramp intersections. Vehicle queuing during these peak hours caused blockages at this intersection, and vehicles had difficulty entering the northbound or southbound lanes from the westbound approach. Vehicles were observed making entries onto Route 11 without inadequate spacing, which sometimes resulted in near-miss incidents. Based on the historical crash data, rear-end crashes were prominent during 2013 and from 2015 through 2017, and could be attributed to these current queueing issues at the intersection.

4.3.9 Route 11 (Valley Pike) from Commonwealth Court to Hood Way

- Pavement markings and striping are faded along the northbound, southbound, and center lanes. *(See Recommendation A18)*
- During AM and PM peak hours, extensive vehicle queues were observed extending along the northbound and southbound lanes due to vehicle backups from the intersections of Route 11 at Apple Valley Way to the Route 11 at the Route 37 Northbound On/Off ramp intersections. Vehicle queuing during these peak hours caused blockages along this stretch of corridor and vehicles had difficulty entering the northbound or southbound lanes. Vehicles were observed making entries onto Route 11 without inadequate spacing, which sometimes

resulted in near-miss incidents. Based on the historical crash data, rear-end crashes were prominent from 2016 through 2017, and could be attributed to these current queueing issues along this stretch of corridor.

4.3.10 Route 11 (Valley Pike) at Hood Way

- Currently, the signal heads for all approaches of the intersection have backplates; however, the signal heads do not have yellow retroreflective borders. Based on historical crash data, rear-end crashes were prominent from 2013 through 2017, and poor visibility of the signal heads could be attributing to these crash statistics. *(See Recommendation A19)*
- Pavement markings and striping at all approaches and legs of the intersection are faded. *(See Recommendation A20)*
- During the AM and PM peak hours, extensive vehicle queues were observed extending along the northbound and southbound lanes due to vehicle backups from the intersections of Route 11 at Apple Valley Way to the Route 11 at the Route 37 Northbound On/Off ramp intersections. Vehicle queuing during these peak hours caused blockages at this intersection, and vehicles had difficulty entering the northbound or southbound lanes (**Figure 34**). Vehicles were observed making entries onto Route 11 without inadequate spacing, which sometimes resulted in near-miss incidents. Alternatively, northbound and southbound vehicles were observed being aggressive in or to prevent westbound traffic from entering Route 11. Based on the historical crash data, rear-end crashes were prominent from 2013 through 2017, and could be attributed to these current queueing issues at the intersection.

Figure 34

4.3.11 Route 11 (Valley Pike) from Hood Way to Apple Valley Way

- Pavement markings and striping are faded along the northbound, southbound, and center lanes. *(See Recommendation A21)*
- The westbound right sight distance (of oncoming southbound vehicles) at the Virginia Eagle Distribution Company entrance/exit driveway is limited due to northbound vehicle queues observed during the PM peak hour as well as the railroad crossing flashing signal post (**Figure 35**). Large semi-tractor trailer vehicles were primarily observed entering and exiting this driveway. Vehicle queues stretching along southbound and northbound Route 11 between Route 37 northbound on/off ramp and Apple Valley Way blocked vehicles entering and exiting the driveway. The limited overhead lighting in combination with vehicle queues and trucks/vehicles entering Route 11 at this unsignalized intersection caused several near-miss incidents. Based on the historical crash data, rear-end crashes and angle crashes were prominent from 2012 through 2017, and may be attributed to these current conditions and vehicles entering/exiting this driveway. *(See Recommendation A22)*
- During the AM and PM peak hours, extensive vehicle queues were observed extending along the northbound and southbound lanes due to vehicle backups from the intersections of Route 11 at Apple Valley Way to the Route 11 at the Route 37 Northbound On/Off ramp intersections. Vehicle queuing during these peak hours caused blockages along this stretch of roadway, and vehicles had difficulty entering the northbound or southbound lanes. Vehicles were observed making entries onto Route 11 without adequate spacing, which sometimes resulted in near-miss incidents. Based on the historical crash data, rear-end crashes were prominent from 2013 through 2017, and could be attributed to the queueing issues at the intersection.

Figure 35

4.3.12 Route 11 (Valley Pike) at Apple Valley Way

- Currently, the signal heads for all approaches of the intersection have backplates; however, the signal heads do not have yellow retroreflective borders. Based on *historical crash data*, rear-end crashes were prominent from 2013 through 2014 and in 2016, and poor visibility of the signal heads could be attributing to these crash statistics. *(See Recommendation A23)*
- Pavement markings and striping are faded for at all approaches and along all legs of the intersection. *(See Recommendation A24)*
- Overhead street signs on the mast arms are not provided for any approaching vehicles. A small street sign post is provided on the southwest corner of the intersection and along the east side of the intersection facing eastbound approach vehicles. Additionally, this existing sign post on the southwest corner is bent. *(See Recommendation A25)*
- A route shield sign panel (Route 11) is located on the east side of the intersection which faces eastbound vehicles. The current location makes it difficult for eastbound vehicles to interpret the road name (**Figure 36**). *(See Recommendation A26)*
- Currently, the eastbound right turn lane is a right turn only condition; however, no signage is provided for vehicles. *(See Recommendation A27)*
- Currently, along the northbound lanes, the taper for the right turn lane into the shopping center just north of the intersection begins at approximately the northbound stop bar. The location of this taper lane starting point extends through the intersection and could be misleading to vehicles as an additional through lane for northbound proceeding vehicles (**Figure 37**).

Figure 36

Figure 37

4.3.13 Route 11 (Valley Pike) from Apple Valley Way to Plainfield Drive

- Pavement markings and striping are faded along the northbound, southbound, and center lanes. *(See Recommendation A28)*

4.3.14 Route 11 (Valley Pike) at Plainfield Drive

- Pavement markings and arrows are faded along the eastbound and northbound approaches of the intersection. *(See Recommendation A29)*

4.3.15 Route 11 (Valley Pike) from Plainfield Drive to Shawnee Drive

- Pavement markings and striping are faded along the northbound, southbound, and center lanes. *(See Recommendation A30)Include observations for Opequon Church Lane*

4.3.16 Route 11 (Valley Pike) at Shawnee Drive

- Overhead street signs on the mast arms are not provided for any approaching vehicles. A small street sign post is provided on the west side of the road facing westbound vehicles. *(See Recommendation A31)*
- The westbound right turn lane left sight distance is obstructed due to the existing building located on the southeast corner of the intersection (**Figure 38**). *(See Recommendation A32). Observation from EB direction (Creekside Lane), Gas station and Auto sales driveways*

Figure 38

4.3.17 Route 11 (Valley Pike) at Rubbermaid Entrance/Creekside Station

- Currently, the signal heads for all approaches of the intersection have backplates; however, the signal heads do not have yellow retroreflective borders. *(See Recommendation A33)*
- Overhead street signs on the mast arms are not provided for northbound and southbound approaches. *(See Recommendation A34)*
- Currently, pedestrian facilities (i.e., pedestrian signals, crosswalks, and ramps) are provided at the intersection along the south and west legs of the intersection. Despite providing these pedestrian facilities, no overhead "Turning Vehicles Yield To Pedestrians" sign panels (R10-15) are provided on the mast arms for any approach. *(See Recommendation A35)*

4.3.18 Overall Corridor

- Private driveways occur frequently along the Route 11 corridor, and in most cases, these driveways provide little to no pavement markings and/or signage. While neither the City of Winchester nor VDOT is responsible for the maintenance of these private driveways the lack of these improvements could be contributing to dangerous vehicular movements and crashes along the corridor. Combination of considerable heavy vehicle traffic and frequent driveways resulted in slower speeds and queues on Route 11. *(See Recommendation A36)*
- Pedestrian facilities are provided inconsistently along the length of the corridor and in most cases are non-compliant with ADA standards and/or are discontinuous. Most of the pedestrian facilities along Route 11 are present to the north of Rubbermaid Entrance or to the south of Kernstown Commons Shopping Center. Note that this corridor was occupied by pedestrian and bicycle traffic (**Figure 39**), and this corridor did not properly, despite having the right-of-away, accommodate the pedestrian activity along the entire length of the corridor. Based on historical crash data, pedestrian related crashes occurred in 2014, 2016, and 2017, and the lack of these facilities could be contributing to these crash rates. *(See Recommendation A37)*

Figure 39

- The corridor provides little to no overhead lighting along the sides of the road for this stretch of roadway. Businesses provide commercial lighting along the corridor which helps light the corridor; however, this is not adequate lighting for the subject roadway. *(See Recommendation A38)*
- Signalized intersections along the corridor experienced queuing issues at some approaches, and in some scenarios prevented or blocked other movements from proceeding. These blockages could be contributing to some of the crashes as vehicles approach or proceed through the intersection. *(See Recommendation A39)*
- The subject corridor provides private driveways and roadways for multiple industrial facilities, and ultimately subjects Route 11 to increased volumes of semi-tractor trailer trucks. As a result, trucks are entering and exiting Route 11 throughout the day, as observed during the field review. Vehicles entering onto Route 11 at the unsignalized intersections cause additional conflict points. Based on historical crash data, semi-truck tractor trailer related crashes occurred and could be due to no advanced warning of trucks entering the roadway. *(See Recommendation A40)*
- No operation issues were observed at the intersections of Route 11 at Opequon Church Lane, Route 11 at Battle Park Drive and section of Route 11 between Battle Park Drive and Rubbermaid Entrance.

4.4 Recommendations

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

4.4.1 Route 11 (Valley Pike) at Renaissance Drive

A1. Consider installing High Visibility Signal backplates with retroreflective borders to all traffic signal heads for all approaches at the intersection. Currently, this area lacks overhead street lighting, and the installation of yellow retroreflective borders on the backplates can be used to improve visibility and could prevent future crashes for the area.

A2. Refurbish pavement markings along the northbound and southbound approaches, and install a stop bar for the westbound approach, per standards outlined in **Table 12**.

4.4.2 Route 11 (Valley Pike) from Renaissance Drive to Prosperity Drive

A3. Refurbish pavement markings along the northbound and southbound lanes, per standards in **Table 12**.

4.4.3 Route 11 (Valley Pike) at Prosperity Drive (unsignalized intersection)

A4. Refurbish pavement markings along all approaches and legs of the intersection, per standards in **Table 12**.

A5. Consider replacing the blank street name sign on the existing "Stop" sign panel (R1-1) post located on the northeast corner of the intersection, and install a new street name sign for northbound and southbound facing vehicles, per standards outlined in **Table 12**.

A6. Consider relocating the existing street name sign post on the southwest corner closer to the intersection.

A7. Consider installing a "Right Lane Must Turn Right" sign panel (R3-7R) along the east side of the road along the northbound approach.

4.4.4 Route 11 (Valley Pike) from Prosperity Drive to Kernstown Commons Boulevard

A8. Refurbish pavement markings along the northbound and southbound lanes, per standards in **Table 12**.

4.4.5 Route 11 (Valley Pike) at Kernstown Commons Boulevard/Route 37 Southbound On/Off Ramp

A9. Consider installing retroreflective yellow borders to all signal heads. Implementing these borders could improve visibility and mitigate future rear-end crashes.

A10. Refurbish pavement markings and pavement striping along all legs and approaches except for the eastbound approach, per standards outlined in **Table 12**.

A11. Consider installing advanced warning flashing signals to the existing advanced warning sign panels (W3-3). Implementing these flashing signals provides enhanced visibility and warning of the upcoming signal.

4.4.6 Route 11 (Valley Pike) at Route 37 Northbound On/Off Ramp

A12. Currently, a larger sized shoulder lane is provided on the east side of the road along the north leg of the intersection, adjacent to the current merge location. Approximately 100 feet north of this merge point, a northbound right turn pocket lane begins for vehicles entering the Carquest Auto Parts entrance/exit driveway (Fay Street). Given the proximity of the merge point to this northbound right turn pocket lane and the existing paved shoulder lane, consider removing the merge condition to provide an additional lane that ultimately connects with the existing northbound right turn pocket lane. Extending the existing northbound right turn lane to connect to the eastbound right-most left turn receiving lane could mitigate the queuing issues occurring at the intersection as well as mitigate future rear-end and side-swipe crashes along the north leg of the intersection. Furthermore, providing this additional lane allocates the necessary and safe lane change distance for northbound traveling vehicles (prior to the intersection of Route 11 at Commonwealth Court) where the right lane terminates.

4.4.7 Route 11 (Valley Pike) from Route 37 Northbound Off-Ramp to Commonwealth Court

A13. Refurbish pavement markings and pavement striping along the northbound and southbound lanes, per standards outlined in **Table 12**.

A14. Should Recommendation A12 not be implemented, consider installing “Lane Ends Merge Left” sign panel (W9-2), lane ends sign panel (W4-2), and pavement marking arrows per standards outlined in MUTCD 3B-14C.

A15. Install and/or refurbish pavement markings at the eastbound and westbound approaches of the intersection of Route 11 at Fay Street, per standards outlined in **Table 12**.

4.4.8 Route 11 (Valley Pike) at Commonwealth Court

A16. Consider installing retroreflective yellow borders to all signal heads. Implementing these borders could improve visibility and mitigate future rear-end crashes.

A17. Refurbish pavement striping along the northbound and southbound approaches and legs of the intersection, per standards outlined in **Table 12**.

4.4.9 Route 11 (Valley Pike) from Commonwealth Court to Hood Way

A18. Refurbish pavement markings and striping along the northbound, southbound, and center lanes, per standards outlined in **Table 12**.

4.4.10 Route 11 (Valley Pike) at Hood Way

A19. Consider installing retroreflective yellow borders to all signal heads. Implementing these borders could improve visibility and mitigate future rear-end crashes.

A20. Refurbish pavement markings and striping at all approaches and legs of the intersection, per standards outlined in **Table 12**.

4.4.11 Route 11 (Valley Pike) from Hood Way to Apple Valley Way

A21. Refurbish pavement markings and striping along the northbound, southbound, and center lanes, per standards outlined in **Table 12**.

A22. Consider installing “Trucks Entering Highway” sign panel along the northbound and southbound lanes along this stretch of corridor. Providing these advanced warning signs for vehicles proceeding northbound or southbound along this stretch of corridor could mitigate future crashes.

4.4.12 Route 11 (Valley Pike) at Apple Valley Way

A23. Consider installing retroreflective yellow borders to all signal heads. Implementing these borders could improve visibility and mitigate future rear-end crashes.

A24. Refurbish pavement markings and striping at all approaches and legs of the intersection, per standards outlined in **Table 12**.

A25. Consider installing sign panels on the mast arms for all approaches at the intersection, per standards outlined in **Table 12**.

A26. Consider relocating the route shield sign panel to the southwest corner or along the south side of the eastbound for eastbound vehicles.

A27. Consider installing a right turn only sign panel (R3-5R) on the mast arm over the right turn lane.

4.4.13 Route 11 (Valley Pike) from Apple Valley Way to Plainfield Drive

A28. Refurbish pavement markings and striping along the northbound, southbound, and center lanes, per standards outlined in **Table 12**.

4.4.14 Route 11 (Valley Pike) at Plainfield Drive

A29. Refurbish pavement markings and striping along the eastbound and northbound approaches, per standards outlined in **Table 12**.

4.4.15 Route 11 (Valley Pike) from Plainfield Drive to Shawnee Drive

A30. Refurbish pavement markings and striping along the northbound, southbound, and center lanes, per standards outlined in **Table 12**.

4.4.16 Route 11 (Valley Pike) at Shawnee Drive

A31. Consider installing sign panels on the mast arms for all approaches at the intersection, per standards outlined in **Table 12**.

A32. Consider relocating the existing westbound right turn lane stop bar closer to the intersection to provide adequate left sight distance of approaching northbound vehicles.

4.4.17 Route 11 (Valley Pike) at Brookfield Drive

A33. Consider installing retroreflective yellow borders to all signal heads.

A34. Consider installing sign panels on the mast arms for all approaches at the intersection, per standards outlined in **Table 12**.

A35. Consider installing “Turning Vehicles Yield To Pedestrians” sign panels (R10-15) on the mast arm for all approaches at the intersection.

4.4.18 Overall Corridor

A36. Consider conducting an access management study along the corridor to evaluate the multiple access driveways.

A37. Consider updating and/or installing pedestrian facilities along the length of the corridor, per standards outlined in **Table 12**.

A38. Consider conducting a lighting study to evaluate the lighting along the corridor.

A39. Consider evaluating and/or optimizing current signal timings along the corridor to help alleviate congestion and queuing issues.

A40. Consider installing “Trucks Entering Highway” sign panels along the northbound and southbound lanes to provide additional warning to vehicles.

5 Improvement Alternatives

This section summarizes the improvement alternatives considered for the Route 11 corridor. The proposed improvements along Route 11 are primarily driven by a need to address existing and future safety and operational concerns. The alternatives were developed based upon the results of the Existing Conditions and No-Build Conditions analyses, field observation, review of prior studies/recommendations, as well as coordination with VDOT Staunton District Office and TMPD, Frederick County, WinFred MPO, and the City of Winchester. An in-person Alternatives Development Workshop was held on April 3, 2018 at the Frederick County Administration Building.

5.1 Future Year 2030 Build Alternatives

The approximately 1.9-mile study corridor of Route 11 comprises of twelve (12) intersections:

- Route 11 and Battle Park Drive
- Route 11 and Rubbermaid Entrance / Creekside Station
- Route 11 and Shawnee Drive / Creekside Lane
- Route 11 and Opequon Church Lane
- Route 11 and Apple Valley Road
- Route 11 and Hood Way
- Route 11 and Commonwealth Court
- Route 11 and 37 N (WB) On and Off Ramp
- Route 11 and Route 37 S (EB) On and Off Ramp / Kernstown Commons Boulevard
- Route 11 and Kernstown Commons Boulevard South
- Route 11 and Prosperity Drive
- Route 11 and Renaissance Drive

The discussion during the Alternatives Development Workshop primarily focused on these intersection locations, since the congestion and safety issues within the study corridor are centered on these intersections. Several preliminary improvement alternatives were presented based on the operational and safety analysis results. The improvement alternatives were vetted and prioritized by the Study Work Group (SWG) and a list of "Preferred Alternatives" were selected to move forward for the Future 2030 Build Analysis. Planning level conceptual layouts for these preferred alternatives were developed and are briefly summarized below. The layouts presented below cover only those locations where improvements are proposed. Alternatives are as follows:

- Alternative A[1] - Operational Improvements (To be implemented by the County)
- Alternative B[2] – Geometric Improvements on Route 11 between Shawnee Drive and Rubbermaid Entrance
- Alternative C[2] – Pedestrian, Transit and Access Management Improvements along Route 11
- Alternative D[2] – Innovative Intersection Improvements at Route 11 and Apple Valley Road

5.1.1 Year 2030 Build Alternative A – Operational Improvements (To be implemented by the County)

5.1.1.1 Route 11/Creekside Station/Rubbermaid Entrance Intersection

The existing signal timings/splits and phasing are proposed to be optimized. The existing signal is proposed to be coordinated with adjacent signals. To improve the visibility of the signal, the existing signal heads are proposed to be retrofitted with High Visibility Backplates (HVBPs) with retroreflective borders. Street name panels are proposed to be installed on the signal mast arms. To improve the pedestrian safety "Turning Vehicle Yield to Pedestrian" R10-15 sign is proposed on all the approaches.

5.1.1.2 Route 11/Shawnee Drive/Creekside Lane Intersection

The existing signal timings/splits and phasing are proposed to be optimized. Street name panels are proposed to be installed on the signal mast arms. The westbound left turn lane is proposed to be restriped to provide additional storage of 300 feet to improve the capacity.

5.1.1.3 Route 11/Opequon Church Lane Intersection

The improvement proposes to install "Do Not Block the Intersection" sign on the northbound and southbound direction along with the installation of a Stop Bar markings.

5.1.1.4 Route 11/Plainfield Drive Intersection

The improvement proposes to refurbish pavement markings for eastbound lanes for better lane visibility. Refurbishment of center lane pavement markings on Route 11 between Apple Valley Road and Shawnee Drive is also proposed with this improvement.

5.1.1.5 Route 11/Apple Valley Road Intersection

The existing signal timings/splits and phasing are proposed to be optimized. To improve the visibility of the signal, the existing signal heads are proposed to be retrofitted with High Visibility Backplates (HVBPs) with retroreflective borders. Street name panels are proposed to be installed on the signal mast arms. The improvement proposes to install "Right Turn Only Lane" R3-5R sign for the westbound approach on signal mast arm and ground mounted "Truck Entering Highway" signs between Hood Way and Apple Valley Road. For better visibility, the route shield sign panel is proposed to be relocated to southwest corner for the eastbound vehicles. The improvement proposes to refurbish pavement markings for northbound, southbound and center lanes on Route 11 for better lane visibility.

5.1.1.6 Route 11/Hood Way Intersection

The existing signal timings/splits and phasing are proposed to be optimized. To improve the visibility of the signal, the existing signal heads are proposed to be retrofitted with High Visibility Backplates (HVBPs) with retroreflective borders. The improvement proposes to install "Truck Entering Highway" signs between Hood Way and Apple Valley Road. The improvement proposes to refurbish pavement markings for northbound, southbound and center lanes on Route 11 as well as the westbound approach on Hood Way for better lane visibility.

5.1.1.7 Route 11/Commonwealth Court Intersection

The existing signal timings/splits and phasing are proposed to be optimized. To improve the visibility of the signal, the existing signal heads are proposed to be retrofitted with High Visibility Backplates (HVBPs) with retroreflective

[1] Alternative A will be implemented by the County from their operational funds

[2] Safety benefits from Alternative A will be added to the safety benefits for Alternatives B, C and D. Similarly, cost associated with implementing Alternative A will be added to the cost of implementing Alternatives B, C and D.

borders. The improvement proposes to refurbish pavement markings for northbound, southbound and center lanes on Route 11 for better lane visibility.

5.1.1.8 Route 11/Fay Street Intersection

The improvement proposes to refurbish pavement markings for northbound, southbound and center lanes on Route 11 as well as the eastbound and westbound approaches on Fay Street for better lane visibility.

5.1.1.9 Route 11/Route 37 North (WB) On and Off Ramps Intersection

The existing signal timings/splits and phasing are proposed to be optimized. To improve the visibility of the signal, the existing signal heads are proposed to be retrofitted with High Visibility Backplates (HVBPs) with retroreflective borders. The improvement proposes to relocate the signal cabinet.

5.1.1.10 Route 11/Kernstown Common Boulevard North/Route 37 South On and Off Ramps Intersection

The existing signal timings/splits and phasing are proposed to be optimized. To improve the visibility of the signal, the existing signal heads are proposed to be retrofitted with High Visibility Backplates (HVBPs) with retroreflective borders.

5.1.1.11 Route 11/Kernstown Common Boulevard South Intersection

The improvement proposes to install "Right Turn Only Lane" R3-5R sign for the northbound approach. Street name panels are proposed to be installed for the northbound and southbound approach and replaces for the westbound approach. For better lane visibility, refurbishing the pavement markings on all the approaches of the intersection is proposed. Realigning the street name sign on the southwest corner is recommended for better visibility.

5.1.1.12 Route 11/Prosperity Drive Intersection

For better lane visibility, refurbishing the pavement markings on all the approaches of the intersection is proposed.

5.1.1.13 Route 11/Renaissance Drive Intersection

For better lane visibility, refurbishing the pavement markings on all the approaches of the intersection is proposed. The improvements proposes to install a stop sign for the westbound approach.

5.1.2 Year 2030 Build Alternative B – Geometric Improvements on Route 11 between Shawnee Drive and Rubbermaid Entrance

5.1.2.1 Route 11 - Shawnee Drive and Creekside Station/Rubbermaid Entrance Intersections

The improvement alternative proposed to improve the capacity by providing an additional travel lane in the northbound direction on Route 11 in between Shawnee Drive and Rubbermaid Entrance/Creekside Station. The geometric improvements include extending the box culvert, closure of the north access to the First Bank on east side of the Route 11, and relocating the signal equipment at the intersection of Route 11 at Shawnee Drive/Creekside Lane. **Figure 40** shows the conceptual layout of the improvements at this location.

5.1.3 Year 2030 Build Alternative C – Pedestrian, Transit and Access Management Improvements along Route 11

5.1.3.1 Route 11/Battle Park Drive Intersection

As a part of this improvement alternative the bus stop is proposed to be upgraded with a bus shelter. The bus stops on north and south side of intersection are proposed to be relocated on the far side of the intersection. The existing north access to Kernstown Apartments is proposed to be converted to a Right-In/Right-Out only access to meet VDOT standards and to improve the safety.

5.1.3.2 Route 11/Creekside Station/Rubbermaid Entrance Intersection

A sidewalk is proposed on east side of Route 11 in between Rubbermaid Entrance and Shawnee Drive to improve pedestrian accessibility. Part of the sidewalk will be constructed by the City of Winchester under a different contract. **Figure 40** shows the sidewalk connection along the east side of Route 11.

5.1.3.3 Route 11/Shawnee Drive/Creekside Lane Intersection

A shared used path is proposed on east side of Route 11 in between Shawnee Drive and Plainfield Drive to provide pedestrian accessibility throughout corridor. The improvement alternative proposes to convert the entrances to 7-Eleven store to right in/right out only access and closure of south access to 7 – Eleven Store as shown on **Figure 41**.

5.1.3.4 Route 11/Plainfield Drive Intersection

A shared used path is proposed on east side of Route 11 in between Plainfield Drive and Apple Valley Road to provide pedestrian accessibility throughout corridor. **Figure 42** shows the connection of shared use path along east side of Route 11.

5.1.3.5 Route 11/Apple Valley Road Intersection

A shared used path is proposed on east side of Route 11 at Apple Valley Road to provide pedestrian accessibility throughout the corridor. The access management improvement proposes the closure of south access to Leonard Building and Truck Accessories Store on Route 11 as shown on **Figure 43**.

5.1.3.6 Route 11/Apple Valley Road Intersection

A shared used path is proposed on east side of Route 11 in between Apple Valley Road and Hood Way to provide pedestrian accessibility throughout the corridor as shown on **Figure 44**.

5.1.3.7 Route 11/Hood Way Intersection

A shared used path is proposed on east side of Route 11 in between Hood Way and Commonwealth Court to provide pedestrian accessibility throughout the corridor along with pedestrian facilities on the east leg of the intersection. **Figure 45** shows the connection of shared use path along the east side of Route 11.

5.1.3.8 Route 11/Commonwealth Court Intersection

A shared used path is proposed on east side of Route 11 in between Commonwealth Court and Fay Street to provide pedestrian accessibility throughout the corridor, along with pedestrian facilities on the east leg of the intersection. The access management improvements proposed include closure of four accesses to Echo Village, and closure of north entrance to the Citgo and entrance to the empty parking lot on the west side of Route 11 as shown on **Figure 45.** In addition to this, consolidating the north most entrance to the empty lot with the entrance to Schenck Foods is also proposed as shown on **Figure 45**.

5.1.3.9 Route 11/Fay Street Intersection

A shared used path is proposed on the east side of Route 11 in between Fay Street and Route 37 Westbound On/Off Ramps to provide pedestrian accessibility throughout the corridor along with pedestrian facilities on the east and south legs of the intersection. **Figure 46** shows the connection of shared use path along the east side of Route 11.

5.1.3.10 Route 11/ Route 37 North (WB) On and Off Ramps Intersection

A shared used path is proposed on the east side of Route 11 in between Route 37 North On/Off Ramps and Kernstown Common Boulevard North to provide pedestrian accessibility throughout the corridor. **Figure 47** shows the connection of shared use path along the east side of Route 11.

5.1.4 Year 2030 Build Alternative D – Innovative Intersection Improvements at Route 11 and Apple Valley Road

5.1.4.1 Route 11/Apple Valley Road Intersection

The improvement alternative proposes to convert the intersection to a Continuous Green - T (CGT) layout. **Figure 48** shows the conceptual layout of the improvements at this location.

Figure 40. Alternative B Conceptual Layout (Route 11 Between Rubbermaid Entrance & Shawnee Drive)

Figure 41. Alternative C Conceptual Layout (Shawnee Drive)

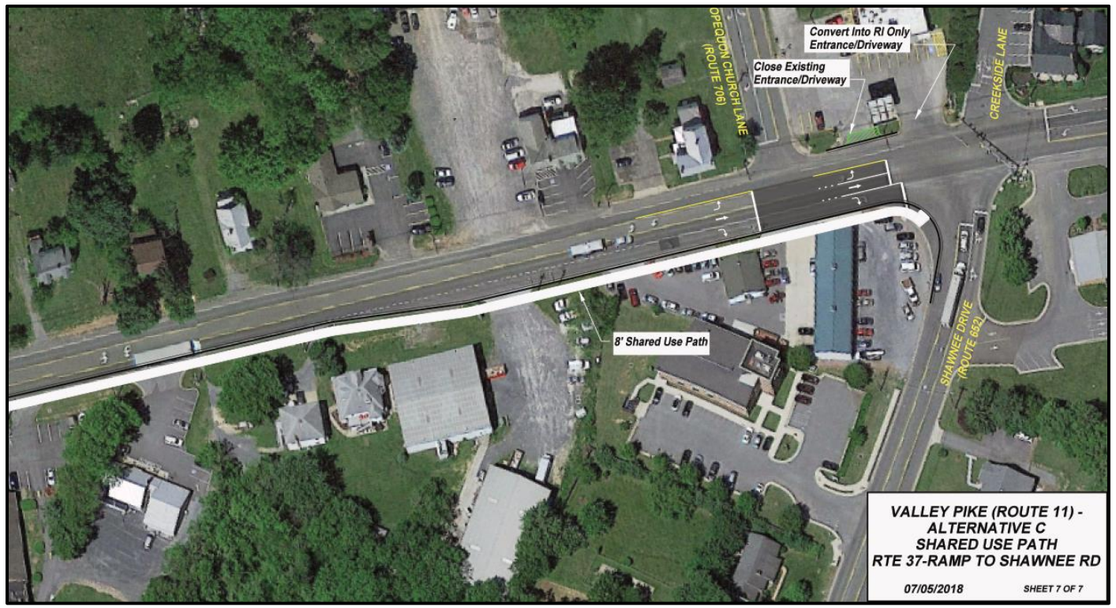


Figure 42. Alternative C Conceptual Layout – Plainfield Drive

Figure 43. Alternative C Conceptual Layout – Apple Valley Road

Figure 44. Alternative C Conceptual Layout – Between Hood Way and Apple Valley Road

Figure 45. Alternative C Conceptual Layout – Hood Way and Commonwealth Court

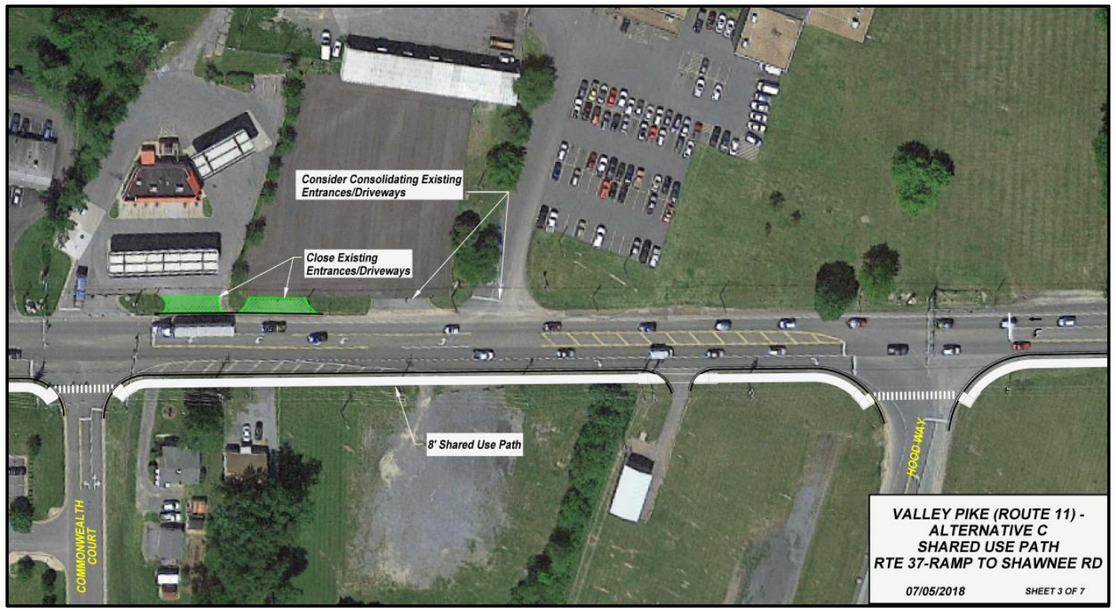


Figure 46. Alternative C Conceptual Layout – Fay Street

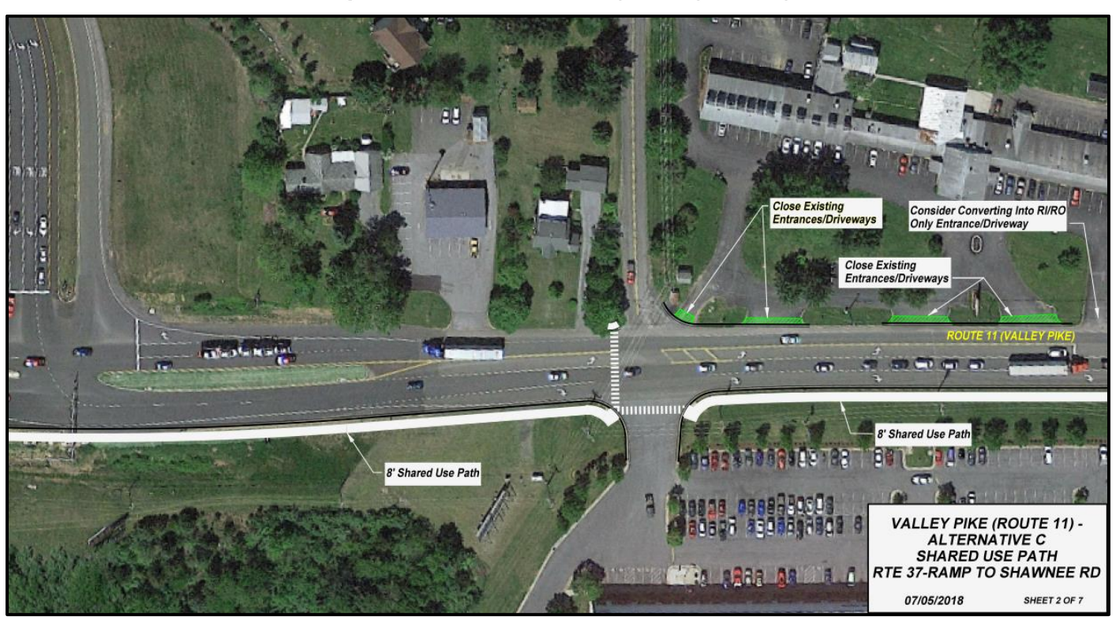


Figure 47. Alternative C Conceptual Layout – Route 37 N (WB) On and Off Ramps

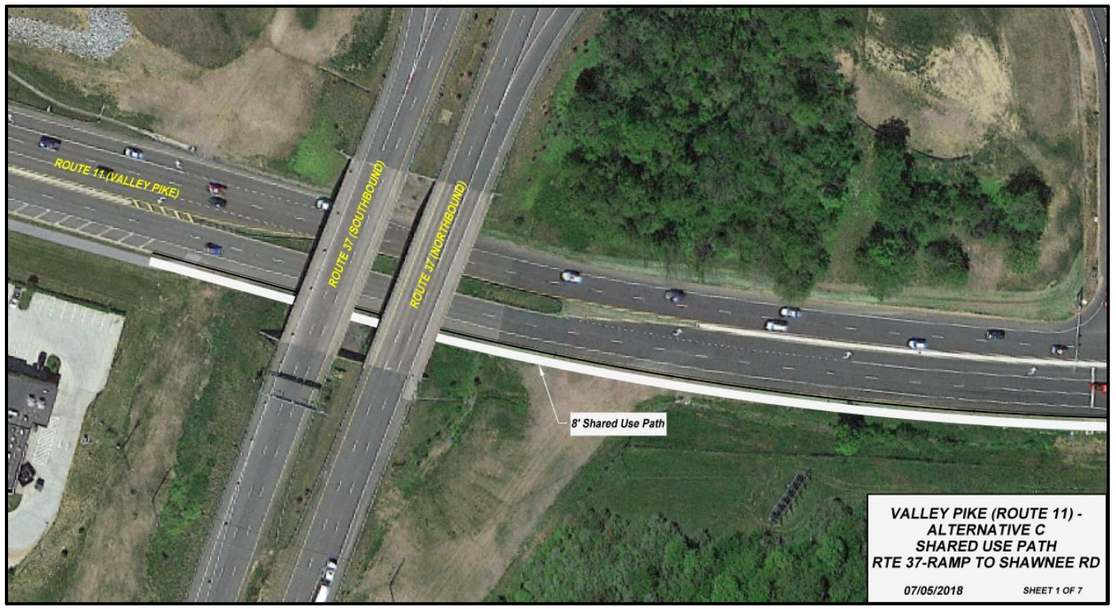


Figure 48. Alternative D Conceptual Layout – Continuous Green T Intersection (Apple Valley Road)

6 FUTURE 2030 BUILD CONDITIONS

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

6.1 Intersection Operations: Future 2030 Build Condition

Operational analysis was performed at each of the study intersections for the 2030 Future Build Conditions. The Synchro models were developed to test the alternatives for the entire corridor. **Tables 13** and **14** summarize the AM and PM peak hour delays and 95th percentile queue for Alternative A, respectively. Alternative A mainly evaluates signal optimization throughout the corridor. Alternative B, which evaluates the intersections of Route 11 at Shawnee Drive and Route 11 at Rubbermaid Entrance, was tested in combination with Alternative A. Similarly, Alternative C and Alternative D were tested in combination with Alternative A improvements. **Tables 15, 17 and 19** summarize the AM and PM peak hour delays for each movement of the study intersections for Alternatives B, C and D, respectively. **Figure 49, 50, 51 and 52** shows the intersection delays and LOS for Alternatives A, B, C and D graphically. The Synchro outputs can be found in the **Appendix**.

Queuing analysis was completed for the study intersections during the AM and PM peak hours for 2030 Build conditions. *Synchro 95th percentile* Queue Lengths in feet were reported for each lane. **Tables 16, 18 and 20** summarize the maximum queue lengths during the AM and PM peak hours for Alternative B, C and D, respectively.

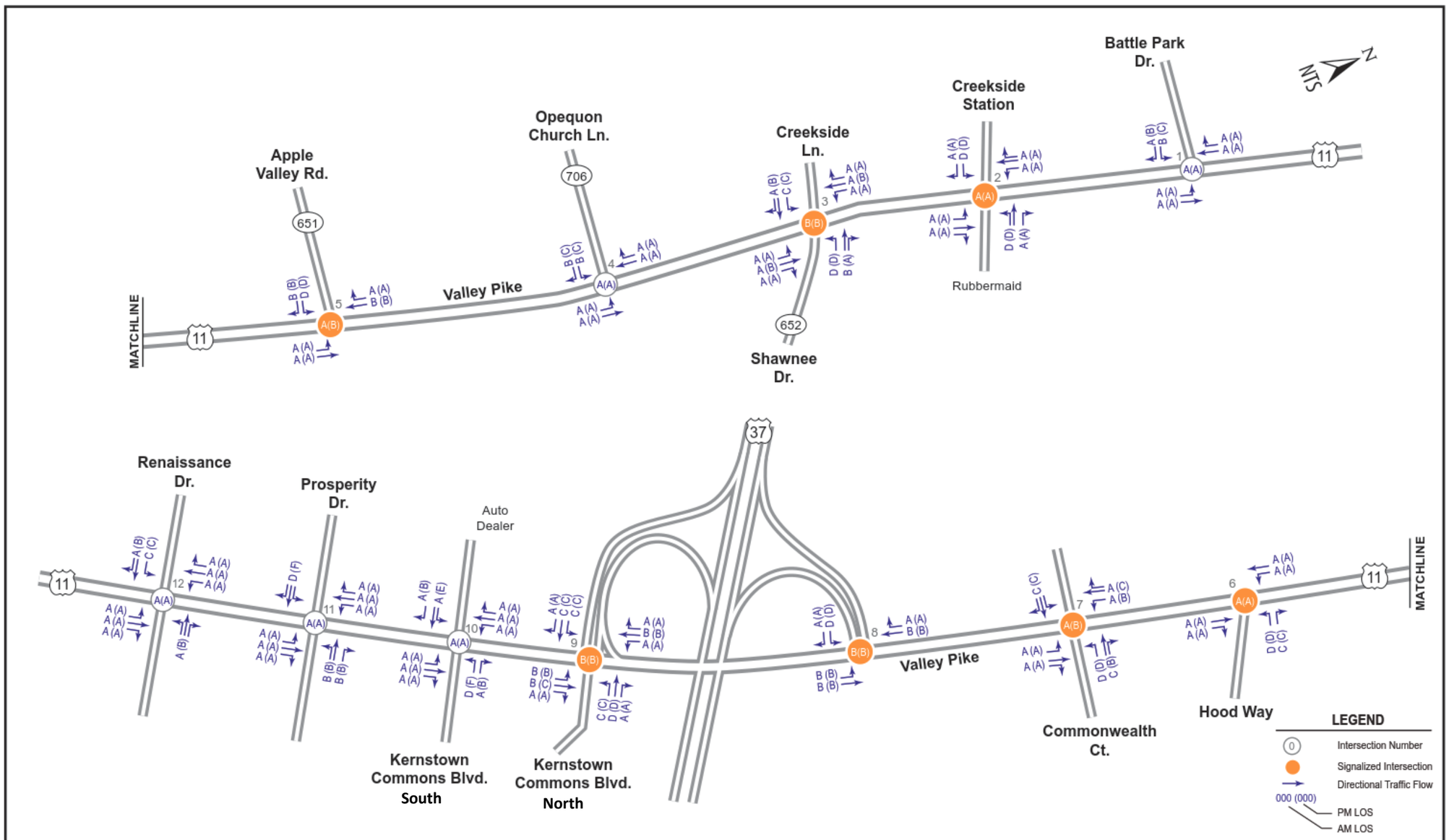
Table 13. Future Build (Alternative A – 2030) AM and PM Hour Delay and Level of Service (LOS)

Intersection Number and Description	Type of Control	Lane Group	Eastbound				Westbound				Northbound				Southbound				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
1 Route 11 and Battle Park Dr			Battle Park Dr								Route 11				Route 11					
	Two-Way Stop	Left	14.8	B	22.7	C	--	--	--	--	8.6	A	9.0	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	0.3	0.8
		Right	9.9	A	10.6	B	--	--	--	--	--	--	--	--					LOS	LOS
		Approach	11.2	B	18.2	C	--	--	--	--	0.2	A	0.2	A	0.0	A	0.0	A	A	A
2 Route 11 and Rubbermaid Ent/ Creekside Station			Creekside Station				Rubbermaid Entrance				Route 11				Route 11					
	Signal	Left	42.8	D	45.9	D	48.6	D	37.3	D	0.7	A	3.0	A	2.4	A	4.8	A	Delay	Delay
		Through	--	--	--	--					0.8	A	4.5	A	4.4	A	9.6	A	3.4	8.8
		Right	0.0	A	1.3	A	0.2	A	1.0	A									LOS	LOS
		Approach	32.1	C	27.3	C	37.6	D	18.5	B	0.8	A	4.4	A	4.2	A	9.2	A	A	A
3 Route 11 and Shawnee Dr/ Creekside Lane			Creekside Lane				Shawnee Dr				Route 11				Route 11					
	Signal	Left	31.7	C	23.4	C	53.6	D	44.4	D	3.5	A	7.0	A	6.3	A	9.3	A	Delay	Delay
		Through	0.0	A	15.1	B	12.5	B	6.4	A	8.3	A	17.2	B	8.3	A	13.2	B	11.7	16.5
		Right									1.4	A	2.0	A	0.0	A	0.0	A	LOS	LOS
		Approach	23.8	C	17.0	B	36.3	D	28.8	C	6.1	A	13.9	B	7.6	A	12.6	B	B	B
4 Route 11 and Opequon Church Lane			Opequon Church Lane								Route 11				Route 11					
	Two-Way Stop	Left	11.6	B	15.6	C	--	--	--	--	8.6	A	9.8	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	0.6	0.5
		Right	11.6	B	15.6	C	--	--	--	--	--	--	--	--	0.0	A	0.0	A	LOS	LOS
		Approach	11.6	B	15.6	C	--	--	--	--	0.1	A	0.1	A	0.0	A	0.0	A	A	A
5 Route 11 and Apple Valley Rd			Apple Valley Rd								Route 11				Route 11					
	Signal	Left	49.3	D	46.2	D	--	--	--	--	2.5	A	4.1	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	2.0	A	3.3	A	10.9	B	14.5	B	8.5	11.3
		Right	13.2	B	10.5	B	--	--	--	--	--	--	--	--	3.7	A	2.1	A	LOS	LOS
		Approach	31.7	C	25.3	C	--	--	--	--	2.1	A	3.4	A	9.6	A	12.8	B	A	B
6 Route 11 and Hood Way							Hood Way				Route 11				Route 11					
	Signal	Left	--	--	--	--	43.8	D	40.7	D	--	--	--	--	1.7	A	1.9	A	Delay	Delay
		Through	--	--	--	--	--	--	--	--	7.4	A	9.4	A	2.2	A	3.6	A	5.6	6.7
		Right	--	--	--	--	28.7	C	20.2	C	0.1	A	0.2	A	--	--	--	--	LOS	LOS
		Approach	--	--	--	--	39.3	D	37.2	D	7.0	A	8.3	A	2.2	A	3.5	A	A	A
7 Route 11 and Commonwealth Ct			Gas Station				Commonwealth Ct				Route 11				Route 11					
	Signal	Left	30.6	C	28.1	C	46.2	D	44.5	D	1.7	A	4.3	A	3.2	A	11.2	B	Delay	Delay
		Through					26.1	C	13.8	B	6.0	A	9.2	A	3.1	A	25.1	C	6.1	18.1
		Right									1.3	A	0.9	A					LOS	LOS
		Approach	30.6	C	28.1	C	37.1	D	33.5	C	5.9	A	9.1	A	3.1	A	24.3	C	A	B

Table 13. Contd. Future Build (Alternative A – 2030) AM and PM Hour Delay and Level of Service (LOS)

Intersection Number and Description	Type of Control	Lane Group	Eastbound				Westbound				Northbound				Southbound				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
8 Route 11 and Route 37 N (WB) on and off ramp			Route 37 N (WB) on & off ramp								Route 11				Route 11					
	Signal	Left	42.4	D	40.8	D	--	--	--	--	14.0	B	18.2	B	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	11.4	B	11.6	B	11.3	B	10.7	B	19.8	16.7
		Right	6.9	A	7.2	A	--	--	--	--	--	--	--	--	4.2	A	1.9	A	LOS	LOS
		Approach	30.5	C	28.9	C	--	--	--	--	12.1	B	13.7	B	10.4	B	9.3	A	B	B
9 Route 11 and Route 37 S (EB) on and off ramp / Kernstown Commons Blvd			Route 37 S (EB) on & off ramp				Kernstown Commons Blvd				Route 11				Route 11					
	Signal	Left	32.3	C	30.3	C	21.5	C	22.7	C	12.3	B	13.8	B	7.9	A	9.3	A	Delay	Delay
		Through	31.0	C	31.1	C	44.1	D	39.1	D	19.9	B	25.1	C	11.3	B	12.0	B	13.4	13.4
		Right	7.7	A	6.8	A	1.2	A	0.9	A	0.0	A	0.2	A	0.2	A	1.7	A	LOS	LOS
		Approach	16.9	B	16.5	B	17.3	B	21.2	C	17.2	B	20.5	C	7.8	A	6.7	A	B	B
10 Route 11 and Kernstown Commons Blvd South			Auto Dealership				Kernstown Commons Blvd S				Route 11				Route 11					
	Two-Way Stop	Left	0.0	A	39.3	E	35.0	D	80.0	F	8.6	A	0.0	A	8.6	A	9.4	A	Delay	Delay
		Through					--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	1.6	3.7
		Right	0.0	A	12.0	B	10.0	A	11.0	B	0.0	A	0.0	A	0.0	A	0.0	A	LOS	LOS
		Approach	0.0	A	21.1	C	16.7	C	30.0	D	0.0	A	0.0	A	0.9	A	1.7	A	A	A
11 Route 11 and Prosperity Dr			Prosperity Dr				Prosperity Dr				Route 11				Route 11					
	Two-Way Stop	Left	26.2	D	51.6	F	11.5	B	14.2	B	8.5	A	8.8	A	8.4	A	8.5	A	Delay	Delay
		Through									0.0	A	0.0	A	0.0	A	0.0	A	2.0	5.4
		Right					11.5	B	14.2	B	0.0	A	0.0	A	0.0	A	0.0	A	LOS	LOS
		Approach	26.2	D	51.6	F	11.5	B	14.2	B	0.3	A	0.1	A	0.7	A	0.4	A	A	A
112 Route 11 and Renaissance Dr							Renaissance Dr				Route 11				Route 11					
	Two-Way Stop	Left	15.6	C	20.2	C	9.8	A	10.8	B	8.2	A	9.8	A	8.4	A	8.3	A	Delay	Delay
		Through	0.0	A	12.3	B					0.0	A	0.0	A	0.0	A	0.0	A	0.2	0.4
		Right												A	0.0	A	0.0	A	LOS	LOS
		Approach	15.6	C	17.9	C	9.8	A	10.8	B	0.1	A	0.0	A	0.2	A	0.1	A	A	A

Figure 49. Future Build (Alternative A – 2030) AM (PM) Peak Level of Service



STARS VDOT Virginia Department of Transportation

US ROUTE 11 (WINCHESTER CORRIDOR), City of Winchester, VA

US ROUTE 11 FUTURE 2030 BUILD ALTERNATIVE A PEAK HOUR LEVEL OF SERVICE (LOS)

FIGURE 49

Table 14. Future Build (Alternative A – 2030) Conditions: Summary of Intersection Queues (95th Percentile Queue, feet)

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
1 Route 11 and Battle Park Dr			Battle Park Dr						Route 11			Route 11		
	Two-Way Stop	Left	--	1	12	--	--	--	130	1	2	--	--	--
		Through	--	--	--	--	--	--	--	0	0	--	0	0
		Right	--	1	2	--	--	--	--	--	--			
2 Route 11 and Rubbermaid Entrance / Creekside Station			Rubbermaid Entrance			Creekside Station			Route 11			Route 11		
	Signal	Left	--	21	81	--	32	50	170	2	m11	150	12	24
		Through	--	--	--				--	7	45	--	69	136
		Right	--	0	0	--	0	0						
3 Route 11 and Shawnee Dr/ and Creekside Lane			Creekside Lane			Shawnee Dr			Route 11			Route 11		
	Signal	Left	--	21	81	--	32	50	170	2	m11	150	12	24
		Through	--	--	--	--	46	43	--	7	45	--	69	136
		Right		21	81	--	32	50	170	2	m11	150	12	24
4 Route 11 and Opequon Church Lane			Opequon Church Lane						Route 11			Route 11		
	Two-Way Stop	Left	--	4	10	--	--	--	200	1	1	--	--	--
		Through	--	--	--	--	--	--	--	0	0	--	0	0
		Right	340	4	10	--	--	--	--	--	--	--	0	0
5 Route 11 and Apple Valley Rd			Apple Valley Rd						Route 11			Route 11		
	Signal	Left	--	114	135	--	--	--	250	0	m12	--	--	--
		Through	--	--	--	--	--	--	--	1	244	--	111	413
		Right	500	45	59	--	--	--	--	--	--	150	15	17
6 Route 11 and Hood Way						Hood Way			Route 11			Route 11		
	Signal	Left	--	--	--	--	18	54	--	--	--	170	m4	m3
		Through	--	--	--	--	--	--	--	375	213	--	230	77
		Right	--	--	--	230	9	14	400	0	0	--	--	--
7 Route 11 and Commonwealth Ct			Gas Station			Commonwealth Ct			Route 11			Route 11		
	Signal	Left	--	28	46	--	32	97	350	m2	m2	130	8	m26
		Through				--	21	34	--	273	#376	--	59	#924
		Right												
8 Route 11 and Route 37 N (WB) on and off ramp			Route 37 N (WB) on and off ramp						Route 11			Route 11		
	Signal	Left	--	195	188	--	--	--	400	105	156	--	--	--
		Through	--	--	--	--	--	--	--	117	150	--	85	41
		Right	--	58	61	--	--	--	--	--	--	80	8	m26
9 Route 11 and Route 37 S (EB) on and off ramp/ Kernstown Commons Blvd			Route 37 S (EB) on and off ramp			Kernstown Commons Blvd N			Route 11			Route 11		
	Signal	Left	--	98	91	115	21	29	--	64	103	340	23	m30
		Through	--	31	43	--	52	78	--	121	175	--	68	142
		Right	--	62	52	--	0	0	--	0	0	--	0	0
10 Route 11 and Kernstown Commons Blvd South						Kernstown Commons Blvd S			Route 11			Route 11		
	Two-Way Stop	Left	--	0	1	--	13	47	160	0	0	--	5	11
		Through				--	--	--	--	0	0	--	0	0
		Right	--	0	0	--	6	12	300	0	0	240	0	0
11 Route 11 and Prosperity Dr			Prosperity Dr			Prosperity Dr			Route 11			Route 11		
	Two-Way Stop	Left	--	23	85	--	2	7	225	1	0	175	4	2
		Through							--	0	0	--	0	0
		Right				85	2	7	--	0	0	215	0	0
12 Route 11 and Renaissance Dr						Renaissance Dr			Route 11			Route 11		
	Two-Way Stop	Left	190	0	2	--	0	2	230	0	0	105	1	1
		Through	--	0	0				--	0	0	--	0	0
		Right										265	0	0

NOTES: # Synchro results indicates that 95th % queue may be longer

m Synchro results indicates that volume (and therefore the queue) is metered by upstream signal

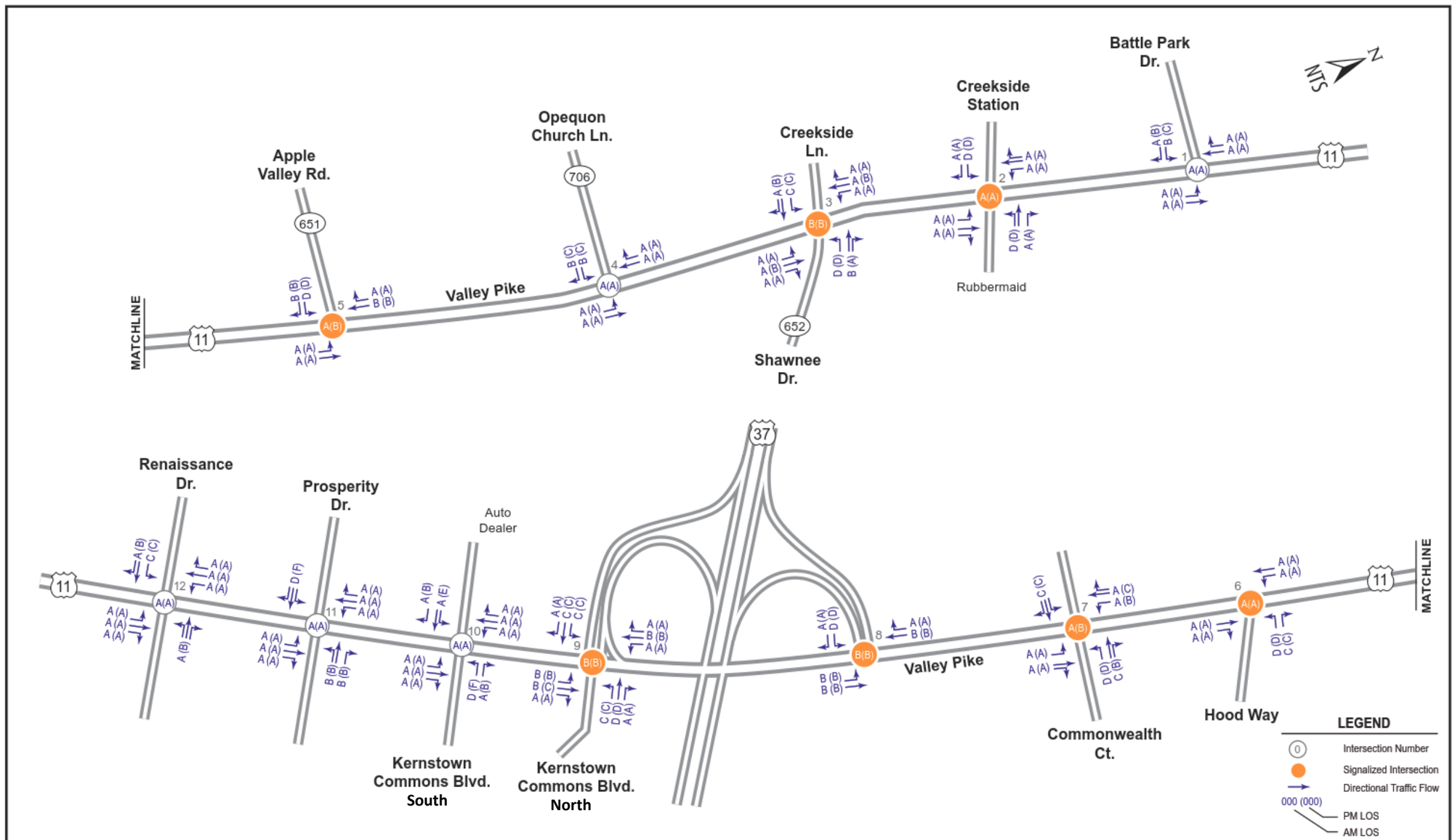
Table 15. Future Build (Alternative B – 2030) AM and PM Hour Delay and Level of Service (LOS)

Intersection Number and Description	Type of Control	Lane Group	Eastbound				Westbound				Northbound				Southbound				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
1 Route 11 and Battle Park Dr			Battle Park Dr								Route 11				Route 11					
	Two-Way Stop	Left	14.8	B	22.6	C	--	--	--	--	8.3	A	9.0	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	0.3	0.8
		Right	9.9	A	10.6	B	--	--	--	--	--	--	--	--					LOS	LOS
		Approach	11.2	B	18.2	C	--	--	--	--	0.2	A	0.2	A	0.0	A	0.0	A	A	A
2 Route 11 and Rubbermaid Ent/ Creekside Station			Creekside Station				Rubbermaid Entrance				Route 11				Route 11					
	Signal	Left	42.8	D	45.7	D	48.6	D	37.2	D	0.7	A	2.2	A	2.4	A	4.9	A	Delay	Delay
		Through	--	--	--	--					0.8	A	3.2	A	4.4	A	9.7	A	3.4	8.2
		Right	0.0	A	1.3	A	0.2	A	1.0	A									LOS	LOS
		Approach	32.1	C	27.2	C	37.6	D	18.5	B	0.8	A	3.1	A	4.2	A	9.2	A	A	A
3 Route 11 and Shawnee Dr/ Creekside Lane			Creekside Lane				Shawnee Dr				Route 11				Route 11					
	Signal	Left	31.7	C	23.4	C	53.6	D	44.4	D	3.5	A	7.0	A	6.3	A	9.4	A	Delay	Delay
		Through	0.0	A	15.1	B	12.5	B	6.4	A	8.3	A	17.5	B	8.3	A	13.7	B	11.7	16.6
		Right									1.4	A	2.0	A	0.0	A	0.0	A	LOS	LOS
		Approach	23.8	C	17.0	B	36.3	D	28.8	C	6.1	A	13.9	B	7.6	A	13.1	B	B	B
4 Route 11 and Opequon Church Lane			Opequon Church Lane								Route 11				Route 11					
	Two-Way Stop	Left	11.6	B	15.6	C	--	--	--	--	8.6	A	9.8	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	0.6	0.5
		Right	11.6	B	15.6	C	--	--	--	--	--	--	--	--	0.0	A	0.0	A	LOS	LOS
		Approach	11.6	B	15.6	C	--	--	--	--	0.1	A	0.1	A	0.0	A	0.0	A	A	A
5 Route 11 and Apple Valley Rd			Apple Valley Rd								Route 11				Route 11					
	Signal	Left	49.3	D	46.2	D	--	--	--	--	2.5	A	4.1	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	2.1	A	3.3	A	10.9	B	14.2	B	8.5	11.1
		Right	13.2	B	10.5	B	--	--	--	--	--	--	--	--	3.7	A	2.3	A	LOS	LOS
		Approach	31.7	C	25.3	C	--	--	--	--	2.2	A	3.4	A	9.3	A	12.5	B	A	B
6 Route 11 and Hood Way							Hood Way				Route 11				Route 11					
	Signal	Left	--	--	--	--	43.8	D	40.7	D	--	--	--	--	1.7	A	1.9	A	Delay	Delay
		Through	--	--	--	--	--	--	--	--	7.4	A	9.4	A	2.2	A	3.6	A	5.6	6.7
		Right	--	--	--	--	28.7	C	20.2	C	0.1	A	0.2	A	--	--	--	--	LOS	LOS
		Approach	--	--	--	--	39.3	D	37.2	D	7.0	A	8.3	A	2.2	A	3.6	A	A	A
7 Route 11 and Commonwealth Ct			Gas Station				Commonwealth Ct				Route 11				Route 11					
	Signal	Left	30.6	C	28.1	C	46.2	D	44.5	D	1.7	A	4.3	A	3.2	A	11.2	B	Delay	Delay
		Through					26.1	C	13.8	B	6.0	A	9.2	A	3.1	A	25.1	C	6.1	18.1
		Right									1.3	A	0.9	A					LOS	LOS
		Approach	30.6	C	28.1	C	37.1	D	33.5	C	5.9	A	9.1	A	3.1	A	24.4	C	A	B

Table 15. Contd. Future Build (Alternative B – 2030) AM and PM Hour Delay and Level of Service

Intersection Number and Description	Type of Control	Lane Group	Eastbound				Westbound				Northbound				Southbound				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
8 Route 11 and Route 37 N (WB) on and off ramp			Route 37 N (WB) on & off ramp								Route 11				Route 11					
	Signal	Left	42.4	D	40.8	D	--	--	--	--	14.0	B	18.1	B	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	11.4	B	11.5	B	11.3	B	10.7	B	19.8	16.7
		Right	6.9	A	7.2	A	--	--	--	--	--	--	--	--	4.2	A	1.9	A	LOS	LOS
		Approach	30.5	C	28.9	C	--	--	--	--	12.1	B	13.6	B	10.4	B	9.3	A	B	B
9 Route 11 and Route 37 S (EB) on and off ramp / Kernstown Commons Blvd			Route 37 S (EB) on & off ramp				Kernstown Commons Blvd				Route 11				Route 11					
	Signal	Left	32.3	C	30.9	C	21.5	C	22.7	C	12.3	B	13.6	B	7.9	A	9.2	A	Delay	Delay
		Through	31.0	C	31.3	C	44.1	D	39.1	D	19.9	B	24.8	C	11.3	B	11.9	B	13.4	13.4
		Right	7.7	A	6.9	A	1.2	A	0.9	A	0.0	A	0.2	A	0.2	A	1.7	A	LOS	LOS
		Approach	16.9	B	16.7	B	17.3	B	21.2	C	17.2	B	20.3	C	7.8	A	6.6	A	B	B
101 Route 11 and Kernstown Commons Blvd South			Auto Dealership				Kernstown Commons Blvd S				Route 11				Route 11					
	Two-Way Stop	Left	0.0	A	39.3	E	35.0	D	79.9	F	8.6	A	0.0	A	8.6	A	9.4	A	Delay	Delay
		Through					--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	1.6	3.7
		Right	0.0	A	12.0	B	10.0	A	11.0	B	0.0	A	0.0	A	0.0	A	0.0	A	LOS	LOS
		Approach	0.0	A	21.1	C	16.7	C	30.0	D	0.0	A	0.0	A	0.9	A	1.7	A	A	A
11 Route 11 and Prosperity Dr			Prosperity Dr				Prosperity Dr				Route 11				Route 11					
	Two-Way Stop	Left	26.2	D	51.6	F	11.5	B	14.2	B	8.5	A	8.8	A	8.4	A	8.5	A	Delay	Delay
		Through									0.0	A	0.0	A	0.0	A	0.0	A	2.0	5.4
		Right					11.5	B	14.2	B	0.0	A	0.0	A	0.0	A	0.0	A	LOS	LOS
		Approach	26.2	D	51.6	F	11.5	B	14.2	B	0.3	A	0.1	A	0.7	A	0.4	A	A	A
112 Route 11 and Renaissance Dr							Renaissance Dr				Route 11				Route 11					
	Two-Way Stop	Left	15.6	C	20.2	C	9.8	A	10.8	B	8.2	A	9.8	A	8.4	A	8.3	A	Delay	Delay
		Through	0.0	A	12.3	B					0.0	A	0.0	A	0.0	A	0.0	A	0.2	0.4
		Right												A	0.0	A	0.0	A	LOS	LOS
		Approach	15.6	C	17.9	C	9.8	A	10.8	B	0.1	A	0.0	A	0.2	A	0.1	A	A	A

Figure 50. Future Build (Alternative B – 2030) AM (PM) Peak Level of Service



STARS VDOT Virginia Department of Transportation

US ROUTE 11 (WINCHESTER CORRIDOR), City of Winchester, VA

US ROUTE 11 FUTURE 2030 BUILD ALTERNATIVE B PEAK HOUR LEVEL OF SERVICE (LOS)

FIGURE 50

Table 16. Future Build (Alternative B – 2030) Conditions: Summary of Intersection Queues (95th Percentile Queue, feet)

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
1 Route 11 and Battle Park Dr			Battle Park Dr						Route 11			Route 11		
	Two-Way Stop	Left	--	1	12	--	--	--	130	1	2	--	--	--
		Through	--	--	--	--	--	--	--	0	0	--	0	0
		Right	--	1	2	--	--	--	--	--	--			
2 Route 11 and Rubbermaid Entrance / Creekside Station			Rubbermaid Entrance			Creekside Station			Route 11			Route 11		
	Signal	Left	--	21	81	--	32	50	170	2	m11	150	12	24
		Through	--	--	--				--	7	45	--	69	136
		Right	--	0	0	--	0	0						
3 Route 11 and Shawnee Dr/ and Creekside Lane			Creekside Lane			Shawnee Dr			Route 11			Route 11		
	Signal	Left	--	9	14	--	129	172	--	m8	m1	225	27	32
		Through	--	0	25	--	46	43	--	174	#551	--	120	214
		Right							--	8	10	100	0	m0
4 Route 11 and Opequon Church Lane			Opequon Church Lane						Route 11			Route 11		
	Two-Way Stop	Left	--	4	10	--	--	--	200	1	1	--	--	--
		Through	--	--	--	--	--	--	--	0	0	--	0	0
		Right	340	4	10	--	--	--	--	--	--	--	0	0
5 Route 11 and Apple Valley Rd			Apple Valley Rd						Route 11			Route 11		
	Signal	Left	--	114	135	--	--	--	250	0	m12	--	--	--
		Through	--	--	--	--	--	--	--	1	244	--	111	413
		Right	500	45	59	--	--	--	--	--	--	150	15	17
6 Route 11 and Hood Way						Hood Way			Route 11			Route 11		
	Signal	Left	--	--	--	--	18	54	--	--	--	170	m4	m3
		Through	--	--	--	--	--	--	--	375	213	--	230	77
		Right	--	--	--	230	9	14	400	0	0	--	--	--
7 Route 11 and Commonwealth Ct			Gas Station			Commonwealth Ct			Route 11			Route 11		
	Signal	Left	--	28	46	--	32	97	350	m2	m2	130	8	m26
		Through				--	21	34	--	273	#376	--	59	#924
		Right												
8 Route 11 and Route 37 N (WB) on and off ramp			Route 37 N (WB) on and off ramp						Route 11			Route 11		
	Signal	Left	--	195	188	--	--	--	400	105	156	--	--	--
		Through	--	--	--	--	--	--	--	117	150	--	85	41
		Right	--	58	61	--	--	--	--	--	--	80	8	m2
9 Route 11 and Route 37 S (EB) on and off ramp/ Kernstown Commons Blvd			Route 37 S (EB) on and off ramp			Kernstown Commons Blvd N			Route 11			Route 11		
	Signal	Left	--	98	91	115	21	29	--	64	103	340	23	m30
		Through	--	31	43	--	52	78	--	121	176	--	68	142
		Right	--	62	52	--	0	0	--	0	0	--	0	0
10 Route 11 and Kernstown Commons Blvd South						Kernstown Commons Blvd S			Route 11			Route 11		
	Two-Way Stop	Left	--	0	1	--	13	47	160	0	0	--	5	11
		Through				--	--	--	--	0	0	--	0	0
		Right	--	0	0	--	6	12	300	0	0	240	0	0
11 Route 11 and Prosperity Dr			Prosperity Dr			Prosperity Dr			Route 11			Route 11		
	Two-Way Stop	Left	--	23	85	--	2	7	225	1	0	175	4	2
		Through							--	0	0	--	0	0
		Right				85	2	7	--	0	0	215	0	0
12 Route 11 and Renaissance Dr						Renaissance Dr			Route 11			Route 11		
	Two-Way Stop	Left	190	0	2	--	0	2	230	0	0	105	1	1
		Through	--	0	0				--	0	0	--	0	0
		Right										265	0	0

NOTES: # Synchro results indicates that 95th % queue may be longer

m Synchro results indicates that volume (and therefore the queue) is metered by upstream signal

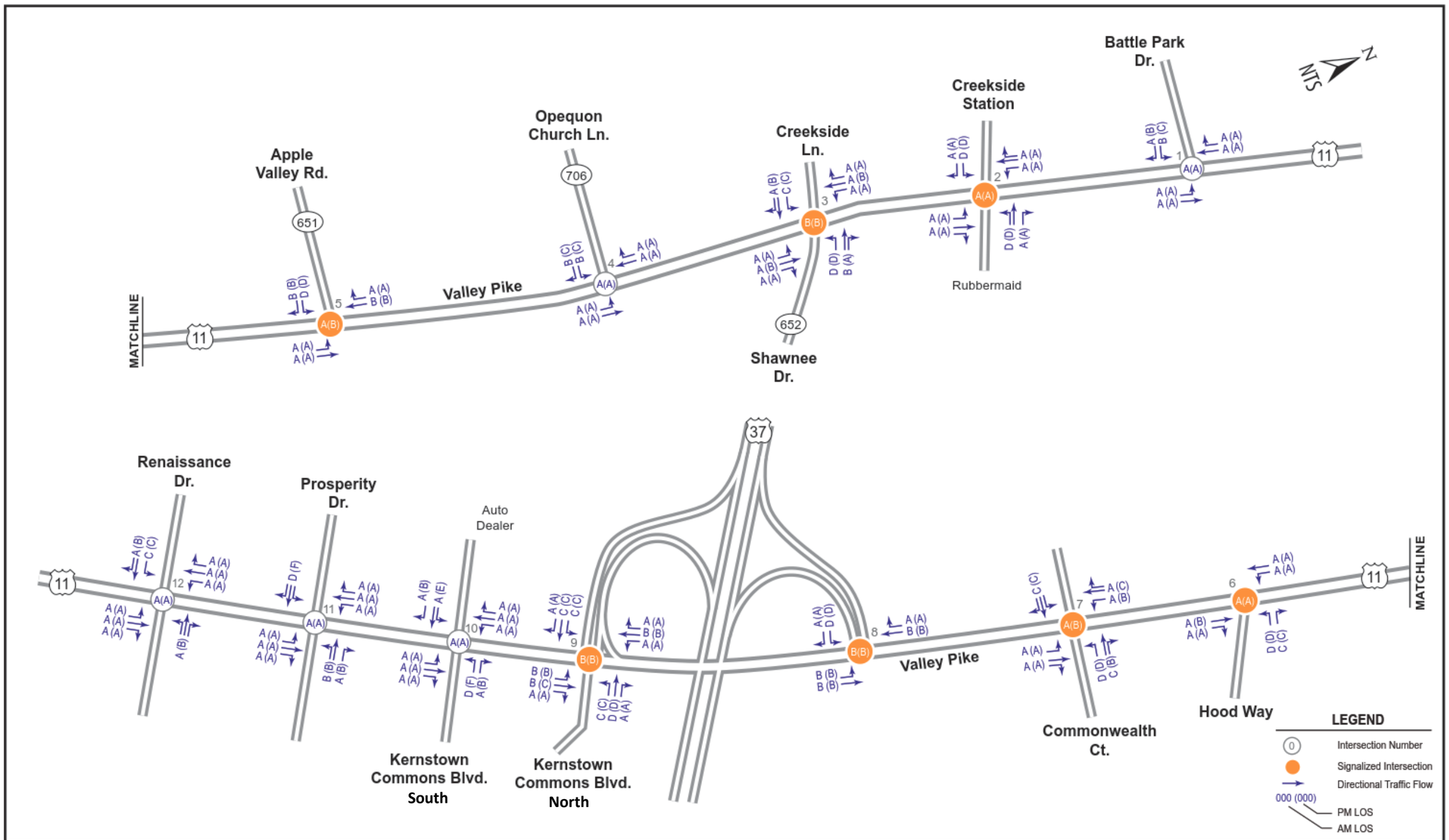
Table 17. Future Build (Alternative C – 2030) AM and PM Hour Delay and Level of Service (LOS)

Intersection Number and Description	Type of Control	Lane Group	Eastbound				Westbound				Northbound				Southbound				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
1 Route 11 and Battle Park Dr			Battle Park Dr								Route 11				Route 11					
	Two-Way Stop	Left	14.8	B	22.7	C	--	--	--	--	8.3	A	9.0	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	0.3	0.8
		Right	9.9	A	10.6	B	--	--	--	--	--	--	--	--					LOS	LOS
		Approach	11.2	B	18.2	C	--	--	--	--	0.2	A	0.2	A	0.0	A	0.0	A	A	A
2 Route 11 and Rubbermaid Ent/ Creekside Station			Creekside Station				Rubbermaid Entrance				Route 11				Route 11					
	Signal	Left	42.8	D	45.9	D	48.6	D	37.3	D	0.7	A	3.0	A	2.4	A	4.8	A	Delay	Delay
		Through	--	--	--	--					0.8	A	4.5	A	4.4	A	9.6	A	3.4	8.8
		Right	0.0	A	1.3	A	0.2	A	1.0	A									LOS	LOS
		Approach	32.1	C	27.3	C	37.6	D	18.5	B	0.8	A	4.3	A	4.2	A	9.2	A	A	A
3 Route 11 and Shawnee Dr/ Creekside Lane			Creekside Lane				Shawnee Dr				Route 11				Route 11					
	Signal	Left	31.7	C	23.4	C	53.6	D	44.4	D	3.5	A	7.3	A	6.3	A	9.3	A	Delay	Delay
		Through	0.0	A	15.1	B	12.5	B	6.4	A	8.3	A	17.4	B	8..3		13.3	B	11.7	16.4
		Right									1.4	A	2.1	A	0.0	A	0.0	A	LOS	LOS
		Approach	23.8	C	17.0	B	36.3	D	28.8	C	6.1	A	13.8	B	7.6	A	12.6	B	B	B
4 Route 11 and Opequon Church Lane			Opequon Church Lane								Route 11				Route 11					
	Two-Way Stop	Left	11.6	B	15.6	C	--	--	--	--	8.6	A	9.8	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	0.6	0.5
		Right	11.6	B	15.6	C	--	--	--	--	--	--	--	--	0.0	A	0.0	A	LOS	LOS
		Approach	11.6	B	15.6	C	--	--	--	--	0.1	A	0.1	A	0.0	A	0.0	A	A	A
5 Route 11 and Apple Valley Rd			Apple Valley Rd								Route 11				Route 11					
	Signal	Left	49.3	D	46.2	D	--	--	--	--	2.5	A	4.4	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	2.0	A	4.0	A	10.9	B	14.6	B	8.5	11.6
		Right	13.2	B	10.5	B	--	--	--	--	--	--	--	--	3.7	A	2.2	A	LOS	LOS
		Approach	31.7	C	25.3	C	--	--	--	--	2.1	A	4.0	A	9.3	A	12.9	B	A	B
6 Route 11 and Hood Way							Hood Way				Route 11				Route 11					
	Signal	Left	--	--	--	--	43.8	D	40.8	D	--	--	--	--	1.7	A	1.7	A	Delay	Delay
		Through	--	--	--	--	--	--	--	--	7.4	A	9.6	A	2.2	A	3.4	A	5.6	6.7
		Right	--	--	--	--	28.7	C	20.2	C	0.1	A	0.2	A	--	--	--	--	LOS	LOS
		Approach	--	--	--	--	39.3	D	37.2	D	7.0	A	8.5	A	2.2	A	3.3	A	A	A
7 Route 11 and Commonwealth Ct			Gas Station				Commonwealth Ct				Route 11				Route 11					
	Signal	Left	30.6	C	28.1	C	46.2	D	44.5	D	1.7	A	4.6	A	3.2	A	11.6	B	Delay	Delay
		Through					26.1	C	13.8	B	6.0	A	9.6	A	3.1	A	25.5	C	6.1	18.5
		Right									1.3	A	0.9	A					LOS	LOS
		Approach	30.6	C	28.1	C	37.1	D	33.5	C	5.9	A	9.4	A	3.1	A	24.7	C	A	B

Table 17. Contd. Future Build (Alternative C – 2030) AM and PM Hour Delay and Level of Service

Intersection Number and Description	Type of Control	Lane Group	Eastbound				Westbound				Northbound				Southbound				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
8 Route 11 and Route 37 N (WB) on and off ramp			Route 37 N (WB) on & off ramp								Route 11				Route 11					
	Signal	Left	42.4	D	40.8	D	--	--	--	--	14.0	B	16.8	B	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	11.4	B	10.3	B	11.3	B	10.8	B	19.8	16.4
		Right	6.9	A	7.2	A	--	--	--	--	--	--	--	--	4.2	A	1.9	A	LOS	LOS
		Approach	30.5	C	28.9	C	--	--	--	--	12.1	B	12.4	B	10.4	B	9.4	A	B	B
9 Route 11 and Route 37 S (EB) on and off ramp / Kernstown Commons Blvd			Route 37 S (EB) on & off ramp				Kernstown Commons Blvd				Route 11				Route 11					
	Signal	Left	32.3	C	28.6	C	21.5	C	21.9	C	12.3	B	14.4	B	7.9	A	9.0	A	Delay	Delay
		Through	31.0	C	30.9	C	44.1	D	39.1	D	19.9	B	26.0	C	11.3	B	13.5	B	13.4	13.8
		Right	7.7	A	6.8	A	1.2	A	0.9	A	0.0	A	0.2	A	0.2	A	1.7	A	LOS	LOS
		Approach	16.9	B	15.9	B	17.3	B	21.1	C	17.2	B	21.3	C	7.8	A	7.2	A	B	B
10 Route 11 and Kernstown Commons Blvd South			Auto Dealership				Kernstown Commons Blvd S				Route 11				Route 11					
	Two-Way Stop	Left	0.0	A	39.3	E	35.0	D	80.2	F	8.6	A	0.0	A	8.6	A	9.4	A	Delay	Delay
		Through					--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	1.6	3.7
		Right	0.0	A	11.9	B	10.0	A	11.0	B	0.0	A	0.0	A	0.0	A	0.0	A	LOS	LOS
		Approach	0.0	A	21.1	C	16.7	C	30.0	D	0.0	A	0.0	A	0.9	A	1.7	A	A	A
11 Route 11 and Prosperity Dr			Prosperity Dr				Prosperity Dr				Route 11				Route 11					
	Two-Way Stop	Left	26.2	D	51.6	F	11.5	B	14.2	B	8.5	A	8.8	A	8.4	A	8.5	A	Delay	Delay
		Through									0.0	A	0.0	A	0.0	A	0.0	A	2.0	5.4
		Right					8.5	A	14.2	B	0.0	A	0.0	A	0.0	A	0.0	A	LOS	LOS
		Approach	26.2	D	51.6	F	11.5	B	14.2	B	0.3	A	0.1	A	0.7	A	0.4	A	A	A
112 Route 11 and Renaissance Dr							Renaissance Dr				Route 11				Route 11					
	Two-Way Stop	Left	15.6	C	20.2	C	9.8	A	10.8	B	8.2	A	9.8	A	8.4	A	8.3	A	Delay	Delay
		Through	0.0	A	12.3	B					0.0	A	0.0	A	0.0	A	0.0	A	0.2	0.4
		Right												A	0.0	A	0.0	A	LOS	LOS
		Approach	15.6	C	17.9	C	9.8	A	10.8	B	0.1	A	0.0	A	0.2	A	0.1	A	A	A

Figure 51. Future Build (Alternative C – 2030) AM (PM) Peak Level of Service



STARS VDOT Virginia Department of Transportation

US ROUTE 11 (WINCHESTER CORRIDOR), City of Winchester, VA

US ROUTE 11 FUTURE 2030 BUILD ALTERNATIVE C PEAK HOUR LEVEL OF SERVICE (LOS)

FIGURE 51

Table 18. Future Build (Alternative C – 2030) Conditions: Summary of Intersection Queues (95th Percentile Queue, feet)

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
1 Route 11 and Battle Park Dr			Battle Park Dr						Route 11			Route 11		
	Two-Way Stop	Left	--	1	12	--	--	--	130	1	2	--	--	--
		Through	--	--	--	--	--	--	--	0	0	--	0	0
		Right	--	1	2	--	--	--	--	--	--			
2 Route 11 and Rubbermaid Entrance / Creekside Station			Rubbermaid Entrance			Creekside Station			Route 11			Route 11		
	Signal	Left	--	21	81	--	32	50	170	2	m11	150	12	24
		Through	--	--	--				--	7	45	--	69	136
		Right	--	0	0	--	0	0						
3 Route 11 and Shawnee Dr/ and Creekside Lane			Creekside Lane			Shawnee Dr			Route 11			Route 11		
	Signal	Left	--	9	14	--	129	172	--	m8	m1	225	27	32
		Through	--	0	25	--	46	43	--	174	#551	--	120	211
		Right							--	8	13	100	0	m0
4 Route 11 and Opequon Church Lane			Opequon Church Lane						Route 11			Route 11		
	Two-Way Stop	Left	--	4	10	--	--	--	200	1	1	--	--	--
		Through	--	--	--	--	--	--	--	0	0	--	0	0
		Right	340	4	10	--	--	--	--	--	--	--	0	0
5 Route 11 and Apple Valley Rd			Apple Valley Rd						Route 11			Route 11		
	Signal	Left	--	114	135	--	--	--	250	0	m19	--	--	--
		Through	--	--	--	--	--	--	--	1	375	--	111	411
		Right	500	45	59	--	--	--	--	--	--	150	15	19
6 Route 11 and Hood Way						Hood Way			Route 11			Route 11		
	Signal	Left	--	--	--	--	18	54	--	--	--	170	m4	m3
		Through	--	--	--	--	--	--	--	375	213	--	230	81
		Right	--	--	--	230	9	14	400	0	0	--	--	--
7 Route 11 and Commonwealth Ct			Gas Station			Commonwealth Ct			Route 11			Route 11		
	Signal	Left	--	28	46	--	32	97	350	m2	m2	130	8	m27
		Through				--	21	34	--	273	#376	--	59	#924
		Right												
8 Route 11 and Route 37 N (WB) on and off ramp			Route 37 N (WB) on and off ramp						Route 11			Route 11		
	Signal	Left	--	195	188	--	--	--	400	105	154	--	--	--
		Through	--	--	--	--	--	--	--	117	148	--	85	41
		Right	--	58	61	--	--	--	--	--	--	80	8	m2
9 Route 11 and Route 37 S (EB) on and off ramp/ Kernstown Commons Blvd			Route 37 S (EB) on and off ramp			Kernstown Commons Blvd N			Route 11			Route 11		
	Signal	Left	--	98	90	115	21	29	--	64	105	340	23	m28
		Through	--	31	43	--	52	78	--	121	178	--	68	156
		Right	--	62	52	--	0	0	--	0	0	--	0	0
10 Route 11 and Kernstown Commons Blvd South						Kernstown Commons Blvd S			Route 11			Route 11		
	Two-Way Stop	Left	--	0	1	--	13	47	160	0	0	--	5	11
		Through				--	--	--	--	0	0	--	0	0
		Right	--	0	0	--	6	12	300	0	0	240	0	0
11 Route 11 and Prosperity Dr			Prosperity Dr			Prosperity Dr			Route 11			Route 11		
	Two-Way Stop	Left	--	23	85	--	2	7	225	1	0	175	4	2
		Through							--	0	0	--	0	0
		Right				85	2	7	--	0	0	215	0	0
12 Route 11 and Renaissance Dr						Renaissance Dr			Route 11			Route 11		
	Two-Way Stop	Left	190	0	2	--	0	2	230	0	0	105	1	1
		Through	--	0	0				--	0	0	--	0	0
		Right										265	0	0

NOTES: # Synchro results indicates that 95th % queue may be longer

m Synchro results indicates that volume (and therefore the queue) is metered by upstream signal

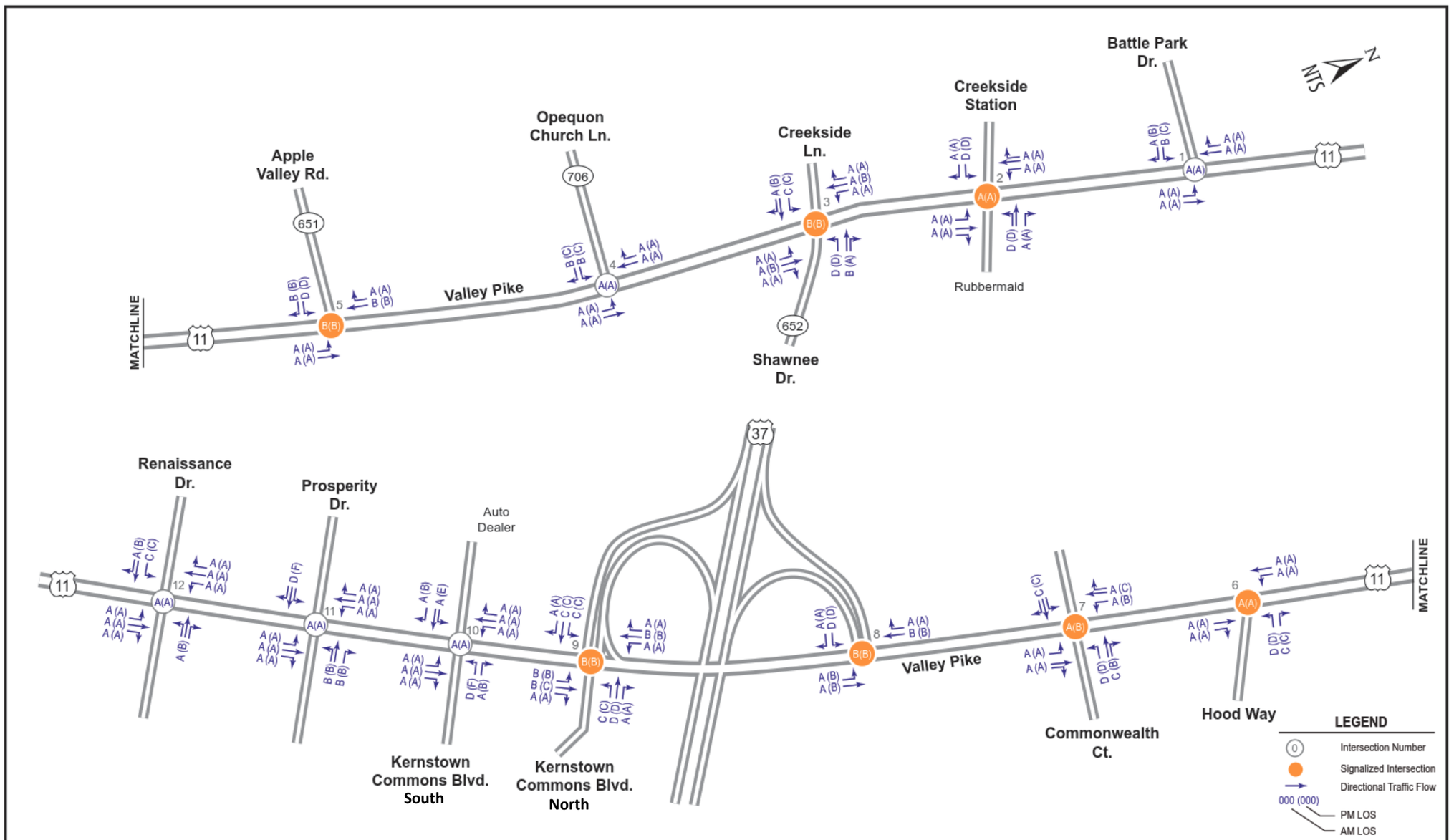
Table 19. Future Build (Alternative C – 2030) AM and PM Hour Delay and Level of Service (LOS)

Intersection Number and Description	Type of Control	Lane Group	Eastbound				Westbound				Northbound				Southbound				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
1 Route 11 and Battle Park Dr			Battle Park Dr								Route 11				Route 11					
	Two-Way Stop	Left	14.8	B	22.6	C	--	--	--	--	8.3	A	9.0	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	0.3	0.8
		Right	9.9	A	10.6	B	--	--	--	--	--	--	--	--					LOS	LOS
		Approach	11.2	B	18.2	C	--	--	--	--	0.2	A	0.2	A	0.0	A	0.0	A	A	A
2 Route 11 and Rubbermaid Ent/ Creekside Station			Creekside Station				Rubbermaid Entrance				Route 11				Route 11					
	Signal	Left	42.8	D	45.8	D	48.6	D	37.2	D	0.6	A	2.4	A	2.4	A	4.8	A	Delay	Delay
		Through	--	--	--	--					0.9	A	3.5	A	4.4	A	9.7	A	3.4	8.3
		Right	0.0	A	1.3	A	0.2	A	1.0	A									LOS	LOS
		Approach	32.1	C	27.2	C	37.6	D	18.5	B	0.8	A	3.4	A	4.2	A	9.2	A	A	A
3 Route 11 and Shawnee Dr/ Creekside Lane			Creekside Lane				Shawnee Dr				Route 11				Route 11					
	Signal	Left	31.7	C	23.4	C	53.6	D	44.4	D	2.3	A	5.3	A	6.3	A	9.4	A	Delay	Delay
		Through	0.0	A	15.1	B	12.5	B	6.4	A	5.8	A	16.6	B	8.4	A	13.5	B	10.7	16.3
		Right									0.9	A	2.1	A	0.0	A	0.0	A	LOS	LOS
		Approach	23.8	C	17.0	B	36.3	D	28.8	C	4.2	A	13.2	B	7.7	A	12.9	B	B	B
4 Route 11 and Opequon Church Lane			Opequon Church Lane								Route 11				Route 11					
	Two-Way Stop	Left	11.6	B	15.6	C	--	--	--	--	8.6	A	9.8	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	0.6	0.5
		Right	11.6	B	15.6	C	--	--	--	--	--	--	--	--	0.0	A	0.0	A	LOS	LOS
		Approach	11.6	B	15.6	C	--	--	--	--	0.1	A	0.1	A	0.0	A	0.0	A	A	A
5 Route 11 and Apple Valley Rd			Apple Valley Rd								Route 11				Route 11					
	Signal	Left	49.3	D	46.2	D	--	--	--	--	4.9	A	5.0	A	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	0.0	A	0.0	A	13.9	B	14.9	B	15.0	15.7
		Right	13.2	B	10.5	B	--	--	--	--	--	--	--	--	5.3	A	2.7	A	LOS	LOS
		Approach	31.7	C	25.3	C	--	--	--	--	4.9	A	5.0	A	12.0	B	13.2	B	B	B
6 Route 11 and Hood Way							Hood Way				Route 11				Route 11					
	Signal	Left	--	--	--	--	43.8	D	40.7	D	--	--	--	--	0.6	A	1.7	A	Delay	Delay
		Through	--	--	--	--	--	--	--	--	6.3	A	8.6	A	0.7	A	3.1	A	4.5	6.2
		Right	--	--	--	--	28.7	C	20.2	C	0.1	A	0.2	A	--	--	--	--	LOS	LOS
		Approach	--	--	--	--	39.3	D	37.2	D	6.1	A	7.6	A	0.7	A	3.0	A	A	A
7 Route 11 and Commonwealth Ct			Gas Station				Commonwealth Ct				Route 11				Route 11					
	Signal	Left	30.6	C	28.1	C	46.2	D	44.5	D	1.0	A	4.3	A	3.1	A	13.5	B	Delay	Delay
		Through					26.1	C	13.8	B	3.0	A	9.2	A	3.9	A	27.7	C	4.5	19.3
		Right									1.3	A	0.9	A					LOS	LOS
		Approach	30.6	C	28.1	C	37.1	D	33.5	C	3.0	A	9.1	A	3.8	A	26.9	C	A	B

Table 19. Contd. Future Build (Alternative D – 2030) AM and PM Hour Delay and Level of Service

Intersection Number and Description	Type of Control	Lane Group	Eastbound				Westbound				Northbound				Southbound				Overall	
			AM		PM		AM		PM		AM		PM		AM		PM			
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	AM	PM
8 Route 11 and Route 37 N (WB) on and off ramp			Route 37 N (WB) on & off ramp								Route 11				Route 11					
	Signal	Left	42.4	D	40.8	D	--	--	--	--	9.0	A	18.2	B	--	--	--	--	Delay	Delay
		Through	--	--	--	--	--	--	--	--	7.4	A	11.6	B	12.2	B	10.8	B	18.6	16.7
		Right	6.9	A	7.2	A	--	--	--	--	--	--	--	--	4.4	A	2.1	A	LOS	LOS
		Approach	30.5	C	28.9	C	--	--	--	--	7.8	A	13.7	B	11.1	B	9.4	A	B	B
9 Route 11 and Route 37 S (EB) on and off ramp / Kernstown Commons Blvd			Route 37 S (EB) on & off ramp				Kernstown Commons Blvd				Route 11				Route 11					
	Signal	Left	32.3	C	30.6	C	21.5	C	22.7	C	12.3	B	13.7	B	7.5	A	9.1	A	Delay	Delay
		Through	31.0	C	31.2	C	44.1	D	39.1	D	19.9	B	24.9	C	11.9	B	11.7	B	13.6	13.4
		Right	7.7	A	6.9	A	1.2	A	0.9	A	0.0	A	0.2	A	0.2	A	1.7	A	LOS	LOS
		Approach	16.9	B	16.6	B	17.3	B	21.2	C	17.2	B	20.4	C	8.1	A	6.6	A	B	B
10 Route 11 and Kernstown Commons Blvd South			Auto Dealership				Kernstown Commons Blvd S				Route 11				Route 11					
	Two-Way Stop	Left	0.0	A	39.3	E	35.0	D	79.9	F	8.6	A	0.0	A	8.6	A	9.4	A	Delay	Delay
		Through					--	--	--	--	0.0	A	0.0	A	0.0	A	0.0	A	1.6	3.7
		Right	0.0	A	11.9	B	10.0	A	11.0	B	0.0	A	0.0	A	0.0	A	0.0	A	LOS	LOS
		Approach	0.0	A	21.1	C	16.7	C	30.0	D	0.0	A	0.0	A	0.9	A	1.7	A	A	A
11 Route 11 and Prosperity Dr			Prosperity Dr				Prosperity Dr				Route 11				Route 11					
	Two-Way Stop	Left	26.2	D	51.6	F	11.5	B	14.2	B	8.5	A	8.8	A	8.4	A	8.5	A	Delay	Delay
		Through									0.0	A	0.0	A	0.0	A	0.0	A	2.0	5.4
		Right					11.5	B	14.2	B	0.0	A	0.0	A	0.0	A	0.0	A	LOS	LOS
		Approach	26.2	D	51.6	F	11.5	B	14.2	B	0.3	A	0.1	A	0.7	A	0.4	A	A	A
112 Route 11 and Renaissance Dr							Renaissance Dr				Route 11				Route 11					
	Two-Way Stop	Left	15.6	C	20.2	C	9.8	A	10.8	B	8.2	A	9.8	A	8.4	A	8.3	A	Delay	Delay
		Through	0.0	A	12.3	B					0.0	A	0.0	A	0.0	A	0.0	A	0.2	0.4
		Right												A	0.0	A	0.0	A	LOS	LOS
		Approach	15.6	C	17.9	C	9.8	A	10.8	B	0.1	A	0.0	A	0.2	A	0.1	A	A	A

Figure 52. Future Build (Alternative D – 2030) AM (PM) Peak Level of Service



STARS VDOT Virginia Department of Transportation

US ROUTE 11 (WINCHESTER CORRIDOR), City of Winchester, VA

US ROUTE 11 FUTURE 2030 BUILD ALTERNATIVE D PEAK HOUR LEVEL OF SERVICE (LOS)

FIGURE 52

Table 20. Future Build (Alternative D – 2030) Conditions: Summary of Intersection Queues (95th Percentile Queue, feet)

Intersection Number and Description	Type of Control	Lane Group	Eastbound			Westbound			Northbound			Southbound		
			Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)	Storage Bay Length	AM Queue (ft)	PM Queue (ft)
1 Route 11 and Battle Park Dr			Battle Park Dr						Route 11			Route 11		
	Two-Way Stop	Left	--	1	12	--	--	--	130	1	2	--	--	--
		Through	--	--	--	--	--	--	--	0	0	--	0	0
		Right	--	1	2	--	--	--	--	--	--			
2 Route 11 and Rubbermaid Entrance / Creekside Station			Rubbermaid Entrance			Creekside Station			Route 11			Route 11		
	Signal	Left	--	21	81	--	32	50	170	2	m11	150	12	24
		Through	--	--	--				--	7	44	--	69	136
		Right	--	0	0	--	0	0						
3 Route 11 and Shawnee Dr/ and Creekside Lane			Creekside Lane			Shawnee Dr			Route 11			Route 11		
	Signal	Left	--	9	14	--	129	172	--	m3	m1	225	27	32
		Through	--	0	25	--	46	43	--	172	#555	--	121	212
		Right							--	8	31	100	0	m0
4 Route 11 and Opequon Church Lane			Opequon Church Lane						Route 11			Route 11		
	Two-Way Stop	Left	--	4	10	--	--	--	200	1	1	--	--	--
		Through	--	--	--	--	--	--	--	0	0	--	0	0
		Right	340	4	10	--	--	--	--	--	--	--	0	0
5 Route 11 and Apple Valley Rd			Apple Valley Rd						Route 11			Route 11		
	Signal	Left	--	114	135	--	--	--	250	55	m28	--	--	--
		Through	--	--	--	--	--	--	--	0	0	--	233	451
		Right	500	45	59	--	--	--	--	--	--	150	46	26
6 Route 11 and Hood Way						Hood Way			Route 11			Route 11		
	Signal	Left	--	--	--	--	18	54	--	--	--	170	m1	m3
		Through	--	--	--	--	--	--	--	344	218	--	12	82
		Right	--	--	--	230	9	14	400	0	1	--	--	--
7 Route 11 and Commonwealth Ct			Gas Station			Commonwealth Ct			Route 11			Route 11		
	Signal	Left	--	28	46	--	32	97	350	m1	m2	130	9	m33
		Through				--	21	34	--	98	#376	--	88	#924
		Right												
8 Route 11 and Route 37 N (WB) on and off ramp			Route 37 N (WB) on and off ramp						Route 11			Route 11		
	Signal	Left	--	195	188	--	--	--	400	66	156	--	--	--
		Through	--	--	--	--	--	--	--	74	150	--	134	41
		Right	--	58	61	--	--	--	--	--	--	80	21	m2
9 Route 11 and Route 37 S (EB) on and off ramp/ Kernstown Commons Blvd			Route 37 S (EB) on and off ramp			Kernstown Commons Blvd N			Route 11			Route 11		
	Signal	Left	--	98	91	115	21	29	--	64	103	340	20	m30
		Through	--	31	43	--	52	78	--	121	175	--	65	142
		Right	--	62	52	--	0	0	--	0	0	--	0	31
10 Route 11 and Kernstown Commons Blvd South						Kernstown Commons Blvd S			Route 11			Route 11		
	Two-Way Stop	Left	--	0	1	--	13	47	160	0	0	--	5	11
		Through				--	--	--	--	0	0	--	0	0
		Right	--	0	0	--	6	12	300	0	0	240	0	0
11 Route 11 and Prosperity Dr			Prosperity Dr			Prosperity Dr			Route 11			Route 11		
	Two-Way Stop	Left	--	23	85	--	2	7	225	1	0	175	4	2
		Through							--	0	0	--	0	0
		Right				85	2	7	--	0	0	215	0	0
12 Route 11 and Renaissance Dr						Renaissance Dr			Route 11			Route 11		
	Two-Way Stop	Left	190	0	2	--	0	2	230	0	0	105	1	1
		Through	--	0	0				--	0	0	--	0	0
		Right										265	0	0

NOTES: # Synchro results indicates that 95th % queue may be longer

m Synchro results indicates that volume (and therefore the queue) is metered by upstream signal

7 Crash Reduction Analysis

A crash reduction analysis was conducted for US Route 11 from Battle Park Drive to Renaissance Drive. As part of the crash reduction methodology, the *Crash Mitigation Factor Clearinghouse*[3] and *FHWA Desktop Reference for Crash Reduction Factors*[4] were utilized to calculate the Crash Reduction Factors (CRFs) associated with each proposed alternative along US Route 11 in Winchester, Virginia, from the Virginia Department of Transportation (VDOT), Frederick County, and the City of Winchester. The CRFs were applied to the crash history data from the *VDOT Crashtools Database*[5] to determine the expected number of crashes and the percent reduction in crashes per alternative. Expected crashes were projected to the year 2030 (base build year) and then calculated over a 20-year life cycle to 2050. The expected crashes were then utilized to compare the *No Build* and *Build* conditions based on the 20-year projection to evaluate the efficacy of the proposed alternative.

7.1 Analysis Method

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

7.1.1 Proposed Roadway Modifications and CRFs

The CRFs were selected based on the improvements designated for the *2030 and 2050 Build* conditions. In **Appendix,** includes the following: 1) the countermeasures proposed, 2) categories of countermeasures obtained from the *CMF Clearinghouse* and/or *FHWA Desktop Reference* source, 3) applicable crash type and severity, 4) percent of applicable crashes, and 5) notes for selected CRFs. It should be noted that CRFs are not provided for all roadway modifications in the *Crash Mitigation Factor Clearinghouse* or *FHWA Desktop Reference for Crash Reduction Factors*. Roadway modifications without designated CRFs were not given a CRF for this analysis; therefore, those improvements did not have any impact on the expected crashes.

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

Equation 1. Composite CRF Calculation

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

7.1.2 Applicable Crash Calculations

To properly determine how the improvements impact the 2030 and 2050 expected crashes, a detailed evaluation was conducted of historical crash data (2012-2017). Not every crash at a specific location would be eliminated due to an improvement. For example, when installing a right-in-right-out at an unsignalized intersection, only left-turn and through-movement crashes related to that respective approach would be expected to be reduced. Therefore, the CRF should only be applied to the specific crashes that may have been affected by the improvement. So, for each improvement with a known CRF, the number of crashes impacted by the improvement was determined by analyzing each crash within the *VDOT Crashtools Database* from the five (5) most recent calendar years of crash data (2012-2017). Then, the percent of applicable crashes (i.e., number of applicable crashes across the five calendar years divided by the total number of crashes across the five calendar years) was determined for each improvement with a known CRF, as shown in **Equation 2**.

Equation 2. Percentage of Applicable Crashes Calculation

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

7.1.3 Crash Reduction Evaluation

Based on the 2012-2017 crash data within the *VDOT Crashtools Database*, the average numbers of property damage only (O), Visible and Non-Visible Injury (B+C), and fatal or ambulatory injury (K+A) over the most recent five years were calculated. The existing average crashes were then projected into 2030 (i.e., 13-year projection based on the 0.5% growth rate) to which a base build year was established. These estimates were then projected out to the year 2050 (i.e., 20-year projection) to estimate the expected number of (O), (B+C), and (K+A) crashes for the *Build* conditions over the 20-year life cycle, assuming a 0.5% growth rate from Battle Park Drive to Renaissance Drive.

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

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

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

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

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

$$2030\ Build\ Expected\ Crashes = [2030\ No\ Build\ Expected\ Crashes - [2030\ No\ Build\ Expected\ Crashes * \%\ Applicable\ Crashes * (CRF)]$$

The percent reduction in (O), (B+C), and (K+A) crashes between the *2050 No-Build* and *Build* conditions per package was calculated for each intersection and segment along the US Route 11 corridor over the 20-year cycle life.

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

7.2 Analysis Results

The total crash reduction values over the 20-year cycle life (i.e., from 2030 to 2050) and percentages for each alternative are provided in **Table 21**.

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

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

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

Table 21. Percent Crash Reduction per Alternative (20-Year Cycle Life)

Location	Package	PDO Crashes (Reduction)	B+C Crashes (Reduction)	K+A Crashes (Reduction)	Total Percent Reduction
Battle Park Dr. to Creekside Station/Rubbermaid Entrance at Route 11	Alternative A	0	0	0	0%
	Alternative B+A	0	0	0	0%
	Alternative C+A	0	0	0	0%
	Alternative D+A	0	0	0	0%
Creekside Station/Rubbermaid Entrance at Route 11	Alternative A	3.03	0	1.51	32%
	Alternative B+A	3.03	0	1.51	32%
	Alternative C+A	5.06	0	2.53	54%
	Alternative D+A	3.03	0	1.51	32%
Rubbermaid Entrance to Shawnee Dr./Creekside Ln. at Route 11	Alternative A	0	0	0	0%
	Alternative B+A	0	0	0	0%
	Alternative C+A	0	0	0	0%
	Alternative D+A	0	0	0	0%
Shawnee Dr./Creekside Ln. at Route 11	Alternative A	0.38	1.13	0	8%
	Alternative B+A	0.38	1.13	0	8%
	Alternative C+A	0.38	1.13	0	8%
	Alternative D+A	0.38	1.13	0	8%
Shawnee Dr./Creekside Ln. to Apple Valley Rd at Route 11	Alternative A	0	0	0	0%
	Alternative B+A	0	0	0	0%
	Alternative C+A	1.11	2.05	0	3%
	Alternative D+A	0	0	0	0%
Apple Valley Rd at Route 11	Alternative A	4.11	1.03	0	22%
	Alternative B+A	4.11	1.03	0	22%
	Alternative C+A	8.46	2.11	0	45%
	Alternative D+A	5.5	1.38	0	29%
Apple Valley Rd to Hood Way at Route 11	Alternative A	0	0	0	0%
	Alternative B+A	0	0	0	0%
	Alternative C+A	0	0	0	0%
	Alternative D+A	0	0	0	0%
Hood Way at Route 11	Alternative A	12.33	2.05	1.03	22%
	Alternative B+A	12.33	2.05	1.03	22%
	Alternative C+A	12.33	2.05	1.03	22%
	Alternative D+A	12.33	2.05	1.03	22%
Hood Way to Commonwealth Ct at Route 11	Alternative A	0	0	0	0%
	Alternative B+A	0	0	0	0%
	Alternative C+A	3.14	0.79	0.79	17%
	Alternative D+A	0	0	0	0%
Commonwealth Ct at Route 11	Alternative A	8.77	3.29	0	23%
	Alternative B+A	8.77	3.29	0	23%
	Alternative C+A	15.62	5.86	0	41%
	Alternative D+A	8.77	3.29	0	23%

Table 21. Cont. Percent Crash Reduction per Alternative (20-Year Cycle Life)

Location	Package	PDO Crashes (Reduction)	B+C Crashes (Reduction)	K+A Crashes (Reduction)	Total Percent Reduction
Commonwealth Ct to WR 37 WB Ramps at Route 11	Alternative A	0	0	0	0%
	Alternative B+A	0	0	0	0%
	Alternative C+A	5.16	6.88	1.72	37%
	Alternative D+A	0	0	0	0%
WR 37 WB Ramps at Route 11	Alternative A	5.14	5.14	0	22%
	Alternative B+A	5.14	5.14	0	22%
	Alternative C+A	5.14	5.14	0	22%
	Alternative D+A	5.14	5.14	0	22%
WR 37 WB Ramps to Kernstown Blvd/SR 37 EB Ramps at Route 11	Alternative A	0	0	0	0%
	Alternative B+A	0	0	0	0%
	Alternative C+A	0	0	0	0%
	Alternative D+A	0	0	0	0%
Kernstown Blvd/SR 37 EB Ramps at Route 11	Alternative A	19.08	3.18	2.12	22%
	Alternative B+A	19.08	3.18	2.12	22%
	Alternative C+A	19.08	3.18	2.12	22%
	Alternative D+A	19.08	3.18	2.12	22%
Kernstown Blvd/SR 37 EB Ramps to Renaissance Dr. at Route 11	Alternative A	0	0	0	0%
	Alternative B+A	0	0	0	0%
	Alternative C+A	0	0	0	0%
	Alternative D+A	0	0	0	0%
Renaissance Dr. at Route 11	Alternative A	0	0	0	0%
	Alternative B+A	0	0	0	0%
	Alternative C+A	0	0	0	0%
	Alternative D+A	0	0	0	0%

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

8 Improvement Prioritization

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

8.1 Planning Level Cost Estimates

Planning level cost estimates were developed for all the candidate improvement alternatives. The *VDOT Project Cost Estimating System (PCES), Version 7.10* for VDOT Staunton District was used for estimating the project costs. The construction unit costs included in the spreadsheet were inflated at a rate of 4.69% per year to obtain the construction unit costs for the construction year 2027[6]. Construction costs include mobilization, maintenance of traffic and construction engineering and inspection (CEI). In addition to the construction costs, right-of-way/Utilities (ROW) costs were also estimated. ROW costs were estimated at 27.59% of the construction and Preliminary Engineering (PE) cost.

Table 22 below summarizes the planning level cost estimate developed for each of the candidate SYIP improvement alternatives. The cost estimates shown in this table break down the total project costs into Preliminary Engineering (PE) and construction (CN), and ROW. The planning level cost estimates are developed to get a preliminary idea of the funding requirements to implement the projects throughout Route 11 corridor as per the VDOT's Project Cost Estimation System (PCES).

Table 22. Planning Level Cost Estimates (Year 2030 US Dollars)

Alternative/Location	Cost Estimate			
	Preliminary Engineering (PE)	Right-of-Way/Utilities (ROW)	Construction (CN)	Total
ALTERNATIVE B: Geometric improvements on Route 11 between Shawnee Drive and Rubbermaid Entrance	$173,141.00	$321,634.00	$992,623.00	$1,487,398.00
ALTERNATIVE C: Pedestrian, Transit and Access Management Improvements along Route 11	$305,714.00	$559,971.00	$1,786,902.00	$2,652,587.00
ALTERNATIVE D: Innovative Intersection Improvements at Route 11 and Apple Valley Road - Continuous Green - T (CGT) layout	$373,718.00	$728,106.00	$2,265,302.00	$3,367,126.00
			Sum	**$7,507,111.00**

8.2 Planning Level Schedule Estimates

Planning level schedules were developed for all improvement alternatives. Schedule estimates were based on familiarity with complexity of projects within the Staunton District as well as discussions with the SWG. **Table 23** summarizes schedules by phases of project: Preliminary Engineering (PE), ROW and Utility Relocation (ROW) and Construction (CN).

Table 23. Planning Level Schedules (months)

Alternative/Location	Preliminary Engineering (PE)[1]			
	Preliminary Engineering (PE)[1]	Right-of-Way/Utilities (ROW)[3]	Construction (CN)[2]	Total
ALTERNATIVE B: Geometric improvements on Route 11 between Shawnee Drive and Rubbermaid Entrance	12	6	8	26
ALTERNATIVE C: Pedestrian, Transit and Access Management Improvements along Route 11	12	6	12	30
ALTERNATIVE D: Innovative Intersection Improvements at Route 11 and Apple Valley Road - Continuous Green - T (CGT) layout	12	12	8	32

Notes:

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

8.3 Benefit Cost Analysis

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

8.3.1 Operational Benefit

The determination of operational benefit for each improvement alternative was based on the methodology of calculating reduction in travel delay because of the proposed improvements. This methodology converts the vehicle delay into person delays by accounting for the vehicle occupancy. Consistent with the *2009 National Household Travel Survey (NHTS)*[7], average vehicle occupancies of 1.13 and 1.74 were assumed for work trips and non-work trips, respectively, assuming 250 work days per year and 60% of peak hour volumes are work trips.

Similarly, USDOT's *"Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis, 2016"*[8], *Table 4* was used to determine the hourly values for travel time savings for each occupant in a vehicle as $25.40/hour and $13.60/hour for work and non-work trips, respectively.

[6] The inflation rates as per VDOT's Project Cost Estimation System (PCES)
[7] FHWA Report No. FHWA-PL-11-022, Summary of Travel Trends: 2009 National Household Travel Survey
[8] USDOT Guidance: "The Value of Travel Time Savings: Departmental Guidance for Conducting Economic Evaluations, Revision 2 (2016 Update)"

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

Equation 5. Present Value of Benefits (PVB_D)

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

Where,

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

Table 24 shows the delay reduction cost savings per alternative. The detailed calculations are summarized and included in the **Appendix.**

Table 24. Delay Savings Analysis

Alternative	Total Cost Savings
Alternative B	$14,988,848.00
Alternative C	$14,296,648.00
Alternative D	$11,856,548.00

8.3.2 Safety Benefit

As part of the crash analysis, the differences in crashes between the *2050 No-Build* and *Build* conditions were calculated for O, (B+C), and (K+A) crashes over the 20-year life cycle. To further analyze the impact of the proposed alternatives, societal costs were applied to the crash reduction values, as provided by the VDOT Highway Safety Improvement Program (HSIP)[9]. Cost savings per crash type are provided below:

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

Total cost savings per alternative are provided in **Table 25.** Additionally, the breakdown of the crash reduction and cost savings over the 20-year life cycle per intersection is provided in **Table 26** and are provided in **Appendix**.

Table 25. Cost Benefit Analysis (Net Present Value over 20-Year Cycle Life)

Package	PDO (NPV)	B+C (NPV)	K+A (NPV)	Total Cost Savings (NPV)
Alternative A	$ 419,098.00	$ 977,326.00	$ 3,238,835.00	$ 4,635,259.00
Alternative B+A	$ 419,098.00	$ 977,326.00	$ 3,238,835.00	$ 4,635,259.00
Alternative C+A	$ 598,751.00	$ 1,764,040.00	$ 5,179,220.00	$ 7,542,011.00
Alternative D+A	$ 430,141.00	$ 998,828.00	$ 3,238,835.00	$ 4,667,804.00

Table 26. Cost Benefit Analysis Per Intersection (Net Present Value over 20-Year Cycle Life)

Location	Package	PDO (NPV)	B+C (NPV)	K+A (NPV)	Total Cost Savings (NPV)
Battle Park Dr. to Creekside Station/Rubbermaid Entrance at Route 11	Alternative A	$0.00	$0.00	$0.00	$0.00
	Alternative B+A	$0.00	$0.00	$0.00	$0.00
	Alternative C+A	$0.00	$0.00	$0.00	$0.00
	Alternative D+A	$0.00	$0.00	$0.00	$0.00
Creekside Station/Rubbermaid Entrance at Route 11	Alternative A	$24,026.00	$0.00	$1,052,059.00	$1,076,085.00
	Alternative B+A	$24,026.00	$0.00	$1,052,059.00	$1,076,085.00
	Alternative C+A	$40,164.00	$0.00	$1,758,707.00	$1,076,085.00
	Alternative D+A	$24,026.00	$0.00	$1,052,059.00	$1,076,085.00
Creekside Station/Rubbermaid Entrance to Shawnee Dr./Creekside Ln. at Route 11	Alternative A	$0.00	$0.00	$0.00	$0.00
	Alternative B+A	$0.00	$0.00	$0.00	$0.00
	Alternative C+A	$0.00	$0.00	$0.00	$0.00
	Alternative D+A	$0.00	$0.00	$0.00	$0.00
Shawnee Dr./Creekside Ln. at Route 11	Alternative A	$2,990.00	$69,881.00	$0.00	$72,872.00
	Alternative B+A	$2,990.00	$69,881.00	$0.00	$72,872.00
	Alternative C+A	$2,990.00	$69,881.00	$0.00	$72,872.00
	Alternative D+A	$2,990.00	$69,881.00	$0.00	$72,872.00
Shawnee Dr./Creekside Ln. to Apple Valley Rd at Route 11	Alternative A	$0.00	$0.00	$0.00	$0.00
	Alternative B+A	$0.00	$0.00	$0.00	$0.00
	Alternative C+A	$8,766.00	$126,806.00	$0.00	$135,573.00
	Alternative D+A	$0.00	$0.00	$0.00	$0.00

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

Table 26. Cont. Cost Benefit Analysis Per Intersection (Net Present Value over 20-Year Cycle Life)

Location	Package	PDO (NPV)	B+C (NPV)	K+A (NPV)	Total Cost Savings (NPV)
Apple Valley Rd at Route 11	Alternative A	$32,600.00	$63,476.00	$0.00	$96,076.00
	Alternative B+A	$32,600.00	$63,476.00	$0.00	$96,076.00
	Alternative C+A	$67,110.00	$130,670.00	$0.00	$197,780.00
	Alternative D+A	$43,643.00	$84,978.00	$0.00	$128,621.00
Apple Valley Rd to Hood Way at Route 11	Alternative A	$0.00	$0.00	$0.00	$0.00
	Alternative B+A	$0.00	$0.00	$0.00	$0.00
	Alternative C+A	$0.00	$0.00	$0.00	$0.00
	Alternative D+A	$0.00	$0.00	$0.00	$0.00
Hood Way at Route 11	Alternative A	$97,800.00	$126,952.00	$713,741.00	$938,494.00
	Alternative B+A	$97,800.00	$126,952.00	$713,741.00	$938,494.00
	Alternative C+A	$97,800.00	$126,952.00	$713,741.00	$938,494.00
	Alternative D+A	$97,800.00	$126,952.00	$713,741.00	$938,494.00
Hood Way to Commonwealth Ct at Route 11	Alternative A	$0.00	$0.00	$0.00	$0.00
	Alternative B+A	$0.00	$0.00	$0.00	$0.00
	Alternative C+A	$24,923.00	$8,777.00	$38,712.00	$72,414.00
	Alternative D+A	$0.00	$0.00	$0.00	$0.00
Commonwealth Ct at Route 11	Alternative A	$69,550.00	$203,133.00	$0.00	$272,684.00
	Alternative B+A	$69,550.00	$203,133.00	$0.00	$272,684.00
	Alternative C+A	$123,929.00	$361,956.00	$0.00	$485,886.00
	Alternative D+A	$69,550.00	$203,133.00	$0.00	$272,684.00
Commonwealth Ct to WR 37 WB Ramps at Route 11	Alternative A	$0.00	$0.00	$0.00	$0.00
	Alternative B+A	$0.00	$0.00	$0.00	$0.00
	Alternative C+A	$40,937.00	$425,114.00	$1,195,025.00	$1,661,077.00
	Alternative D+A	$0.00	$0.00	$0.00	$0.00
WR 37 WB Ramps at Route 11	Alternative A	$40,750.00	$317,380.00	$0.00	$358,130.00
	Alternative B+A	$40,750.00	$317,380.00	$0.00	$358,130.00
	Alternative C+A	$40,750.00	$317,380.00	$0.00	$358,130.00
	Alternative D+A	$40,750.00	$317,380.00	$0.00	$358,130.00
WR 37 WB Ramps to Kernstown Blvd/SR 37 EB Ramps at Route 11	Alternative A	$0.00	$0.00	$0.00	$0.00
	Alternative B+A	$0.00	$0.00	$0.00	$0.00
	Alternative C+A	$0.00	$0.00	$0.00	$0.00
	Alternative D+A	$0.00	$0.00	$0.00	$0.00

Table 26. Cont. Cost Benefit Analysis Per Intersection (Net Present Value over 20-Year Cycle Life)

Location	Package	PDO (NPV)	B+C (NPV)	K+A (NPV)	Total Cost Savings (NPV)
Kernstown Blvd/SR 37 EB Ramps at Route 11	Alternative A	$151,382.00	$196,504.00	$1,473,035.00	$1,820,922.00
	Alternative B+A	$151,382.00	$196,504.00	$1,473,035.00	$1,820,922.00
	Alternative C+A	$151,382.00	$196,504.00	$1,473,035.00	$1,820,922.00
	Alternative D+A	$151,382.00	$196,504.00	$1,473,035.00	$1,820,922.00
Kernstown Blvd/SR 37 EB Ramps to Renaissance Dr. at Route 11	Alternative A	$0.00	$0.00	$0.00	$0.00
	Alternative B+A	$0.00	$0.00	$0.00	$0.00
	Alternative C+A	$0.00	$0.00	$0.00	$0.00
	Alternative D+A	$0.00	$0.00	$0.00	$0.00
Renaissance Dr. at Route 11	Alternative A	$0.00	$0.00	$0.00	$0.00
	Alternative B+A	$0.00	$0.00	$0.00	$0.00
	Alternative C+A	$0.00	$0.00	$0.00	$0.00
	Alternative D+A	$0.00	$0.00	$0.00	$0.00

8.3.3 Cost of Construction

The 2027 cost estimate for each alternative as summarized in Table 19 was used in the calculation of B/C ratios. The following equation was used to develop the B/C ratios:

Equation 6. Benefit/Cost Ratio (BCR)

$$BCR = PVB/PVC$$

Where,

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

PVC = Present Value of Costs = 2027 cost estimates

Table 27 summarizes the calculated BCR for each of the improvement alternatives.

Table 27. BCR per Improvement Alternative

Alternative	Delay Reduction Benefit (PVB_D)	Safety Benefit (PVB_S)	Present Value of Costs (PVC)	Benefit-Cost Ratio (BCR)
Alternative B	$14,988,848.00	$ 4,635,259.00	$1,487,398.00	8.11
Alternative C	$14,296,648.00	$ 7,542,011.00	$2,652,587.00	6.09
Alternative D	$11,856,548.00	$ 4,667,804.00	$3,367,126.00	3.84

Notes:

1. The PVC value of Alternative A was included for the calculations of BCR ratio for Alternatives B, C and D.

8.3.4 Project Prioritization

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

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

Table 28 summarizes these factors for each improvement alternative proposed by this study.

Table 28. Project Prioritization Criteria

Alternative	B/C Ratio	Safety Improvements	Geometric Improvements	No Anticipated ROW Impacts
Alternative B	8.11	✓	✓	✓
Alternative C	6.09	✓	✓	✓
Alternative D	3.84	✓	✓	✓

Based on the review of the criteria, all the alternatives identified has a Benefit- Cost Ratio higher than one (1) and has a very high effectiveness Therefore, all the following alternatives should be submitted for SMART SCALE or other funding sources:

- Alternative B – Geometric Improvements on Route 11 between Shawnee Drive and Rubbermaid Entrance
- Alternative C – Pedestrian, Transit and Access Management Improvements
- Alternative D – Continuous Green -T at Route 11/Apple Valley Road

The District, in coordination with the localities may choose to advance some or all of these projects at their discretion.